Contents

Preface 13

Extended Library Functions 19
aclcheck(3SEC) 20
aclsord(3SEC) 22
acltmode(3SEC) 23
acltotext(3SEC) 24
acos(3M) 26
acosh(3M) 27
asin(3M) 28
atan2(3M) 29
atan(3M) 30
au_open(3BSM) 31
au_preselect(3BSM) 32
au_to(3BSM) 34
au_user_mask(3BSM) 37
bgets(3GEN) 38
bufsplit(3GEN) 39
cbrt(3M) 40
ceil(3M) 41
config_admin(3CFGADM) 42
ConnectToServer(3DMI) 50
copylist(3GEN) 51
copysign(3M) 52
cos(3M) 53
cosh(3M) 54
cpc(3CPC) 55
cpc_access(3CPC) 57
cpc_bind_event(3CPC) 58
cpc_count_usr_events(3CPC) 64
cpc_event(3CPC) 66
cpc_event_diff(3CPC) 68
cpc_getcpuver(3CPC) 70
cpc_pctx_bind_event(3CPC) 72
cpc_seterrfn(3CPC) 74
cpc_shared_open(3CPC) 76
cpc_strerror(3CPC) 78
cpc_version(3CPC) 81
demangle(3EXT) 82
devid_get(3DEVID) 83
di_binding_name(3DEVINFO) 86
di_child_node(3DEVINFO) 88
di_devnode(3DEVINFO) 90
di_init(3DEVINFO) 91
di_minor_dev(3DEVINFO) 94
di_minor_next(3DEVINFO) 95
di_prom_init(3DEVINFO) 96
di_prom_prop_data(3DEVINFO) 97
di_prom_prop_lookup_bytes(3DEVINFO) 99
di_prop_bytes(3DEVINFO) 101
di_prop_lookup_bytes(3DEVINFO) 103
di_prop_next(3DEVINFO) 105
DisconnectToServer(3DMI) 106
di_walk_minor(3DEVINFO) 107
di_walk_node(3DEVINFO) 109
DmiAddComponent(3DMI) 111
DmiAddRow(3DMI) 115
dmi_error(3DMI) 120
DmiGetConfig(3DMI) 121
DmiListAttributes(3DMI) 124
DmiRegisterCi(3DMI) 129
eac_error(3EXACCT) 131
eac_open(3EXACCT) 132
eac_pack_object(3EXACCT) 134
Contents

ea_set_item(3EXACCT) 138
elf32_checksum(3ELF) 140
elf32_fsize(3ELF) 141
elf32_getehdr(3ELF) 142
elf32_getphdr(3ELF) 144
elf32_getshdr(3ELF) 146
elf32_xlateto(3ELF) 147
elf(3ELF) 149
elf_begin(3ELF) 155
elf_cntl(3ELF) 160
elf_errmsg(3ELF) 162
elf_fill(3ELF) 163
elf_flagdata(3ELF) 164
elf_getarhdr(3ELF) 166
elf_getarsym(3ELF) 168
elf_getbase(3ELF) 169
elf_getdata(3ELF) 170
elf_getident(3ELF) 174
elf_getscn(3ELF) 176
elf_hash(3ELF) 178
elf_kind(3ELF) 179
elf_rawfile(3ELF) 180
elf_strptr(3ELF) 181
elf_update(3ELF) 182
elf_version(3ELF) 186
erf(3M) 187
exp(3M) 188
expm1(3M) 189
fabs(3M) 190
floor(3M) 191
fmod(3M) 192
freeDmiString(3DMI) 193
gelf(3ELF) 194
getacinfo(3BSM) 199
getauclassent(3BSM) 201
getauditflags(3BSM) 203
getauevent(3BSM) 204
getauthattr(3SECDB) 206
<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>getauusername(3BSM)</td>
<td>209</td>
</tr>
<tr>
<td>getexecattr(3SECDB)</td>
<td>211</td>
</tr>
<tr>
<td>getfauditflags(3BSM)</td>
<td>214</td>
</tr>
<tr>
<td>getprofattr(3SECDB)</td>
<td>215</td>
</tr>
<tr>
<td>getprojent(3EXACCT)</td>
<td>217</td>
</tr>
<tr>
<td>getuserattr(3SECDB)</td>
<td>221</td>
</tr>
<tr>
<td>gmatch(3GEN)</td>
<td>223</td>
</tr>
<tr>
<td>hypot(3M)</td>
<td>224</td>
</tr>
<tr>
<td>ilogb(3M)</td>
<td>225</td>
</tr>
<tr>
<td>isencrypt(3GEN)</td>
<td>226</td>
</tr>
<tr>
<td>isnan(3M)</td>
<td>227</td>
</tr>
<tr>
<td>j0(3M)</td>
<td>228</td>
</tr>
<tr>
<td>kstat(3EXT)</td>
<td>229</td>
</tr>
<tr>
<td>kstat(3KSTAT)</td>
<td>231</td>
</tr>
<tr>
<td>kstat_chain_update(3KSTAT)</td>
<td>237</td>
</tr>
<tr>
<td>kstat_lookup(3KSTAT)</td>
<td>238</td>
</tr>
<tr>
<td>kstat_open(3KSTAT)</td>
<td>239</td>
</tr>
<tr>
<td>kstat_read(3KSTAT)</td>
<td>240</td>
</tr>
<tr>
<td>kva_match(3SECDB)</td>
<td>241</td>
</tr>
<tr>
<td>kvm_getu(3KVM)</td>
<td>242</td>
</tr>
<tr>
<td>kvm_nextproc(3KVM)</td>
<td>244</td>
</tr>
<tr>
<td>kvm_nlist(3KVM)</td>
<td>246</td>
</tr>
<tr>
<td>kvm_open(3KVM)</td>
<td>247</td>
</tr>
<tr>
<td>kvm_read(3KVM)</td>
<td>249</td>
</tr>
<tr>
<td>lgamma(3M)</td>
<td>251</td>
</tr>
<tr>
<td>libdevinfo(3DEVINFO)</td>
<td>253</td>
</tr>
<tr>
<td>libnvpair(3NVPAIR)</td>
<td>256</td>
</tr>
<tr>
<td>libpicl(3PICL)</td>
<td>257</td>
</tr>
<tr>
<td>libpicltree(3PICLTREE)</td>
<td>260</td>
</tr>
<tr>
<td>libtnfctl(3TNF)</td>
<td>263</td>
</tr>
<tr>
<td>log10(3M)</td>
<td>268</td>
</tr>
<tr>
<td>log1p(3M)</td>
<td>269</td>
</tr>
<tr>
<td>log(3M)</td>
<td>270</td>
</tr>
<tr>
<td>logb(3M)</td>
<td>271</td>
</tr>
<tr>
<td>maillock(3MAIL)</td>
<td>272</td>
</tr>
<tr>
<td>matherr(3M)</td>
<td>274</td>
</tr>
<tr>
<td>m_create_layout(3LAYOUT)</td>
<td>280</td>
</tr>
<tr>
<td>md5(3EXT)</td>
<td>282</td>
</tr>
</tbody>
</table>
Contents
sqrt(3M) 492
SSAgentIsAlive(3SNMP) 493
SSAOidCmp(3SNMP) 496
SSAStringCpy(3SNMP) 498
strccpy(3GEN) 499
strfind(3GEN) 501
sysevent_free(3SYSEVENT) 502
sysevent_get_attr_list(3SYSEVENT) 503
sysevent_get_class_name(3SYSEVENT) 504
sysevent_get_vendor_name(3SYSEVENT) 506
sysevent_post_event(3SYSEVENT) 508
tan(3M) 510
tanh(3M) 511
tnfctl_buffer_alloc(3TNF) 512
tnfctl_close(3TNF) 514
tnfctl_indirect_open(3TNF) 516
tnfctl_internal_open(3TNF) 519
tnfctl_kernel_open(3TNF) 521
tnfctl_pid_open(3TNF) 522
tnfctl_probe_apply(3TNF) 527
tnfctl_probe_state_get(3TNF) 530
tnfctl_register_funcs(3TNF) 534
tnfctl_strerror(3TNF) 535
tnfctl_trace_attrs_get(3TNF) 536
tnfctl_trace_state_set(3TNF) 538
TNF_DECLARE_RECORD(3TNF) 540
TNF_PROBE(3TNF) 543
tnf_process_disable(3TNF) 548
tracing(3TNF) 550
volmgt_acquire(3VOLMGT) 554
volmgt_check(3VOLMGT) 557
volmgt_feature_enabled(3VOLMGT) 559
volmgt_inuse(3VOLMGT) 560
volmgt_owenspath(3VOLMGT) 561
volmgt_release(3VOLMGT) 562
volmgt_root(3VOLMGT) 563
volmgt_running(3VOLMGT) 564
volmgt_symname(3VOLMGT) 565
wsreg_add_child_component(3WSREG) 567
wsreg_add_compatible_version(3WSREG) 569
wsreg_add_dependent_component(3WSREG) 571
wsreg_add_display_name(3WSREG) 573
wsreg_add_required_component(3WSREG) 575
wsreg_can_access_registry(3WSREG) 577
wsreg_clone_component(3WSREG) 579
wsreg_components_equal(3WSREG) 580
wsreg_create_component(3WSREG) 581
wsreg_get(3WSREG) 582
wsreg_initialize(3WSREG) 583
wsreg_query_create(3WSREG) 584
wsreg_query_set_id(3WSREG) 585
wsreg_query_set_instance(3WSREG) 586
wsreg_query_set_location(3WSREG) 587
wsreg_query_set_unique_name(3WSREG) 588
wsreg_query_set_version(3WSREG) 589
wsreg_register(3WSREG) 590
wsreg_set_data(3WSREG) 592
wsreg_set_id(3WSREG) 594
wsreg_set_instance(3WSREG) 595
wsreg_set_location(3WSREG) 597
wsreg_set_parent(3WSREG) 598
wsreg_set_type(3WSREG) 599
wsreg_set_uninstaller(3WSREG) 600
wsreg_set_unique_name(3WSREG) 601
wsreg_set_vendor(3WSREG) 602
wsreg_set_version(3WSREG) 603
wsreg_unregister(3WSREG) 604
y0(3M) 606

Index 607
Preface

Both novice users and those familiar with the SunOS operating system can use online man pages to obtain information about the system and its features. A man page is intended to answer concisely the question “What does it do?” The man pages in general comprise a reference manual. They are not intended to be a tutorial.

Overview

The following contains a brief description of each man page section and the information it references:

- Section 1 describes, in alphabetical order, commands available with the operating system.
- Section 1M describes, in alphabetical order, commands that are used chiefly for system maintenance and administration purposes.
- Section 2 describes all of the system calls. Most of these calls have one or more error returns. An error condition is indicated by an otherwise impossible returned value.
- Section 3 describes functions found in various libraries, other than those functions that directly invoke UNIX system primitives, which are described in Section 2.
- Section 4 outlines the formats of various files. The C structure declarations for the file formats are given where applicable.
- Section 5 contains miscellaneous documentation such as character-set tables.
- Section 6 contains available games and demos.
- Section 7 describes various special files that refer to specific hardware peripherals and device drivers. STREAMS software drivers, modules and the STREAMS-generic set of system calls are also described.
- Section 9 provides reference information needed to write device drivers in the kernel environment. It describes two device driver interface specifications: the Device Driver Interface (DDI) and the Driver/Kernel Interface (DKI).
- Section 9E describes the DDI/DKI, DDI-only, and DKI-only entry-point routines a developer can include in a device driver.
- Section 9F describes the kernel functions available for use by device drivers.
- Section 9S describes the data structures used by drivers to share information between the driver and the kernel.

Below is a generic format for man pages. The man pages of each manual section generally follow this order, but include only needed headings. For example, if there are no bugs to report, there is no BUGS section. See the intro pages for more information and detail about each section, and man(1) for more information about man pages in general.

NAME

This section gives the names of the commands or functions documented, followed by a brief description of what they do.

SYNOPSIS

This section shows the syntax of commands or functions. When a command or file does not exist in the standard path, its full path name is shown. Options and arguments are alphabetized, with single letter arguments first, and options with arguments next, unless a different argument order is required.

The following special characters are used in this section:

[ ] Brackets. The option or argument enclosed in these brackets is optional. If the brackets are omitted, the argument must be specified.

... Ellipses. Several values can be provided for the previous argument, or the previous argument can be specified multiple times, for example, "filename ...".

| Separator. Only one of the arguments separated by this character can be specified at a time.

{ } Braces. The options and/or arguments enclosed within braces are interdependent, such that everything enclosed must be treated as a unit.
PROTOCOL  This section occurs only in subsection 3R to indicate the protocol description file.

DESCRIPTION  This section defines the functionality and behavior of the service. Thus it describes concisely what the command does. It does not discuss OPTIONS or cite EXAMPLES. Interactive commands, subcommands, requests, macros, and functions are described under USAGE.

IOCTL  This section appears on pages in Section 7 only. Only the device class that supplies appropriate parameters to the ioctl(2) system call is called ioctl and generates its own heading. ioctl calls for a specific device are listed alphabetically (on the man page for that specific device). ioctl calls are used for a particular class of devices all of which have an io ending, such as mtcio(7I).

OPTIONS  This section lists the command options with a concise summary of what each option does. The options are listed literally and in the order they appear in the SYNOPSIS section. Possible arguments to options are discussed under the option, and where appropriate, default values are supplied.

OPERANDS  This section lists the command operands and describes how they affect the actions of the command.

OUTPUT  This section describes the output – standard output, standard error, or output files – generated by the command.

RETURN VALUES  If the man page documents functions that return values, this section lists these values and describes the conditions under which they are returned. If a function can return only constant values, such as 0 or –1, these values are listed in tagged paragraphs. Otherwise, a single paragraph describes the return values of each function. Functions declared void do not return values, so they are not discussed in RETURN VALUES.

ERRORS  On failure, most functions place an error code in the global variable errno indicating why they failed. This section lists alphabetically all error codes a function can generate and describes the conditions that cause each error. When more than
one condition can cause the same error, each condition is described in a separate paragraph under the error code.

**USAGE**

This section lists special rules, features, and commands that require in-depth explanations. The subsections listed here are used to explain built-in functionality:

- Commands
- Modifiers
- Variables
- Expressions
- Input Grammar

**EXAMPLES**

This section provides examples of usage or of how to use a command or function. Wherever possible a complete example including command-line entry and machine response is shown. Whenever an example is given, the prompt is shown as `example%`, or if the user must be superuser, `example#`. Examples are followed by explanations, variable substitution rules, or returned values. Most examples illustrate concepts from the SYNOPSIS, DESCRIPTION, OPTIONS, and USAGE sections.

**ENVIRONMENT VARIABLES**

This section lists any environment variables that the command or function affects, followed by a brief description of the effect.

**EXIT STATUS**

This section lists the values the command returns to the calling program or shell and the conditions that cause these values to be returned. Usually, zero is returned for successful completion, and values other than zero for various error conditions.

**FILES**

This section lists all file names referred to by the man page, files of interest, and files created or required by commands. Each is followed by a descriptive summary or explanation.

**ATTRIBUTES**

This section lists characteristics of commands, utilities, and device drivers by defining the attribute type and its corresponding value. See attributes(5) for more information.

**SEE ALSO**

This section lists references to other man pages, in-house documentation, and outside publications.
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAGNOSTICS</td>
<td>This section lists diagnostic messages with a brief explanation of the condition causing the error.</td>
</tr>
<tr>
<td>WARNINGS</td>
<td>This section lists warnings about special conditions which could seriously affect your working conditions. This is not a list of diagnostics.</td>
</tr>
<tr>
<td>NOTES</td>
<td>This section lists additional information that does not belong anywhere else on the page. It takes the form of an aside to the user, covering points of special interest. Critical information is never covered here.</td>
</tr>
<tr>
<td>BUGS</td>
<td>This section describes known bugs and, wherever possible, suggests workarounds.</td>
</tr>
</tbody>
</table>
Extended Library Functions
NAME
aclcheck – check the validity of an ACL

SYNOPSIS
cc [... flag ...] file [... -lsec [... library ...]]
#include <sys/acl.h>

int aclcheck(aclent_t *aclbufp, int nentries, int *which);

DESCRIPTION
The aclcheck() function checks the validity of an ACL pointed to by aclbufp. The
nentries argument is the number of entries contained in the buffer. The which
parameter returns the index of the first entry that is invalid.

The function verifies that an ACL pointed to by aclbufp is valid according to the
following rules:

- There must be exactly one GROUP_OBJ ACL entry.
- There must be exactly one USER_OBJ ACL entry.
- There must be exactly one OTHER_OBJ ACL entry.
- If there are any GROUP ACL entries, then the group ID in each group ACL entry
  must be unique.
- If there are any USER ACL entries, then the user ID in each user ACL entry must be
  unique.
- If there are any GROUP or USER ACL entries, then there must be exactly one
  CLASS_OBJ (ACL mask) entry.
- If there are any default ACL entries, then the following apply:
  - There must be exactly one default GROUP_OBJ ACL entry.
  - There must be exactly one default OTHER_OBJ ACL entry.
  - There must be exactly one default USER_OBJ ACL entry.
  - If there are any DEF_GROUP entries, then the group ID in each DEF_GROUP ACL
    entry must be unique.
  - If there are any DEF_USER entries, then the user ID in each DEF_USER ACL
    entry must be unique.
  - If there are any DEF_GROUP or DEF_USER entries, then there must be exactly
    one DEF_CLASS_OBJ (default ACL mask) entry.
- If any of the above rules are violated, then the function fails with errno set to
  EINVAL.

RETURN VALUES
If the ACL is valid, aclcheck() will return 0. Otherwise errno is set to EINVAL and
return code is set to one of the following:

GRP_ERROR There is more than one GROUP_OBJ or
    DEF_GROUP_OBJ ACL entry.

USER_ERROR There is more than one USER_OBJ or DEF_USER_OBJ
    ACL entry.

CLASS_ERROR There is more than one CLASS_OBJ (ACL mask) or
    DEF_CLASS_OBJ (default ACL mask) entry.
OTHER_ERROR

There is more than one OTHER_OBJ or DEF_OTHER_OBJ ACL entry.

DUPLICATE_ERROR

Duplicate entries of USER, GROUP, DEF_USER, or DEF_GROUP.

ENTRY_ERROR

The entry type is invalid.

MISS_ERROR

Missing an entry. The which parameter returns −1 in this case.

MEM_ERROR

The system cannot allocate any memory. The which parameter returns −1 in this case.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO

acl(2), aclsort(3SEC)
NAME
aclsort - sort an ACL

SYNOPSIS
cc [ flag ... ] file ... -lsec [ library ... ]
#include <sys/acl.h>

int aclsort(int nentries, int calclass, aclent_t *aclbufp);

DESCRIPTION
The aclbufp argument points to a buffer containing ACL entries. The nentries argument specifies the number of ACL entries in the buffer. The calclass argument, if non-zero, indicates that the CLASS_OBJ (ACL mask) permissions should be recalculated. The union of the permission bits associated with all ACL entries in the buffer other than CLASS_OBJ, OTHER_OBJ, and USER_OBJ is calculated. The result is copied to the permission bits associated with the CLASS_OBJ entry.

The aclsort() function sorts the contents of the ACL buffer as follows:

- Entries will be in the order USER_OBJ, USER, GROUP_OBJ, GROUP, CLASS_OBJ (ACL mask), OTHER_OBJ, DEF_USER_OBJ, DEF_USER, DEF_GROUP_OBJ, DEF_GROUP, DEF_CLASS_OBJ (default ACL mask), and DEF_OTHER_OBJ.

- Entries of type USER, GROUP, DEF_USER, and DEF_GROUP will be sorted in increasing order by ID.

The aclsort() function will succeed if all of the following are true:

- There is exactly one entry each of type USER_OBJ, GROUP_OBJ, CLASS_OBJ (ACL mask), and OTHER_OBJ.

- There is exactly one entry each of type DEF_USER_OBJ, DEF_GROUP_OBJ, DEF_CLASS_OBJ (default ACL mask), and DEF_OTHER_OBJ if there are any default entries.

- Entries of type USER, GROUP, DEF_USER, or DEF_GROUP may not contain duplicate entries. A duplicate entry is one of the same type containing the same numeric ID.

RETURN VALUES
Upon successful completion, the function returns 0. Otherwise, it returns -1.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO
acl(2), aclcheck(3SEC)
acltomode, aclfrommode – convert an ACL to or from permission bits

SYNOPSIS

ce [ flag ... ] file ... -lsec [ library ... ]
#include <sys/types.h>
#include <sys/acl.h>

int acltomode(aclent_t *aclbufp, int nentries, mode_t *modep);
int aclfrommode(aclent_t *aclbufp, int nentries, mode_t *modep);

DESCRIPTION

The acltomode() function converts an ACL pointed to by aclbufp into the permission bits buffer pointed to by modep. If the USER_OBJ ACL entry, GROUP_OBJ ACL entry, or the OTHER_OBJ ACL entry cannot be found in the ACL buffer, then the function fails with errno set to EINVAL.

The USER_OBJ ACL entry permission bits are copied to the file owner permission bits in the permission bits buffer. The OTHER_OBJ ACL entry permission bits are copied to the file other permission bits in the permission bits buffer. If there is a CLASS_OBJ (ACL mask) entry, then the CLASS_OBJ ACL entry permission bits are intersected (bitwise AND) with the GROUP_OBJ ACL entry permission bits and the result is copied to the file group permission bits in the permission bits buffer. Otherwise, the GROUP_OWNER ACL entry permission bits are copied to the file group permission bits in the permission bits buffer.

The aclfrommode() function converts the permission bits pointed to by modep into an ACL pointed to by aclbufp. If the USER_OBJ ACL entry, GROUP_OBJ ACL entry, or the OTHER_OBJ ACL entry cannot be found in the ACL buffer, then the function fails with errno set to EINVAL.

The file owner permission bits from the permission bits buffer are copied to the USER_OBJ ACL entry. The file other permission bits from the permission bits buffer are copied to the OTHER_OBJ ACL entry. The file group permissions bits from the permission bits buffer are copied to the CLASS_OBJ (ACL mask) entry, if available, and to the GROUP_OBJ ACL entry.

The nentries argument represents the number of ACL entries in the buffer pointed to by aclbufp.

RETURN VALUES

Upon successful completion, the function returns 0. Otherwise, it returns -1 and sets errno to indicate the error.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
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<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO

acl(2)
acltotext(3SEC)

NAME
      acltotext, aclfromtext – convert internal representation to or from external representation

SYNOPSIS
      cc [ flag ... ] file ... -lssec [ library ... ]
      #include <sys/acl.h>
      char *acltotext(aclent_t *aclbufp, int aclcnt);
      aclent_t *aclfromtext(char *acltextp, int *aclcnt);

DESCRIPTION
      The acltotext() function converts an internal ACL representation pointed to by
      aclbufp into an external ACL representation. The space for the external text string is
      obtained using malloc(3C). The caller is responsible for freeing the space upon
      completion.

      The aclfromtext() function converts an external ACL representation pointed to by
      acltextp into an internal ACL representation. The space for the list of ACL entries is
      obtained using malloc(3C). The caller is responsible for freeing the space upon
      completion. The aclcnt argument indicates the number of ACL entries found.

      An external ACL representation is defined as follows:
      
      <acl_entry>[,<acl_entry>]...

      Each <acl_entry> contains one ACL entry. The external representation of an ACL entry
      contains two or three colon-separated fields. The first field contains the ACL entry tag
      type. The entry type keywords are defined as:

      user       This ACL entry with no UID specified in the ACL entry ID field
                  specifies the access granted to the owner of the object. Otherwise,
                  this ACL entry specifies the access granted to a specific user-name
                  or user-id number.

      group      This ACL entry with no GID specified in the ACL entry ID field
                  specifies the access granted to the owning group of the object.
                  Otherwise, this ACL entry specifies the access granted to a specific
                  group-name or group-id number.

      other      This ACL entry specifies the access granted to any user or group
                  that does not match any other ACL entry.

      mask       This ACL entry specifies the maximum access granted to user or
                  group entries.

      default:user This ACL entry with no uid specified in the ACL entry ID field
                  specifies the default access granted to the owner of the object.
                  Otherwise, this ACL entry specifies the default access granted to a
                  specific user-name or user-ID number.

      default:group This ACL entry with no gid specified in the ACL entry ID field
                  specifies the default access granted to the owning group of the
                  object.

      This ACL entry with no gid specified in the ACL entry ID field
                  specifies the default access granted to the owning group of the
                  object.

      This ACL entry with no uid specified in the ACL entry ID field
                  specifies the default access granted to the owner of the object.
                  Otherwise, this ACL entry specifies the default access granted to a
                  specific user-name or user-ID number.

      This ACL entry with no gid specified in the ACL entry ID field
                  specifies the default access granted to the owning group of the
                  object.

      This ACL entry with no uid specified in the ACL entry ID field
                  specifies the default access granted to the owner of the object.
                  Otherwise, this ACL entry specifies the default access granted to a
                  specific user-name or user-ID number.
object. Otherwise, this ACL entry specifies the default access granted to a specific group-name or group-ID number.

default:other  This ACL entry specifies the default access for other entry.
default:mask   This ACL entry specifies the default access for mask entry.

The second field contains the ACL entry ID, as follows:

uid       This field specifies a user-name, or user-ID if there is no user-name associated with the user-ID number.
gid      This field specifies a group-name, or group-ID if there is no group-name associated with the group-ID number.
empty   This field is used by the user and group ACL entry types.

The third field contains the following symbolic discretionary access permissions:

r       read permission
w       write permission
x       execute/search permission
−       no access

RETURN VALUES
Upon successful completion, the acltotext() function returns a pointer to a text string. Otherwise, it returns NULL.

Upon successful completion, the aclfromtext() function returns a pointer to a list of ACL entries. Otherwise, it returns NULL.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO acl(2), malloc(3C)
acos(3M)

NAME
acos – arc cosine function

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double acos(double x);

DESCRIPTION
The acos() function computes the principal value of the arc cosine of x. The value of x
should be in the range [-1,1].

RETURN VALUES
Upon successful completion, acos() returns the arc cosine of x, in the range [0,pi]
radians. If the value of x is not in the range [-1,1], and is not ±Inf or NaN, either 0.0 or
NaN is returned and errno is set to EDOM.

If x is NaN, NaN is returned. If x is ±Inf, either 0.0 is returned and errno is set to
EDOM, or NaN is returned and errno may be set to EDOM.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by
Standards other than XPG4.

ERRORS
The acos() function will fail if:
EDOM The value x is not ±Inf or NaN and is not in the range [-1,1].

The acos() function may fail if:
EDOM The value x is ±Inf.

USAGE
An application wishing to check for error situations should set errno to 0 before
calling acos(). If errno is non-zero on return, or the value NaN is returned, an error
has occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
 cos(3M), isnan(3M), matherr(3M), attributes(5), standards(5)
The acosh(), asinh() and atanh() functions compute the inverse hyperbolic cosine, sine, and tangent of their argument, respectively.

The acosh() function returns NaN and sets errno to EDOM when its argument is less than 1.0.

The atanh() function returns NaN and sets errno to EDOM when its argument has absolute value greater than 1.0.

The atanh() function returns ±Inf and sets errno to ERANGE when its argument is ±1.0.

If x is NaN, the asinh(), acosh() and atanh() functions return NaN.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

The acosh() function will fail if:

EDOM The x argument is less than 1.0.

The atanh() function will fail if:

EDOM The x argument has an absolute value greater than 1.0.
ERANGE The x argument has an absolute value equal to 1.0.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also: cosh(3M), matherr(3M), sinh(3M), tanh(3M), attributes(5), standards(5)
The `asin()` function computes the principal value of the arc sine of `x`. The value of `x` should be in the range \([-1,1]\).

Upon successful completion, `asin()` returns the arc sine of `x`, in the range \([-\pi/2,\pi/2]\) radians. If the value of `x` is not in the range \([-1,1]\) and is not ±Inf or NaN, either 0.0 or NaN is returned and `errno` is set to `EDOM`.

If `x` is NaN, NaN is returned.

If `x` is ±Inf, either 0.0 is returned and `errno` is set to `EDOM` or NaN is returned and `errno` may be set to `EDOM`.

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by Standards other than XPG4.

The `asin()` function will fail if:

**EDOM** The value `x` is not ±Inf or NaN and is not in the range \([-1,1]\).

The `asin()` function may fail if:

**EDOM** The value of `x` is ±Inf.

An application wishing to check for error situations should set `errno` to 0, then call `asin()`. If `errno` is non-zero on return, or the return value is NaN, an error has occurred.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also `isnan(3M), matherr(3M), sin(3M), attributes(5), standards(5)`
atan2 – arc tangent function

cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double atan2(double y, double x);

The `atan2()` function computes the principal value of the arc tangent of \( y/x \), using the signs of both arguments to determine the quadrant of the return value.

Upon successful completion, `atan2()` returns the arc tangent of \( y/x \) in the range \([-\pi,\pi]\) radians. If both arguments are 0.0, 0.0 is returned and `errno` may be set to `EDOM`.

If `x` or `y` is NaN, NaN is returned.

In IEEE 754 mode `atan2()` handles the following exceptional arguments in the spirit of ANSI/IEEE Std 754-1985.

- `atan2(\pm 0, x)` returns \( \pm 0 \) for \( x > 0 \) or \( x = +0 \);
- `atan2(\pm 0, x)` returns \( \pm \pi \) for \( x < 0 \) or \( x = -0 \);
- `atan2(y, \pm 0)` returns \( \pm \pi/2 \) for \( y > 0 \);
- `atan2(y, \pm 0)` returns \( \pm \pi/2 \) for \( y < 0 \);
- `atan2(\pm y, \text{Inf})` returns \( \pm 0 \) for finite \( y > 0 \);
- `atan2(\pm \text{Inf}, x)` returns \( \pm \pi/2 \) for finite \( x \);
- `atan2(\pm y, -\text{Inf})` returns \( \pm \pi \) for finite \( y > 0 \);
- `atan2(\pm \text{Inf}, \text{Inf})` returns \( \pm \pi/4 \);
- `atan2(\pm \text{Inf}, -\text{Inf})` returns \( \pm 3\pi/4 \).

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by Standards other than XPG4.

The `atan2()` function may fail if:

- `EDOM` Both arguments are 0.0.

An application wishing to check for error situations should set `errno` to 0 before calling `atan2()`. If `errno` is non-zero on return, or the return value is NaN, an error has occurred.

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

`atan(3M), isnan(3M), matherr(3M), tan(3M), attributes(5), standards(5)`
atan(3M)

NAME atan – arc tangent function

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double atan(double x);

DESCRIPTION The atan() function computes the principal value of the arc tangent of x.

RETURN VALUES Upon successful completion, atan() returns the arc tangent of x in the range
[-pi/2,pi/2] radians.

If x is NaN, NaN is returned.

If x is ±Inf, ±pi/2 is returned.

ERRORS No errors will occur.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO atan2(3M), isnan(3M), tan(3M), attributes(5)
au_open(3BSM)

NAME
au_open, au_close, au_write – construct and write audit records

SYNOPSIS
cc [ flag ... ] file ... -lbsm -lsocket -lnsl -lintl [ library ... ]
#include <bsm/libbsm.h>

int au_close(int d, int keep, short event);
int au_open(void);
int au_write(int d, token_t *m);

DESCRIPTION
au_open() returns an audit record descriptor to which audit tokens can be written
using au_write(). The audit record descriptor is an integer value that identifies a
storage area where audit records are accumulated.

au_close() terminates the life of an audit record d of type event started by
au_open(). If the keep parameter is zero, the data contained therein is discarded and
the memory used is given up by calling free(3C). Otherwise, the additional
parameters are used to create a header token. Depending on the audit policy
information obtained by auditon(2), additional tokens such as sequence and trailer
tokens may be added to the record. au_close() finally writes the record to the audit
trail by calling audit(2).

au_write() adds the audit token pointed to by m to the audit record identified by
the descriptor d. After this call is made the audit token is no longer available to the
caller.

RETURN VALUES
A successful invocation of au_write() and au_close() will return a 0.

A successful invocation of au_open() returns an audit record descriptor. au_open()
returns -1 if a descriptor could not be allocated. au_write() returns -1 if d is not a
valid descriptor or if audit(2) experienced an error. errno is set to indicate the error.
au_write() will return -1 if d is an invalid descriptor or if m is an invalid token.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
bsmconv(1M), audit(2), auditon(2), au_preselect(3BSM), au_to(3BSM),
free(3C), attributes(5)

NOTES
The functionality described in this man page is available only if the Basic Security
Module (BSM) has been enabled. See bsmconv(1M) for more information.
au_preselect(3BSM)

NAME
au_preselect – preselect an audit event

SYNOPSIS
e e [ flag ... ] file ... -l bsm -l socket -lnsl -l intl [ library ... ]
#include <bsm/libbsm.h>

int au_preselect(au_event_t event, au_mask_t *mask_p, int sorf, int flag);

DESCRIPTION
au_preselect() determines whether or not the audit event event is preselected against the binary preselection mask pointed to by mask_p (usually obtained by a call to getaudit(2)). au_preselect() looks up the classes associated with event in audit_event(4) and compares them with the classes in mask_p. If the classes associated with event match the classes in the specified portions of the binary preselection mask pointed to by mask_p, the event is said to be preselected.

sorf indicates whether the comparison is made with the success portion, the failure portion or both portions of the mask pointed to by mask_p.

The following are the valid values of sorf:

AU_PRS_SUCCESS Compare the event class with the success portion of the preselection mask.

AU_PRS_FAILURE Compare the event class with the failure portion of the preselection mask.

AU_PRS_BOTH Compare the event class with both the success and failure portions of the preselection mask.

flag tells au_preselect() how to read the audit_event(4) database. Upon initial invocation, au_preselect() reads the audit_event(4) database and allocates space in an internal cache for each entry with malloc(3C). In subsequent invocations, the value of flag determines where au_preselect() obtains audit event information. The following are the valid values of flag:

AU_PRS_REREAD Get audit event information by searching the audit_event(4) database.

AU_PRS_USECACHE Get audit event information from internal cache created upon the initial invocation. This option is much faster.

RETURN VALUES
au_preselect() returns:
0 event is not preselected.
1 event is preselected.
-1 An error occurred. au_preselect() couldn’t allocate memory or couldn’t find event in the audit_event(4) database.

FILES
/etc/security/audit_class maps audit class number to audit class names and descriptions
ATTRIBUTES

See attributes(5) for a description of the following attributes:

<table>
<thead>
<tr>
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</table>

SEE ALSO

bsmconv(1M), getaudit(2), au_open(3BSM), getauclassent(3BSM),
getauevent(3BSM), malloc(3C), audit_class(4), audit_event(4),
attributes(5)

NOTES

au_preselect() is normally called prior to constructing and writing an audit record. If the event is not preselected, the overhead of constructing and writing the record can be saved.

The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See bsmconv(1M) for more information.
**NAME**
au_to, au_to_arg, au_to_attr, au_to_data, au_to_groups, au_to_in_addr, au_to_ipc,
au_to_ipc_perm, au_to_iport, au_to_me, au_to_new_in_addr, au_to_new_process,
au_to_new_socket, au_to_new_subject, au_to_opaque, au_to_path, au_to_process,
au_to_return, au_to_socket, au_to_subject, au_to_text – create audit record tokens

**SYNOPSIS**
cc [ flag ...] file ... -lbsm -lsocket -lnsl -lintl [ library ...]
#include <sys/types.h>
#include <sys/vnode.h>
#include <netinet/in.h>
#include <bsm/libbsm.h>
token_t *au_to_arg(char n, char *text, u_long v);
token_t *au_to_attr(struct vattr *attr);
token_t *au_to_cmd(u_long argc, char **argv, char **envp);
token_t *au_to_data(char unit_print, char unit_type, char unit_count,
    char *p);
token_t *au_to_groups(int *groups);
token_t *au_to_in_addr(struct inaddr *internet_addr);
token_t *au_to_new_in_addr(struct inaddr *internet_addr);
token_t *au_to_iport(u_short_t iport);
token_t *au_to_ipc(int id);
token_t *au_to_ipc_perm(struct ipc_perm *perm);
token_t *au_to_iport(u_short_t iport);
token_t *au_to_me(void);
token_t *au_to_newgroups(int n, int *groups);
token_t *au_to_opaque(char *data, short bytes);
token_t *au_to_path(char *path);
token_t *au_to_process(au_id_t auid, uid_t euid, gid_t egid, uid_t
    ruid, gid_t rgid, pid_t pid, au_asid_t sid, au_tid_t *tid);
token_t *au_to_new_process(au_id_t auid, uid_t euid, gid_t egid,
    uid_t ruid, gid_t rgid, pid_t pid, au_asid_t sid, au_tid_addr_t
    *tid);
token_t *au_to_return(char number, uint_t value);
token_t *au_to_socket(struct socket *so);
token_t *au_to_new_socket(struct socket *so);
token_t *au_to_subject(au_id_t auid, uid_t euid, gid_t egid, uid_t
    ruid, gid_t rgid, pid_t pid, au_asid_t sid, au_tid_t *tid);
The `au_to_arg()` function formats the data in v into an “argument token.” The n argument indicates the argument number. The text argument is a null terminated string describing the argument.

The `au_to_attr()` function formats the data pointed to by attr into a “vnode attribute token.”

The `au_to_data()` function formats the data pointed to by p into an “arbitrary data token.” The unit_print parameter determines the preferred display base of the data and is one of AUP_BINARY, AUP_OCTAL, AUP_DECIMAL, AUP_HEX, or AUP_STRING. The unit_type parameter defines the basic unit of data and is one of AUR_BYTE, AUR_CHAR, AUR_SHORT, AUR_INT, or AUR_LONG. The unit_count parameter specifies the number of basic data units to be used and must be positive.

The `au_to_groups()` function formats the array of 16 integers pointed to by groups into a “groups token.”

The `au_to_in_addr()` function formats the data pointed to by internet_addr into an “internet address token.”

The `au_to_ipc()` function formats the data in the id parameter into an “interprocess communications ID token.”

The `au_to_ipc_perm()` function formats the data pointed to by perm into an “interprocess communications permission token.”

The `au_to_iport()` function formats the data pointed to by iport into an “ip port address token.”

The `au_to_me()` function collects audit information from the current process and creates a “subject token” by calling `au_to_subject()`.

The `au_to_newgroups()` function formats the array of n integers pointed to by groups into a “newgroups token.”

The `au_to_subject()` function formats an auid (audit user ID), an euid (effective user ID), an egid (effective group ID), a ruid (real user ID), an rgid (real group ID), a pid (process ID), an sid (audit session ID), an tid (audit terminal ID), into a “subject token.”
The `au_to_new_subject()` function formats an *auid* (audit user ID), an *euid* (effective user ID), an *egid* (effective group ID), a *ruid* (real user ID), an *rgid* (real group ID), a *pid* (process ID), an *sid* (audit session ID), an *tid* (audit terminal ID), into a “subject token.” The audit terminal ID is one that contains an IPv6 IP address.

The `au_to_opaque()` function formats the bytes bytes pointed to by *data* into an “opaque token.” The value of *size* must be positive.

The `au_to_path()` function formats the path name pointed to by *path* into an “path token.”

The `au_to_process()` function formats an *auid* (audit user ID), an *euid* (effective user ID), an *egid* (effective group ID), a *ruid* (real user ID), a *rgid* (real group ID), a *pid* (process ID), an *sid* (audit session ID), and a *tid* (audit terminal ID), into a “process token.” A process token should be used when the process is the object of an action (ie. when the process is the receiver of a signal).

The `au_to_new_process()` function formats an *auid* (audit user ID), an *euid* (effective user ID), an *egid* (effective group ID), a *ruid* (real user ID), a *rgid* (real group ID), a *pid* (process ID), an *sid* (audit session ID), and a *tid* (audit terminal ID), into a “process token.” A process token should be used when the process is the object of an action (ie. when the process is the receiver of a signal). The audit terminal ID is one that contains an IPv6 IP address.

The `au_to_return()` function formats an error number *number* and a return value *value* into a “return value token.”

The `au_to_socket()` function formats the data pointed to by *so* into a “socket token.”

The `au_to_new_socket()` function formats the data pointed to by *so* into a “socket token.” The socket contains IPv6 IP addresses.

The `au_to_text()` function formats the null-terminated string pointed to by *text* into a “text token.”

**RETURN VALUES**

These functions return `NULL` if memory cannot be allocated to put the resultant token into, or if an error in the input is detected.

**ATTRIBUTES**

See `attributes(5)` for a description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`bsmconv(1M), au_open(3BSM), attributes(5)`

**NOTES**

The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See `bsmconv(1M)` for more information.
au_user_mask(3BSM)

NAME
au_user_mask – get user’s binary preselection mask

SYNOPSIS
cc [ flag ... ] file ... -lbsm -lsocket -lnsl -lintl [ library ... ]
#include <bsm/libbsm.h>

int au_user_mask(char *username, au_mask_t *mask_p);

DESCRIPTION
au_user_mask() reads the default, system wide audit classes from
audit_control(4), combines them with the per-user audit classes from the
audit_user(4) database, and updates the binary preselection mask pointed to by
mask_p with the combined value.

The audit flags in the flags field of the audit_control(4) database and the
always-audit-flags and never-audit-flags from the audit_user(4) database represent
binary audit classes. These fields are combined by au_preselect(3BSM) as follows:

mask = (flags + always-audit-flags) − never-audit-flags

au_user_mask() only fails if both the both the audit_control(4) and the
audit_user(4) database entries could not be retrieved. This allows for flexible
configurations.

RETURN VALUES
au_user_mask() returns:
0 Success.
−1 Failure. Both the audit_control(4) and the audit_user(4) database
entries could not be retrieved.

FILES
/etc/security/audit_control contains default parameters read by the
audit daemon, auditd(1M)

/etc/security/audit_user stores per-user audit event mask

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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<thead>
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</tbody>
</table>

SEE ALSO
login(1), bsmconv(1M), getaudit(2), setaudit(2), au_preselect(3BSM),
getacinfo(3BSM), getauusername(3BSM), audit_control(4), audit_user(4),
attributes(5)

NOTES
au_user_mask() should be called by programs like login(1) which set a process’s
preselection mask with setaudit(2). getaudit(2) should be used to obtain audit
characteristics for the current process.

The functionality described in this man page is available only if the Basic Security
Module (BSM) has been enabled. See bsmconv(1M) for more information.
The `bgets()` function reads characters from `stream` into `buffer` until either `count` is exhausted or one of the characters in `breakstring` is encountered in the stream. The read data is terminated with a null byte (`\0`) and a pointer to the trailing null is returned. If a `breakstring` character is encountered, the last non-null is the delimiter character that terminated the scan.

Note that, except for the fact that the returned value points to the end of the read string rather than to the beginning, the call

```
bgets(buffer, sizeof buffer, stream, "\n");
```

is identical to

```
fgets(buffer, sizeof buffer, stream);
```

There is always enough room reserved in the buffer for the trailing null character.

If `breakstring` is null at the first call, no characters will be used to delimit the string.

**RETURN VALUES**

NULL is returned on error or end-of-file. Reporting the condition is delayed to the next call if any characters were read but not yet returned.

**EXAMPLES**

**EXAMPLE 1** Example of `bgets()` function.

```
#include <libgen.h>
char buffer[8];
/* read in first user name from /etc/passwd */
fp = fopen("/etc/passwd","r");
bgets(buffer, 8, fp, ":");
```

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tbody>
</table>

**SEE ALSO**

`gets(3C), attributes(5)`

**NOTES**

When compiling multi-thread applications, the `_REENTRANT` flag must be defined on the compile line. This flag should only be used in multi-thread applications.
NAME
bufsplit – split buffer into fields

SYNOPSIS
cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

size_t bufsplit(char *buf, size_t n, char **a);

DESCRIPTION
bufsplit() examines the buffer, buf, and assigns values to the pointer array, a, so
that the pointers point to the first n fields in buf that are delimited by TABs or
NEWLINEs.

To change the characters used to separate fields, call bufsplit() with buf pointing to
the string of characters, and n and a set to zero. For example, to use colon ( : ), period
( . ), and comma ( , ), as separators along with TAB and NEWLINE:

bufsplit (";.,\t\n", 0, (char**)0 );

RETURN VALUES
The number of fields assigned in the array a. If buf is zero, the return value is zero and
the array is unchanged. Otherwise the value is at least one. The remainder of the
elements in the array are assigned the address of the null byte at the end of the buffer.

EXAMPLES
EXAMPLE 1 Example of bufsplit() function.
	/*
	* set a[0] = "This", a[1] = "is", a[2] = "a",
	* a[3] = "test"
	*/
bufsplit("This\tis\ta\ttest\n", 4, a);

NOTES
bufsplit() changes the delimiters to null bytes in buf.

When compiling multithreaded applications, the _REENTRANT flag must be defined
on the compile line. This flag should only be used in multithreaded applications.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO
attributes(5)
cbrt(3M)

NAME    cbrt – cube root function

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double cbrt(double x);

DESCRIPTION The cbrt() function computes the cube root of x.

RETURN VALUES On successful completion, cbrt() returns the cube root of x. If x is NaN, cbrt() returns NaN.

ERRORS No errors will occur.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO attributes(5)
NAME  
ceil – ceiling value function

SYNOPSIS  
c
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>
double ceil(double x);

DESCRIPTION  
The ceil() function computes the smallest integral value not less than \( x \).

RETURN VALUES  
Upon successful completion, ceil() returns the smallest integral value not less than \( x \), expressed as a type double.

If \( x \) is NaN, NaN is returned.

If \( x \) is \( \pm \text{Inf} \) or \( \pm 0 \), \( x \) is returned.

ERRORS  
No errors will occur.

USAGE  
The integral value returned by ceil() as a double may not be expressible as an int or long int. The return value should be tested before assigning it to an integer type to avoid the undefined results of an integer overflow.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  
floor(3M), isnan(3M), attributes(5)
The config_admin library is a generic interface that is used for dynamic configuration, (DR). Each piece of hardware that supports DR must supply a hardware-specific plugin library that contains the entry points listed in this subsection. The generic library will locate and link to the appropriate library to effect DR operations. The interfaces specified in this subsection are really "hidden" from users of the generic libraries. It is, however, necessary that writers of the hardware-specific plug in libraries know what these interfaces are.

```c
#include <config_admin.h>

cfga_err_t config_change_state(cfga_cmd_t state_change_cmd, int num_ap_ids, char * const *ap_ids, const char *options, struct cfga_confirm *confp, struct cfga_msg *msgp, char **errstring, cfga_flags_t flags);

cfga_err_t config_private_func(const char *function, int num_ap_ids, char * const *ap_ids, const char *options, struct cfga_confirm *confp, struct cfga_msg *msgp, char **errstring, cfga_flags_t flags);

cfga_err_t config_test(int num_ap_ids, char * const *ap_ids, const char *options, struct cfga_msg *msgp, char **errstring, cfga_flags_t flags);

cfga_err_t config_list_ext(int num_ap_ids, char * const *ap_ids, struct cfga_list_data **ap_id_list, int *nlist, const char *options, const char *listsops, char **errstring, cfga_flags_t flags);

int config_ap_id_cmp(const cfga_ap_id_t ap_id1, const cfga_ap_id_t ap_id2);

void config_unload_libs(void);

const char *config_strerror(cfga_err_t cfgerrnum);
```
cfga_err_t cfga_test(const char *ap_id, const char *options, struct cfga_msg *msgp, char **errstring, cfga_flags_t flags);

cfga_err_t cfga_list_ext(const char *ap_id, struct cfga_list_data **ap_id_list, int *nlist, const char *options, const char *listopts, char **errstring, cfga_flags_t flags);

cfga_err_t cfga_help(struct cfga_msg *msgp, const char *options, cfga_flags_t flags);

int cfga_ap_id_cmp(const cfga_ap_id_t ap_id1, const cfga_ap_id_t ap_id2);

The following interfaces have been deprecated and their use is strongly discouraged:

cfga_err_t cfga_stat(const char *ap_id, struct cfga_stat_data *buf, const char *options, char **errstring);

cfga_err_t cfga_list(const char *ap_id, struct cfga_stat_data **ap_id_list, int *nlist, const char *options, char **errstring);

DESCRIPTION

The config_*() functions provide a hardware independent interface to hardware-specific system configuration administration functions. The cfga_*() functions are provided by hardware-specific libraries that are dynamically loaded to handle configuration administration functions in a hardware-specific manner.

The libcfgadm library is used to provide the services of the cfgadm(1M) command. The hardware-specific libraries are located in
/usr/platform/${machine}/lib/cfgadm,
/usr/platform/${arch}/lib/cfgadm, and /usr/lib/cfgadm. The hardware-specific library names are derived from the driver name or from class names in device tree nodes that identify attachment points.

The config_change_state() function performs operations that change the state of the system configuration. The state_change_cmd argument can be one of the following:
CFGA_CMD_INSERT, CFGA_CMD_REMOVE, CFGA_CMD_DISCONNECT, CFGA_CMD_CONNECT, CFGA_CMD_CONFIGURE, or CFGA_CMD_UNCONFIGURE. The state_change_cmd CFGA_CMD_INSERT is used to prepare for manual insertion or to activate automatic hardware insertion of an occupant. The state_change_cmd CFGA_CMD_REMOVE is used to prepare for manual removal or activate automatic hardware removal of an occupant. The state_change_cmd CFGA_CMD_DISCONNECT is used to disable normal communication to or from an occupant in a receptacle. The state_change_cmd CFGA_CMD_CONNECT is used to enable communication to or from an occupant in a receptacle. The state_change_cmd CFGA_CMD_CONFIGURE is used to bring the hardware resources contained on, or attached to, an occupant into the realm of Solaris, allowing use of the occupant’s hardware resources by the system. The state_change_cmd CFGA_CMD_UNCONFIGURE is used to remove the hardware resources contained on, or attached to, an occupant from the realm of Solaris, disallowing further use of the occupant’s hardware resources by the system.
The \textit{flags} argument may contain one or both of the defined flags, \texttt{CFGA\_FLAG\_FORCE} and \texttt{CFGA\_FLAG\_VERBOSE}. If the \texttt{CFGA\_FLAG\_FORCE} flag is asserted certain safety checks will be overridden. For example, this may not allow an occupant in the failed condition to be configured, but might allow an occupant in the failing condition to be configured. Acceptance of a force is hardware dependent. If the \texttt{CFGA\_FLAG\_VERBOSE} flag is asserted hardware-specific details relating to the operation are output utilizing the \texttt{cfga\_msg} mechanism.

The \texttt{config\_private\_func()} function invokes private hardware-specific functions.

The \texttt{config\_test()} function is used to initiate testing of the specified attachment point.

The \texttt{num\_ap\_ids} argument specifies the number of \texttt{ap\_ids} in the \texttt{ap\_ids} array. The \texttt{ap\_ids} argument points to an array of \texttt{ap\_ids}.

The \texttt{ap\_id} argument points to a single \texttt{ap\_id}.

The \texttt{function} and \texttt{options} strings conform to the \texttt{getsubopt(3C)} syntax convention and are used to supply hardware-specific function or option information. No generic hardware-independent functions or options are defined.

The \texttt{cfga\_confirm} structure referenced by \texttt{confp} provides a call-back interface to get permission to proceed should the requested operation require, for example, a noticeable service interruption. The \texttt{cfga\_confirm} structure includes the following members:

\begin{verbatim}
int (*confirm)(void *appdata_ptr, const char *message);
void *appdata_ptr;
\end{verbatim}

The \texttt{confirm()} function is called with two arguments: the generic pointer \texttt{appdata\_ptr} and the message detailing what requires confirmation. The generic pointer \texttt{appdata\_ptr} is set to the value passed in in the \texttt{cfga\_confirm} structure member \texttt{appdata\_ptr} and can be used in a graphical user interface to relate the \texttt{confirm} function call to the \texttt{config\_*()} call. The \texttt{confirm} function should return 1 to allow the operation to proceed and 0 otherwise.

The \texttt{cfga\_msg} structure referenced by \texttt{msgp} provides a call-back interface to output messages from a hardware-specific library. In the presence of the \texttt{CFGA\_FLAG\_VERBOSE} flag, these messages can be informational; otherwise they are restricted to error messages. The \texttt{cfga\_msg} structure includes the following members:

\begin{verbatim}
void (*message\_routine)(void *appdata\_ptr, const char *message);
void *appdata\_ptr;
\end{verbatim}

The \texttt{message\_routine()} function is called with two arguments: the generic pointer \texttt{appdata\_ptr} and the message. The generic pointer \texttt{appdata\_ptr} is set to the value passed in in the \texttt{cfga\_confirm} structure member \texttt{appdata\_ptr} and can be used in a graphical user interface to relate the \texttt{message\_routine()} function call to the \texttt{config\_*()} call. The messages must be in the native language specified by the \texttt{LC\_MESSAGES} locale category; see \texttt{setlocale(3C)}.
For some generic errors a hardware-specific error message can be returned. The storage for the error message string, including the terminating null character, is allocated by the `config_*` functions using `malloc(3C)` and a pointer to this storage returned through `errstring`. If `errstring` is NULL no error message will be generated or returned. If `errstring` is not NULL and no error message is generated, the pointer referenced by `errstring` will be set to NULL. It is the responsibility of the function calling `config_*()` to deallocate the returned storage using `free(3C)`. The error messages must be in the native language specified by the `LC_MESSAGES` locale category; see `setlocale(3C)`.

The `config_list_ext()` function provides the listing interface. When supplied with a list of `ap_ids` through the first two arguments, it returns an array of `cfga_list_data_t` structures for each attachment point specified. If the first two arguments are 0 and NULL respectively, then all attachment points in the device tree will be listed. Additionally, dynamic expansion of an attachment point to list dynamic attachment points may also be requested by passing the `CFGA_FLAG_LIST_ALL` flag through the `flags` argument. Storage for the returned array of `stat` structures is allocated by the `config_list_ext()` function using `malloc(3C)`. This storage must be freed by the caller of `config_list_ext()` by using `free(3C)`.

The `cfga_list_data` structure includes the following members:

- `cfga_log_ext_t ap_log_id; /* Attachment point logical id */`
- `cfga_phys_ext_t ap_phys_id; /* Attachment point physical id */`
- `cfga_class_t ap_class; /* Attachment point class */`
- `cfga_stat_t ap_r_state; /* Receptacle state */`
- `cfga_stat_t ap_o_state; /* Occupant state */`
- `cfga_cond_t ap_cond; /* Attachment point condition */`
- `cfga_busy_t ap_busy; /* Busy indicator */`
- `time_t ap_status_time; /* Attachment point last change */`
- `cfga_info_t ap_info; /* Miscellaneous information */`
- `cfga_type_t ap_type; /* Occupant type */`

The types are defined as follows:

```c
typedef char cfga_log_ext_t[CFGA_LOG_EXT_LEN];
typedef char cfga_phys_ext_t[CFGA_PHYS_EXT_LEN];
typedef char cfga_class_t[CFGA_CLASS_LEN];
typedef char cfga_info_t[CFGA_INFO_LEN];
typedef char cfga_type_t[CFGA_TYPE_LEN];
typedef enum cfga_cond_t;
typedef enum cfga_stat_t;
typedef enum cfga_busy_t;
typedef int cfga_flags_t;
```

The `listopts` argument to `config_list_ext()` conforms to the `getsubopt(3C)` syntax and is used to pass listing sub-options. Currently, only the sub-option `class=class_name` is supported. This list option restricts the listing to attachment points of class `class_name`. 
The listopts argument to cfga_list_ext() is reserved for future use. Hardware-specific libraries should ignore this argument if it is NULL. If listopts is not NULL and is not supported by the hardware-specific library, an appropriate error code should be returned.

The ap_log_id and the ap_phys_id members give the hardware-specific logical and physical names of the attachment point. The ap_busy member indicates activity is present that may result in changes to state or condition. The ap_status_time member provides the time at which either the ap_r_state, ap_o_state, or ap_cond field of the attachment point last changed. The ap_info member is available for the hardware-specific code to provide additional information about the attachment point. The ap_class member contains the attachment point class (if any) for an attachment point. The ap_class member is filled in by the generic library. If the ap_log_id and ap_phys_id members are not filled in by the hardware-specific library, the generic library will fill in these members using a generic format. The remaining members are the responsibility of the corresponding hardware-to-specific library.

The ap_log_id, ap_phys_id, ap_info, ap_class, and ap_type members are fixed-length strings. If the actual string is shorter than the size of the member, it will be null-terminated. Because of this, programs should not rely on there being a terminating null character. When printing these fields, the following format is suggested:

```c
printf("%.s", sizeof(p->ap_log_id), p->ap_log_id);
```

The config_stat(), config_list(), cfga_stat(), and cfga_list() functions and the cfga_stat_data data structure are deprecated interfaces and are provided solely for backward compatibility. Use of these interfaces is strongly discouraged.

The config_ap_id_cmp function performs a hardware dependent comparison on two ap_ids, returning an equal to, less than or greater than indication in the manner of strcmp(3C). Each argument is either a cfga_ap_id_t or can be a null-terminated string. This function can be used when sorting lists of ap_ids, for example with qsort(3C), or when selecting entries from the result of a config_list function call.

The config_unload_libs function unlinks all previously loaded hardware-specific libraries.

The config_strerror function can be used to map an error return value to an error message string. See RETURN VALUES. The returned string should not be overwritten. config_strerror returns NULL if cfgerrnum is out-of-range.

The cfga_help function can be used request that a hardware-specific library output its localized help message.
The **config_*()** and **cfga_*()** functions return the following values. Additional error information may be returned through `errstring` if the return code is not **CFGA_OK**. See DESCRIPTION for details.

<table>
<thead>
<tr>
<th>RETURN VALUES</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CFGA_BUSY</strong></td>
<td>The command was not completed due to an element of the system configuration administration system being busy.</td>
</tr>
<tr>
<td><strong>CFGA_ATTR_INVAL</strong></td>
<td>No attachment points with the specified attributes exists.</td>
</tr>
<tr>
<td><strong>CFGA_ERROR</strong></td>
<td>An error occurred during the processing of the requested operation. This error code includes validation of the command arguments by the hardware-specific code.</td>
</tr>
<tr>
<td><strong>CFGA_INSUFFICIENT_CONDITION</strong></td>
<td>Operation failed due to attachment point condition.</td>
</tr>
<tr>
<td><strong>CFGA_INVAL</strong></td>
<td>The system configuration administration operation requested is not supported on the specified attachment point.</td>
</tr>
<tr>
<td><strong>CFGA_LIB_ERROR</strong></td>
<td>A procedural error occurred in the library, including failure to obtain process resources such as memory and file descriptors.</td>
</tr>
<tr>
<td><strong>CFGA_NACK</strong></td>
<td>The command was not completed due to a negative acknowledgement from the <code>confp-&gt;confirm</code> function.</td>
</tr>
<tr>
<td><strong>CFGA_NO_LIB</strong></td>
<td>A hardware-specific library could not be located using the supplied <code>ap_id</code>.</td>
</tr>
<tr>
<td><strong>CFGA_NOTSUPP</strong></td>
<td>System configuration administration is not supported on the specified attachment point.</td>
</tr>
<tr>
<td><strong>CFGA_OK</strong></td>
<td>The command completed as requested.</td>
</tr>
<tr>
<td><strong>CFGA_OPNOTSUPP</strong></td>
<td>System configuration administration operation is not supported on this attachment point.</td>
</tr>
<tr>
<td><strong>CFGA_PRIV</strong></td>
<td>The caller does not have the required process privileges. For example, if configuration administration is performed through a device driver, the permissions on the device node would be used to control access.</td>
</tr>
<tr>
<td><strong>CFGA_SYSTEM_BUSY</strong></td>
<td>The command required a service interruption and was not completed due to the specified state of the system configuration.</td>
</tr>
</tbody>
</table>
Many of the errors returned by the system configuration administration functions are hardware-specific. The strings returned in erstring may include the following:

- **attachment point ap_id not known**
  - The attachment point detailed in the error message does not exist.

- **unknown hardware option option for operation**
  - An unknown option was encountered in the options string.

- **hardware option option requires a value**
  - An option in the options string should have been of the form option=value.

- **listing option list_option requires a value**
  - An option in the listopts string should have been of the form option=value.

- **hardware option option does not require a value**
  - An option in the options string should have been a simple option.

- **attachment point ap_id is not configured**
  - A config_change_state command to CFGA_CMD_UNCONFIGURE an occupant was made to an attachment point whose occupant was not in the CFGA_STAT_CONFIGURED state.

- **attachment point ap_id is not unconfigured**
  - A config_change_state command requiring an unconfigured occupant was made to an attachment point whose occupant was not in the CFGA_STAT_UNCONFIGURED state.

- **attachment point ap_id condition not satisfactory**
  - A config_change_state command was made to an attachment point whose condition prevented the operation.

- **attachment point ap_id in condition condition cannot be used**
  - A config_change_state operation with force indicated was directed to an attachment point whose condition fails the hardware dependent test.

### ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>SUNWcsu, SUNWkvm</td>
</tr>
<tr>
<td>MT-Level</td>
<td>Safe</td>
</tr>
</tbody>
</table>

### SEE ALSO
cfgadm(1M), devinfo(1M), dlopen(3DL), dlsym(3DL), free(3C), getsubopt(3C), malloc(3C), qsort(3C), setlocale(3C), strcmp(3C), libcfgadm(3LIB), attributes(5)
Applications using this library should be aware that the underlying implementation may use system services which alter the contents of the external variable `errno` and may use file descriptor resources.

The following code shows the intended error processing when `config_*()` returns a value other than `CFGA_OK`:

```c
void emit_error(int cfgerrnum, char *estrp)
{
    const char *ep;
    ep = config_strerror(cfgerrnum);
    if (ep == NULL)
        ep = gettext("configuration administration unknown error");
    if (estrp != NULL && *estrp != '0') {
        (void) fprintf(stderr, "%s: %s\n", ep, estrp);
    } else {
        (void) fprintf(stderr, "%s\n", ep);
    }
    if (estrp != NULL)
        free((void *)estrp);
}
```

Reference should be made to the Hardware Specific Guide for details of System Configuration Administration support.
ConnectToServer(3DMI)

NAME
ConnectToServer – connect to a DMI service provider

SYNOPSIS
tcc [ flag ... ] file ... -ldmici -ldmimi [ library ... ]

#include <dmi/api.hh>

bool_t ConnectToServer(ConnectI *argp, DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION
The ConnectToServer() function enables a management application or a
commponent instrumentation to connect to a DMI service provider.

The argp parameter is an input parameter that uses the following data structure:

struct ConnectIN {
    char *host;
    const char *nettype;
    ServerType servertype;
    RpcType rpctype;
}

The host member indicates the host on which the service provider is running. The
default is localhost.

The nettype member specifies the type of transport RPC uses. The default is netpath.

The servertype member indicates whether the connecting process is a management
application or a component instrumentation.

The rpctype member specifies the type of RPC, either ONC or DCE. Only ONC is
supported in the Solaris 7 release.

The dmi_rpc_handle parameter is the output parameter that returns DMI RPC handle.

RETURN VALUES
The ConnectToServer() function returns TRUE if successful, otherwise FALSE.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
DisconnectToServer(3DMI), attributes(5)
copylist(3GEN)

NAME  
copylist – copy a file into memory

SYNOPSIS  
cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>
char *copylist(const char *filenm, off_t *szptr);

DESCRIPTION  
The copylist() function copies a list of items from a file into freshly allocated memory, replacing new-lines with null characters. It expects two arguments: a pointer filenm to the name of the file to be copied, and a pointer szptr to a variable where the size of the file will be stored.

Upon success, copylist() returns a pointer to the memory allocated. Otherwise it returns NULL if it has trouble finding the file, calling malloc(), or reading the file.

USAGE  
The copylist() function has a transitional interface for 64-bit file offsets. See lf64(5).

EXAMPLES  
EXAMPLE 1 Example of copylist() function.
/* read "file" into buf */
off_t size;
char *buf;
buf = copylist("file", &size);
if (buf) {
  for (i=0; i<size; i++)
    if (buf[i])
      putchar(buf[i]);
    else
      putchar(\n);
} else {
  fprintf(stderr, "%s: Copy failed for "file".\n", argv[0]);
  exit (1);
}

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  
malloc(3C), attributes(5), lf64(5)

NOTES  
When compiling multithreaded applications, the _REENTRANT flag must be defined on the compile line. This flag should only be used in multithreaded applications.
The `copysign()` function returns a value with the magnitude of \( x \) and the sign of \( y \). It produces a NaN with the sign of \( y \) if \( x \) is a NaN.

### ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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<td>MT-Safe</td>
</tr>
</tbody>
</table>

### SEE ALSO

attributes(5)
**NAME**  
`cos` – cosine function

**SYNOPSIS**  
```c
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double cos(double x);
```

**DESCRIPTION**  
The `cos()` function computes the cosine of `x`, measured in radians.

**RETURN VALUES**  
Upon successful completion, `cos()` returns the cosine of `x`.

- If `x` is NaN or ±Inf, NaN is returned.

**ERRORS**  
No errors will occur.

**ATTRIBUTES**  
See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
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<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
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</tbody>
</table>

**SEE ALSO**  
`acos(3M)`, `isnan(3M)`, `sin(3M)`, `tan(3M)`, `attributes(5)`
cosh(3M)

NAME     cosh – hyperbolic cosine function

SYNOPSIS  cc [ flag ... ] file ... -lm [ library ... ]
          #include <math.h>
          double cosh(double x);

DESCRIPTION The cosh() function computes the hyperbolic cosine of x.

RETURN VALUES Upon successful completion, cosh() returns the hyperbolic cosine of x.

If the result would cause an overflow, HUGE_VAL is returned and errno is set to ERANGE.

If x is NaN, NaN is returned.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS   The cosh() function will fail if:
          ERANGE  The result would cause an overflow.

USAGE    An application wishing to check for error situations should set errno to 0 before calling cosh(). If errno is non-zero on return, or the returned value is NaN, an error has occurred.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO acosh(3M), isnan(3M), matherr(3M), sinh(3M), tanh(3M), attributes(5), standards(5)
The UltraSPARC and Pentium microprocessor families contain hardware performance counters that allow the measurement of many different hardware events related to CPU behavior, including instruction and data cache misses as well as various internal states of the processor. More recent processors allow a variety of events to be captured. The counters can be configured to count user events or system events, or both. The two processor families currently share the restriction that only two event types can be measured simultaneously.

UltraSPARC III and Pentium II processors are able to generate an interrupt on counter overflow, allowing the counters to be used for various forms of profiling.

This manual page describes a set of APIs that allow Solaris applications to use these counters. Applications can measure their own behavior, the behavior of other applications, or the behavior of the whole system.

There are two principal models for using these performance counters. Some users of these statistics wish to observe system-wide behavior; others wish to view the performance counters as part of the register set exported by each LWP. On a machine performing more than one activity, these two models are in conflict because the counters represent a critical hardware resource that cannot simultaneously be both shared and private.

To fully support the two-level threads model in Solaris, it would be necessary to virtualize the performance counters to each thread. This version of the library does not allow per-thread data to be captured unless bound threads are used. Even without bound threads, however, the counters can still be used to assess aggregate program behavior.

Although some events are common to all processors, it is apparent that the counters expose a great deal of the specific implementation details of the processor architecture. For this reason, events are specified by name using a string-based hardware event specification language. The values of the tokens in the language vary from processor model to processor model, and can only be interpreted with reference to the relevant hardware documentation. The functions provided to specify the strings use environment variables or arguments so that the names do not have to be compiled in applications, thus extending their longevity and portability across platforms and processor generations.

The following configuration interfaces are provided:

- `cpc_version(3CPC)`: check the version the application was compiled with against the version of the library
- `cpc_getcpuver(3CPC)`: determine the performance counter version of the current CPU
- `cpc_getcciname(3CPC)`: return the corresponding printable string to describe that interface
cpc(3CPC)

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cpc_getnpic(3CPC)</td>
<td>return the number of valid counter registers in the cpc_event(3CPC) data structure</td>
</tr>
<tr>
<td>cpc_getcpuref(3CPC)</td>
<td>return a reference to the corresponding processor documentation</td>
</tr>
</tbody>
</table>

Programming events

Events are specified using a getsubopt(3C)-style language for both the events and the additional control bits that determine what causes the counters to increment. The cpc_strtoevent() function translates a string to an event specification which can then be used to program the counters. The cpc_eventtostr() function returns the canonical form of the string that corresponds to a particular event. The cpc_getusage(3CPC) function returns a string that specifies the syntax of the string, while cpc_walk_names(3CPC) allows the caller to apply a function to each possible event supported on the relevant processor.

Performance counter context

Each processor on the system possesses its own set of performance counter registers. For a single process, it is often desirable to maintain the illusion that the counters are an intrinsic part of that process (whichever processors it runs on), since this allows the events to be directly attributed to the process without having to make passive all other activity on the system.

To achieve this behavior, the library associates performance counter context with each LWP in the process; the context consists of a small amount of kernel memory to hold the counter values when the LWP is not running, and some simple kernel functions to save and restore those counter values from and to the hardware registers when the LWP performs a normal context switch. A process can only observe and manipulate its own copy of the performance counter control and data registers.

Though applications can be modified to instrument themselves as demonstrated above, it is frequently useful to be able to examine the behavior of an existing application without changing the source code. A separate library, libpctx, provides a simple set of interfaces that use the facilities of proc(4) to control a target process, and together with functions in libcpc, allow truss-like tools to be constructed to measure the performance counters in other applications. An example of one such application is cputrack(1).

The functions in libpctx are independent of those in libcpc. These functions manage a process using an event-loop paradigm — that is, the execution of certain system calls by the controlled process cause the library to stop the controlled process and execute callback functions in the context of the controlling process. These handlers can perform various operations on the target process using APIs in libpctx and libcpc that consume pctx_t handles.

Performance Counters In Other Processes

The cputrack(1), cpustat(1M), cpc_access(3CPC), cpc_bind_event(3CPC), cpc_count_usr_events(3CPC), cpc_pctx_bind_event(3CPC), cpc_event(3CPC), cpc_event_diff(3CPC), cpc_getcpuver(3CPC), cpc_seterrfn(3CPC), cpc_shared_bind_event(3CPC), cpc_strtoevent(3CPC), cpc_version(3CPC), pctx_capture(3CPC), pctx_set_events(3CPC), proc(4).

SEE ALSO

cputrack(1), cpustat(1M), cpc_access(3CPC), cpc_bind_event(3CPC), cpc_count_usr_events(3CPC), cpc_pctx_bind_event(3CPC), cpc_event(3CPC), cpc_event_diff(3CPC), cpc_getcpuver(3CPC), cpc_seterrfn(3CPC), cpc_shared_bind_event(3CPC), cpc_strtoevent(3CPC), cpc_version(3CPC), pctx_capture(3CPC), pctx_set_events(3CPC), proc(4).
cpc_access(3CPC)

NAME
cpc_access – test access CPU performance counters

SYNOPSIS
cc [ flag... ] file... -lcpc [ library... ]
#include <libcpc.h>

int cpc_access(void);

DESCRIPTION
Access to CPU performance counters is possible only on systems where the
appropriate hardware exists and is correctly configured. The cpc_access() function
must be used to determine if the hardware exists and is accessible on the platform
before any of the interfaces that use the counters are invoked.

When the hardware is available, access to the per-process counters is always allowed
to the process itself, and allowed to other processes mediated using the existing
security mechanisms of /proc.

RETURN VALUES
Upon successful completion, cpc_access() returns 0. Otherwise, it returns -1 and
sets errno to indicate the error.

By default, two common errno values are decoded and cause the library to print an
error message using its reporting mechanism. See cpc_seterrfn(3CPC) to for a
description of how this behavior can be modified.

ERRORS
The cpc_access() function will fail if:

EAGAIN Another process may be sampling system-wide CPU statistics.
ENOSYS CPU performance counters are inaccessible on this machine.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
cpc(3CPC), cpc_seterrfn(3CPC), proc(4), attributes(5)
cpc_bind_event(3CPC)

NAME

cpc_bind_event, cpc_take_sample, cpc_rele – use CPU performance counters on lwps

SYNOPSIS

cc [ flag... ] file... -lcpc [ library... ]
#include <libcpc.h>

int cpc_bind_event(cpc_event_t *event, int flags);
int cpc_take_sample(cpc_event_t *event);
int cpc_rele(void);

DESCRIPTION

Once the events to be sampled have been selected using, for example, cpc_strtoevent(3CPC), the event selections can be bound to the calling LWP using cpc_bind_event(). If cpc_bind_event() returns successfully, the system has associated performance counter context with the calling LWP. The context allows the system to virtualize the hardware counters to that specific LWP, and the counters are enabled.

Two flags are defined that can be passed into the routine to allow the behavior of the interface to be modified, as described below.

Counter values can be sampled at any time by calling cpc_take_sample(), and dereferencing the fields of the ce_pic[] array returned. The ce_hrt field contains the timestamp at which the kernel last sampled the counters.

To immediately remove the performance counter context on an LWP, the cpc_rele() interface should be used. Otherwise, the context will be destroyed after the LWP or process exits.

The caller should take steps to ensure that the counters are sampled often enough to avoid the 32-bit counters wrapping. The events most prone to wrap are those that count processor clock cycles. If such an event is of interest, sampling should occur frequently so that less than 4 billion clock cycles can occur between samples. Practically speaking, this is only likely to be a problem for otherwise idle systems, or when processes are bound to processors, since normal context switching behavior will otherwise hide this problem.

RETURN VALUES

Upon successful completion, cpc_bind_event() and cpc_take_sample() return 0. Otherwise, these functions return −1, and set errno to indicate the error.

ERRORS

The cpc_bind_event() and cpc_take_sample() functions will fail if:

EFAULT

The event argument specifies a bad address.

ENOTSUP

The caller has attempted an operation that is illegal or not supported on the current platform, such as attempting to specify signal delivery on counter overflow on a CPU that doesn’t generate an interrupt on counter overflow.

EAGAIN

Another process may be sampling system-wide CPU statistics. For cpc_bind_event(), this implies that no new contexts can be created. For cpc_take_sample(), this implies that the performance counter context has been invalidated and must be
released with \texttt{cpc\_rele()}. Robust programs should be coded to expect this behavior and recover from it by releasing the now invalid context by calling \texttt{cpc\_rele()} sleeping for a while, then attempting to bind and sample the event once more.

\textbf{EINVAL} \hspace{1cm} The \texttt{cpc\_take\_sample()} function has been invoked before the context is bound.

\section*{Examples}

\textbf{Example 1} Use hardware performance counters to measure events in a process.

The example below shows how a standalone program can be instrumented with the \texttt{libcpc} routines to use hardware performance counters to measure events in a process. The program performs 20 iterations of a computation, measuring the counter values for each iteration. By default, the example makes the counters measure external cache references and external cache hits; these options are only appropriate for UltraSPARC processors. By setting the \texttt{PERFEVENTS} environment variable to other strings (a list of which can be gleaned from the \texttt{-h} flag of the \texttt{cpustat} or \texttt{cputrack} utilities), other events can be counted. The \texttt{error()} routine below is assumed to be a user-provided routine analogous to the familiar \texttt{printf(3C)} routine from the C library but which also performs an \texttt{exit(2)} after printing the message.

```c
#include <inttypes.h>
#include <stdlib.h>
#include <stdio.h>
#include <unistd.h>
#include <libcpc.h>

int main(int argc, char *argv[]) {
    int cpuver, iter;
    char *setting = NULL;
    cpc_event_t event;

    if (cpc_version(CPC_VER_CURRENT) != CPC_VER_CURRENT)
        error("application:library cpc version mismatch!");

    if ((cpuver = cpc_getcpuver()) == -1)
        error("no performance counter hardware!");

    if ((setting = getenv("PERFEVENTS")) == NULL)
        setting = "pic0=EC_ref,pic1=EC_hit";

    if (cpc_strtoevent(cpuver, setting, &event) != 0)
        error("can't measure '%s' on this processor", setting);

    if (cpc_access() == -1)
        error("can't access perf counters: %s", strerror(errno));

    if (cpc_bind_event(&event, 0) == -1)
        error("can't bind lwp%d: %s", _lwp_self(), strerror(errno));

    for (iter = 1; iter <= 20; iter++) {
        cpc_event_t before, after;
        ...
    }
}
```

\textbf{cpc\_bind\_event(3CPC)}
EXAMPLE 1 Use hardware performance counters to measure events in a process.  
(Continued)

```c
if (cpc_take_sample(&before) == -1)
    break;
/* ==> Computation to be measured goes here <= */
if (cpc_take_sample(&after) == -1)
    break;
(void) printf("%3d: %" PRIId64 " %" PRIId64 "\n", iter,
    after.ce_pic[0] - before.ce_pic[0],
    after.ce_pic[1] - before.ce_pic[1]);
}
if (iter != 20)
    error("can’t sample ‘%s’: %s", setting, strerror(errno));
free(setting);
return (0);
```

EXAMPLE 2 Write a signal handler to catch overflow signals.

This example builds on Example 1, but demonstrates how to write the signal handler to catch overflow signals. The counters are preset so that counter zero is 1000 counts short of overflowing, while counter one is set to zero. After 1000 counts on counter zero, the signal handler will be invoked.

First the signal handler:

```c
#define PRESET0 (UINT64_MAX - 1000ull)
#define PRESET1 0

void emt_handler(int sig, siginfo_t *sip, void *arg)
{
    ucontext_t *uap = arg;
    cpc_event_t sample;
    if (sig != SIGEMT || sip->si_code != EMT_CPCOVF) {
        psignal(sig, "example");
        psiginfo(sip, "example");
        return;
    }
    (void) printf("lwp%d - si_addr %p ucontext: %p %p %p %p\n",
        _lwp_self(), (void *)sip->si_addr,
        (void *)uap->uc_mcontext.gregs[PC],
        (void *)uap->uc_mcontext.gregs[USP]);
    if (cpc_take_sample(&sample) == -1)
        error("can’t sample ‘%s’: %s", strerror(errno));
    (void) printf("0x%" PRIx64 " 0x%" PRIx64 "\n",
```
EXAMPLE 2 Write a signal handler to catch overflow signals. (Continued)

    sample.ce_pic[0], sample.ce_pic[1]);
    (void) fflush(stdout);
    sample.ce_pic[0] = PRESET0;
    sample.ce_pic[1] = PRESET1;
    if (cpc_bind_event(&sample, CPC_BIND_EMT_OVF) == -1)
        error("cannot bind lwp%d: %s", _lwp_self(), strerror(errno));
}

and second the setup code (this can be placed after the code that selects the event to be measured):

    struct sigaction act;
    cpc_event_t event;
    ...
    act.sa_sigaction = emt_handler;
    bzero(&act.sa_mask, sizeof (act.sa_mask));
    act.sa_flags = SA_INIT|SA_RESTART|SA_SIGINFO;
    if (sigaction(SIGEMT, &act, NULL) == -1)
        error("sigaction: %s", strerror(errno));
    event.ce_pic[0] = PRESET0;
    event.ce_pic[1] = PRESET1;
    if (cpc_bind_event(&event, CPC_BIND_EMT_OVF) == -1)
        error("cannot bind lwp%d: %s", _lwp_self(), strerror(errno));

    for (iter = 1; iter <= 20; iter++) {
        /* ==> Computation to be measured goes here <== */
    }
    cpc_bind_event(NULL, 0); /* done */

Note that a more general version of the signal handler would use write(2) directly instead of depending on the signal-unsafe semantics of stderr and stdout. Most real signal handlers will probably do more with the samples than just print them out.

NOTES Sometimes, even the overhead of performing a system call will be too disruptive to the events being measured. Once a call to cpc_bind_event() has been issued, it is possible to directly access the performance hardware registers from within the application. If the performance counter context is active, then the counters will count on behalf of the current LWP.

SPARC rd $pic, $rN ! All UltraSPARC
wr $rN, %pic ! (ditto, but see text)
IA rdpmc ! Pentium II only

If the counter context is not active or has been invalidated, the $pic register (SPARC), and the rdpmc instruction (Pentium) will become unavailable.
Note that the two 32-bit UltraSPARC performance counters are kept in the single 64-bit %pic register so a couple of additional instructions are required to separate the values. Also note that when the %pcr register bit has been set that configures the %pic register as readable by an application, it is also writable. Any values written will be preserved by the context switching mechanism.

Pentium II processors support the non-privileged rdpmc instruction which requires [5] that the counter of interest be specified in %ecx, and returns a 40-bit value in the %edx:%eax register pair. There is no non-privileged access mechanism for Pentium I processors.

As described above, when counting events, some processors allow their counter registers to silently overflow. However more recent CPUs such as UltraSPARC III and Pentium II are capable of generating an interrupt when the hardware counter overflows.

The most obvious use for this facility is to ensure that the full 64-bit counter values are maintained without repeated sampling. However, current hardware does not record which counter overflowed. A more subtle use for this facility is to preset the counter to a value slightly less than the maximum value, then use the resulting interrupt to catch the counter overflow associated with that event. The overflow can then be used as an indication of the frequency of the occurrence of that event.

Note that the interrupt generated by the processor may not be particularly precise. That is, the particular instruction that caused the counter overflow may be earlier in the instruction stream than is indicated by the program counter value in the ucontext.

When cpc_bind_event() is called with the CPC_BIND_EMT_OVF flag set, then as before, the control registers and counters are preset from the 64-bit values contained in event. However, when the flag is set, the kernel arranges to send the calling process a SIGEMT signal when the overflow occurs, with the si_code field of the corresponding siginfo structure set to EMT_CPCOVF, and the si_addr field is the program counter value at the time the overflow interrupt was delivered. Counting, and thus the subsequent delivery of the signal on overflow is disabled until the next call to cpc_bind_event(). Even in a multithreaded process, during execution of the signal handler, the thread behaves as if it is temporarily bound to the running LWP.

Different processors have different counter ranges available, though all processors supported by Solaris allow at least 31 bits to be specified as a counter preset value; thus portable preset values lie in the range UINT64_MAX to UINT64_MAX−INT32_MAX.

The appropriate preset value will often need to be determined experimentally. Typically, it will depend on the event being measured, as well as the desire to minimize the impact of the act of measurement on the event being measured; less frequent interrupts and samples lead to less perturbation of the system.
If the processor cannot detect counter overflow, this call will fail (ENOTSUP). Specifying a null event unbinds the context from the underlying LWP and disables signal delivery. Currently, only user events can be measured using this technique. See Example 2, above.

By default, the library binds the performance counter context to the current LWP only. If the CPC_BIND_LWP_INHERIT flag is set, then any subsequent LWPs created by that LWP will automatically inherit the same performance counter context. The counters will be initialized to 0 as if a `cpc_bind_event()` had just been issued. This automatic inheritance behavior can be useful when dealing with multithreaded programs to determine aggregate statistics for the program as a whole.

If the CPC_BIND_EMT_OVF flag is also set, the process will immediately dispatch a SIGEMT signal to the freshly created LWP so that it can preset its counters appropriately on the new LWP. This initialization condition can be detected using `cpc_take_sample()` to check that both `ce_pic[]` values are set to `UINT64_MAX`.

### ATTRIBUTES

See `attributes(5)` for descriptions of the following attributes:

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</table>

### SEE ALSO

`cpustat(1), cpc(3CPC), cpc_strtoevent(3CPC), attributes(5)`
The `cpc_count_usr_events` and `cpc_count_sys_events` functions can be used to control whether events are counted on behalf of the application running in user mode, while `cpc_count_sys_events` can be used to control whether events are counted on behalf of the application while it is running in the kernel, without otherwise disturbing the binding of events to the invoking LWP. If the `enable` argument is non-zero, counting of events is enabled, otherwise they are disabled.

Upon successful completion, `cpc_count_usr_events` and `cpc_count_sys_events` return 0. Otherwise, the functions return -1 and set `errno` to indicate the error.

The `cpc_count_usr_events` and `cpc_count_sys_events` functions will fail if:

- **EAGAIN** The associated performance counter context has been invalidated by another process.
- **EINVAL** No performance counter context has been created, or an attempt was made to enable system events while delivering counter overflow signals.

**EXAMPLE 1 Use `cpc_count_usr_events`**

In this example, the routine `cpc_count_usr_events` is used to minimize the amount of code that needs to be added to the application. The `cputrack(1)` command can be used in conjunction with these interfaces to provide event programming, sampling, and reporting facilities.

If the application is instrumented in this way and then started by `cputrack` with the `nouser` flag set in the event specification, counting of user events will only be enabled around the critical code section of interest. If the program is run normally, no harm will ensue.

```c
int have_counters = 0;
int main(int argc, char *argv[])
{
    if (cpc_version(CPC_VER_CURRENT) == CPC_VER_CURRENT &&
        cpc_getcpuver() != -1 && cpc_access() == 0)
        have_counters = 1;
```
EXAMPLE 1 Use `cpc_count_usr_events()` to Minimize Code Needed by the Application (Continued)

```c
/* ... other application code */
if (have_counters)
  (void) cpc_count_usr_events(1);
/* ==> Code to be measured goes here <=- */
if (have_counters)
  (void) cpc_count_usr_events(0);
/* ... other application code */
```

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SEE ALSO
`cputrack(1), cpc(3CPC), cpc_access(3CPC), cpc_version(3CPC),
cpc_getcpuver(3CPC), cpc_bind_event(3CPC), cpc_pctx_bind_event(3CPC), attributes(5)`
cpc_event(3CPC)

NAME  | cpc_event – data structure to describe CPU performance counters
SYNOPSIS | #include <libcpc.h>

DESCRIPTION The libcpc interfaces manipulate CPU performance counters using the cpc_event_t data structure. This structure contains several fields that are common to all processors, and some that are processor-dependent. These structures can be declared by a consumer of the API, thus the size and offsets of the fields and the entire data structure are fixed per processor for any particular version of the library. See cpc_version(3CPC) for details of library versioning.

SPARC For UltraSPARC, the structure contains the following members:

```
typedef struct {
    int ce_cpuver;
    hrtime_t ce_hrt;
    uint64_t ce_tick;
    uint64_t ce_pic[2];
    uint64_t ce_pcr;
} cpc_event_t;
```

IA For Pentium, the structure contains the following members:

```
typedef struct {
    int ce_cpuver;
    hrtime_t ce_hrt;
    uint64_t ce_tsc;
    uint64_t ce_pic[2];
    uint32_t ce_pes[2];
    #define ce_cesr ce_pes[0]
} cpc_event_t;
```

The APIs are used to manipulate the highly processor-dependent control registers (the ce_pcr, ce_cesr, and ce_pes fields); the programmer is strongly advised not to reference those fields directly in portable code. The ce_pic array elements contain 64-bit accumulated counter values. The hardware registers are virtualized to 64-bit quantities even though the underlying hardware only supports 32-bits (UltraSPARC) or 40-bits (Pentium) before overflow.

The ce_hrt field is a high resolution timestamp taken at the time the counters were sampled by the kernel. This uses the same timebase as gethrtime(3C).

On SPARC V9 machines, the number of cycles spent running on the processor is computed from samples of the processor-dependent %tick register, and placed in the ce_tick field. On Pentium processors, the processor-dependent time-stamp counter register is similarly sampled and placed in the ce_tsc field.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

```
| ATTRIBUTE TYPE | ATTRIBUTE VALUE |
```
SEE ALSO  
gethrtme(3C), cpc(3CPC), cpc_version(3CPC), attributes(5).
cpc_event_diff(3CPC)

NAME    cpc_event_diff, cpc_event_accum – simple difference and accumulate operations

SYNOPSIS cc [ flag... ] file... -lcpc [ library... ]

#include <libcpc.h>

void cpc_event_accum(cpc_event_t *accum, cpc_event_t *event);
void cpc_event_diff(cpc_event_t *diff, cpc_event_t *after,
                    cpc_event_t *before);

DESCRIPTION The cpc_event_accum() and cpc_event_diff() functions perform common
accumulate and difference operations on cpc_event(3CPC) data structures. Use of
these functions increases program portability, since structure members are not
referenced directly.

cpc_event_accum() The cpc_event_accum() function adds the ce_pic fields of event into the
corresponding fields of accum. The ce_hrt field of accum is set to the later of the times
in event and accum.

SPARC:
The function adds the contents of the ce_tick field of event into the corresponding
field of accum.

IA:
The function adds the contents of the ce_tsc field of event into the corresponding
field of accum.

cpc_event_diff() The cpc_event_diff() function places the difference between the ce_pic fields of
after and before and places them in the corresponding field of diff. The ce_hrt field of
diff is set to the ce_hrt field of after.

SPARC:
Additionally, the function computes the difference between the ce_tick fields of after
and before, and places it in the corresponding field of diff.

IA:
Additionally, the function computes the difference between the ce_tsc fields of after
and before, and places it in the corresponding field of diff.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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cpc_event_diff(3CPC)

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SEE ALSO  cpc(3CPC), cpc_event(3CPC), attributes(5).
# CPC Performance Counter Library

**NAME**  
cpc_getcpuver, cpc_getcciname, cpc_getcpuref, cpc_getusage, cpc_getnpic, cpc_walk_names – determine CPU performance counter configuration

**SYNOPSIS**  
cc [ flag... ] file... -lcpc [ library... ]  
#include <libcpc.h>  

```c
int cpc_getcpuver(void);
const char *cpc_getcciname(int cpuver);
const char *cpc_getcpuref(int cpuver);
const char *cpc_getusage(int cpuver);
uint_t cpc_getnpic(int cpuver);
void cpc_walk_names(int cpuver, int regno, void *arg, void (*action)(void *arg, int regno, const char *name, uint8_t *bits));
```

**DESCRIPTION**  
The `cpc_getcpuver()` function returns an abstract integer that corresponds to the distinguished version of the underlying processor. The library distinguishes between processors solely on the basis of their support for performance counters, so the version returned should not be interpreted in any other way. The set of values returned by the library is unique across all processor implementations.

The `cpc_getcpuver()` function returns -1 if the library cannot support CPU performance counters on the current architecture. This may be because the processor has no such counter hardware, or because the library is unable to recognize it. Either way, such a return value indicates that the configuration functions described on this manual page cannot be used.

The `cpc_getcciname()` function returns a printable description of the processor performance counter interfaces—for example, the string *UltraSPARC I&II*. Note that this name should not be assumed to be the same as the name the manufacturer might otherwise ascribe to the processor. It simply names the performance counter interfaces as understood by the library, and thus names the set of performance counter events that can be described by that interface. If the `cpuver` argument is unrecognized, the function returns NULL.

The `cpc_getcpuref()` function returns a string that describes a reference work that should be consulted to (allow a human to) understand the semantics of the performance counter events that are known to the library. If the `cpuver` argument is unrecognized, the function returns NULL.

The `cpc_getusage()` function returns a compact description of the `getsubopt()`-oriented syntax that is consumed by `cpc_strtoevent(3CPC)`. It is returned as a space-separated set of tokens to allow the caller to wrap lines at convenient boundaries. If the `cpuver` argument is unrecognized, the function returns NULL.

The `cpc_getnpic()` function returns the number of valid fields in the `ce_pic[]` array of a `cpc_event_t` data structure.
The library maintains a list of events that it believes the processor capable of measuring, along with the bit patterns that must be set in the corresponding control register, and which counter the result will appear in. The \texttt{cpc\_walk\_names()} function calls the \texttt{action()} function on each element of the list so that an application can print appropriate help on the set of events known to the library. The \texttt{arg} parameter is passed uninterpreted from the caller on each invocation of the \texttt{action()} function.

If the parameters specify an invalid or unknown CPU or register number, the function silently returns without invoking the action function.

\section*{ATTRIBUTES}
See \texttt{attributes(5)} for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
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<td>SUNWcpcux (64-bit)</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

\section*{SEE ALSO}
\texttt{cpc(3CPC)}, \texttt{attributes(5)}.

\section*{NOTES}
Only SPARC processors are described by the SPARC version of the library, and only Intel processors are described by the Intel version of the library.
cpc_pctx_bind_event(3CPC)

NAME
cpc_pctx_bind_event, cpc_pctx_take_sample, cpc_pctx_rele, cpc_pctx_invalidate – access CPU performance counters in other processes

SYNOPSIS
cc [ flag... ] file... -lcpc -lpctx [ library... ]
#include <libpctx.h>
#include <libcpc.h>

int cpc_pctx_bind_event(pctx_t *pctx, id_t lwpid, cpc_event_t *event, int flags);
int cpc_pctx_take_sample(pctx_t *pctx, id_t lwpid, cpc_event_t *event);
int cpc_pctx_rele(pctx_t *pctx, id_t lwpid);
int cpc_pctx_invalidate(pctx_t *pctx, id_t lwpid);

DESCRIPTION
These functions are designed to be run in the context of an event handler created using the libpctx(3LIB) family of functions that allow the caller, also known as the controlling process, to manipulate the performance counters in the context of a controlled process. The controlled process is described by the pctx argument, which must be obtained from an invocation of pctx_capture(3CPC) or pctx_create(3CPC) and passed to the functions described on this page in the context of an event handler.

The semantics of the functions cpc_pctx_bind_event(), cpc_pctx_take_sample(), and cpc_pctx_rele() are directly analogous to those of cpc_bind_event(), cpc_take_sample(), and cpc_rele() described on the cpc_bind_event(3CPC) manual page.

The cpc_pctx_invalidate() function allows the performance context to be invalidated in an LWP in the controlled process.

RETURN VALUES
These functions return 0 on success. On failure, they return -1 and set errno to indicate the error.

ERRORS
The cpc_pctx_bind_event(), cpc_pctx_take_sample(), and cpc_pctx_rele() functions return the same errno values the analogous functions described on the cpc_bind_event(3CPC) manual page. In addition, these function may fail if:

ESRCH The value of the lwpid argument is invalid in the context of the controlled process.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tr>
</tbody>
</table>
SEE ALSO  cpc(3CPC), cpc_bind_event(3CPC), pctx_capture(3CPC), pctx_create(3CPC), attributes(5).

NOTES  The capability to create and analyze overflow events in other processes is not available, though it may be made available in a future version of this API. In the current implementation, the flags field must be specified as 0.
cpc_seterrfn(3CPC)

NAME  cpc_seterrfn – control libcpc error reporting

SYNOPSIS  cc [ flag... ] file... -lcpc [ library... ] #include <libcpc.h>

typedef void(cpc_errfn_t)(const char *fn, const char *fmt, va_list ap);

void cpc_seterrfn(cpc_errfn_t *errfn);

DESCRIPTION  For the convenience of programmers instrumenting their code, several libcpc
functions automatically emit to stderr error messages that attempt to provide a more
detailed explanation of their error return values. While this can be useful for simple
programs, some applications may wish to report their errors differently—for example,
to a window or to a log file.

The cpc_seterrfn() function allows the caller to provide an alternate function for
reporting errors; the type signature is shown above. The fn argument is passed the
library function name that detected the error, the format string fmt and argument
pointer ap can be passed directly to vsnprintf(3C) or similar varargs-based routine
for formatting.

The default printing routine can be restored by calling the routine with an errfn
argument of NULL.

EXAMPLES  EXAMPLE 1  Debugging example.

This example produces error messages only when debugging the program containing
it, or when the cpc_strtoevent() function is reporting an error when parsing an
event specification.

int debugging;

void myapp_errfn(const char *fn, const char *fmt, va_list ap)
{
    if (strcmp(fn, "strtoevent") != 0 && !debugging)
        return;
    (void) fprintf(stderr, "myapp: cpc_%s()");
    (void) vfprintf(stderr, fmt, ap);
}

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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<tr>
<td>Interface Stability</td>
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</tr>
</tbody>
</table>
SEE ALSO | cpc(3CPC), vsnprintf(3C), attributes(5).

cpc_seterrfn(3CPC)
cpc_shared_open(3CPC)

NAME cpc_shared_open, cpc_shared_bind_event, cpc_shared_take_sample, cpc_shared_rele,
cpc_shared_close – use CPU performance counters on processors

SYNOPSIS cc [ flag...] file... -lcpc [ library... ]
#include <libcpc.h>

int cpc_shared_open(void);
int cpc_shared_bind_event(int fd, cpc_event_t *event, int flags);
int cpc_shared_take_sample(int fd, cpc_event_t *event);
int cpc_shared_rele(int fd);
void cpc_shared_close(int fd);

DESCRIPTION The cpc_shared_open() function allows the caller to access the hardware counters
in such a way that the performance of the currently bound CPU can be measured. The
function returns a file descriptor if successful. Only one such open can be active at a
time on any CPU.

The cpc_shared_bind_event(), cpc_shared_take_sample(), and
cpc_shared_rele() functions are directly analogous to the corresponding
cpc_bind_event(), cpc_take_sample(), and cpc_rele() functions described
on the cpc_bind_event(3CPC) manual page, except that they operate on the
counters of a particular processor.

USAGE If a thread wishes to access the counters using this interface, it must do so using a
thread bound to an lwp, (see the THR_BOUND flag to thr_create(3THR)), that has in
turn bound itself to a processor using processor_bind(2).

Unlike the cpc_bind_event(3CPC) family of functions, no counter context is
attached to those lwps, so the performance counter samples from the processors
reflects the system-wide usage, instead of per-lwp usage.

The first successful invocation of cpc_shared_open() will immediately
invalidate all existing performance counter context on the system, and prevent all
subsequent attempts to bind counter context to lwps from succeeding anywhere on
the system until the last caller invokes cpc_shared_close().

This is because it is impossible to simultaneously use the counters to accurately
measure per-lwp and system-wide events, so there is an exclusive interlock between
these uses.

Access to the shared counters is mediated by file permissions on a cpc pseudo device.
As shipped, only the superuser is allowed to access the shared device; this is because
doing so prevents use of the counters on a per-lwp basis to any other users.

The CPC_BIND_LWP_INHERIT and CPC_BIND_EMT_OVF flags are invalid for the
shared interface.

RETURN VALUES On success, the functions (apart from cpc_shared_close()) return 0. On failure, the
functions return -1 and set errno, to indicate the reason.

76 man pages section 3: Extended Library Functions • Last Revised 14 Sep 1999
The current machine either has no performance counters, or has been configured to disallow access to them system-wide.

The caller does not have appropriate privilege to access the CPU performance counters system-wide.

For cpc_shared_open(), this value implies that the counters on the bound cpu are busy because they are already being used to measure system-wide events by some other caller.

Otherwise, this return value implies that the counters are not available because the thread has been unbound from the processor it was bound to at open time. Robust programs should be coded to expect this behavior, and should invoke cpc_shared_close(), before retrying the operation.

The counters cannot be accessed on the current CPU because the calling thread is not bound to that CPU using processor_bind(2).

The event argument specifies a bad address.

The caller has attempted an operation that is illegal or not supported on the current platform.

See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO processor_bind(2), cpc(3CPC), cpc_bind_event(3CPC), thr_create(3THR), attributes(5)
### NAME
cpc_strtoevent, cpc_eventtostr – translate strings to and from events

### SYNOPSIS
```
cc [ flag...] file... -lcpc [ library... ]
#include <libcpc.h>

int cpc_strtoevent(int cpuver, const char *spec, cpc_event_t *event);
char *cpc_eventtostr(cpc_event_t *event);
```

### DESCRIPTION
The `cpc_strtoevent()` function translates an event specification to the appropriate collection of control bits in a `cpc_event_t` structure pointed to by the `event` argument. The event specification is a `getsubopt(3C)`-style string that describes the event and any attributes that the processor can apply to the event or events. If successful, the function returns 0, the `ce_cpuver` field and the ISA-dependent control registers of event are initialized appropriately, and the rest of the `cpc_event_t` structure is initialized to 0.

The `cpc_eventtostr()` function takes an event and constructs a compact canonical string representation for that event.

### RETURN VALUES
Upon successful completion, `cpc_strtoevent()` returns 0. If the string cannot be decoded, a non-zero value is returned and a message is printed using the library’s error-reporting mechanism (see `cpc_seterrfn(3CPC)`).

Upon successful completion, `cpc_eventtostr()` returns a pointer to a string. The string returned must be freed by the caller using `free(3C)`. If `cpc_eventtostr()` a null pointer is returned.

### USAGE
The event selection syntax used is processor architecture-dependent. The supported processor families allow variations on how events are counted as well as what events can be counted. This information is available in compact form from the `cpc_getusage()` function (see `cpc_getcpuver(3CPC)`), but is explained in further detail below.

#### UltraSPARC
On UltraSPARC processors, the syntax for setting options is as follows:
```
pic0=<eventspec>,pic1=<eventspec> [,sys] [,nouser]
```

This syntax, which reflects the simplicity of the options available using the `%pcr` register, forces both counter events to be selected. By default only user events are counted; however, the `sys` keyword allows system (kernel) events to be counted as well. User event counting can be disabled by specifying the `nouser` keyword.

The keywords `pic0` and `pic1` may be omitted; they can be used to resolve ambiguities if they exist.

#### Pentium I
On Pentium processors, the syntax for setting counter options is as follows:
```
pic0=<eventspec>,pic1=<eventspec> [,sys[[0|1]]] [,nouser[[0|1]]]
[,noedge[[0|1]]] [,pc[[0|1]]]
```

---

78   man pages section 3: Extended Library Functions • Last Revised 14 Sep 1999
The syntax and semantics are the same as UltraSPARC, except that it is possible to specify whether a particular counter counts user or system events. If unspecified, the specification is presumed to apply to both counters.

There are some additional keywords. The noedge keyword specifies that the counter should count clocks (duration) instead of events. The pc keyword allows the external pin control pins to be set high (defaults to low). When the pin control register is set high, the external pin will be asserted when the associated register overflows. When the pin control register is set low, the external pin will be asserted when the counter has been incremented. The electrical effect of driving the pin is dependent upon how the motherboard manufacturer has chosen to connect it, if it is connected at all.

For Pentium II processors, the syntax is substantially more complex, reflecting the complex configuration options available:

```
pic0=<eventspec>,pic1=<eventspec> [,sys[[0|1]]] [,nouser[[0|1]]] [,noedge[[0|1]]] [,pc[[0|1]]] [,inv[[0|1]]] [,int[[0|1]]] [,cmask[0|1]=<maskspec>] [,umask[0|1]=<maskspec>]
```

This syntax is a straightforward extension of the earlier syntax. The additional inv, int, cmask0, cmask1, umask0, and umask1 keywords allow extended counting semantics. The mask specification is a number between 0 and 255, expressed in hexadecimal, octal or decimal notation.

### Examples

**SPARC Example.**

```c
char *setting = "pic0=EC_ref,pic1=EC_hit"; /* UltraSPARC-specific */
if (cpc_strtoevent(cpuver, setting, &event) != 0)
    /* can’t measure ‘setting’ on this processor */
else
    setting = cpc_eventtostr(&event);
```

### Attributes

See `attributes(5)` for descriptions of the following attributes:

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<thead>
<tr>
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</tr>
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</tbody>
</table>

### See Also

`cpc(3CPC), cpc_getcpuver(3CPC), cpc_seterrfn(3CPC), free(3C),
getsubopt(3C), attributes(5)`
These functions are provided as a convenience only. As new processors are usually released asynchronously with software, the library allows the `pic0` and `pic1` keywords to interpret numeric values specified directly in hexadecimal, octal, or decimal.
cpc_version(3CPC)

NAME cpc_version – coordinate CPC library and application versions

SYNOPSIS
cc [ flag...] file... -lcpc [ library... ]
#include <libcpc.h>

uint_t cpc_version(uint_t version);

DESCRIPTION The cpc_version() function takes an interface version as an argument and returns an interface version as a result. Usually, the argument will be the value of CPC_VER_CURRENT bound to the application when it was compiled.

RETURN VALUES If the version requested is still supported by the implementation, cpc_version() returns the requested version number and the application can use the facilities of the library on that platform. If the implementation cannot support the version needed by the application, cpc_version() returns CPC_VER_NONE, indicating that the application will at least need to be recompiled to operate correctly on the new platform, and may require further changes.

If version is CPC_VER_NONE, cpc_version() returns the most current version of the library.

EXAMPLES
EXAMPLE 1 Protect an application from using an incompatible library.

The following lines of code protect an application from using an incompatible library:

if (cpc_version(CPC_VER_CURRENT) == CPC_VER_NONE) {
    /* version mismatch - library cannot translate */
    exit(1);
}

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

ATTRIBUTE TYPE | ATTRIBUTE VALUE
--- | ---
MT-Level | Unsafe
Availability | SUNWcpcu (32-bit)
 | SUNWcpcux (64-bit)
Interface Stability | Evolving

SEE ALSO cpc(3CPC), attributes(5)

NOTES The version number is used only to express incompatible semantic changes in the performance counter interfaces on the given platform within a single instruction set architecture, for example, when a new set of performance counter registers are added to an existing processor family that cannot be specified in the existing cpc_event_t data structure.
NAME
demangle, cplus_demangle – decode a C++ encoded symbol name

SYNOPSIS
e [ flag ... ] file[ library ... ] -ldemangle
#include <demangle.h>
int cplus_demangle(const char *symbol, char *prototype, size_t size);

DESCRIPTION
The cplus_demangle() function decodes (demangles) a C++ linker symbol name
(mangled name) into a (partial) C++ prototype, if possible. C++ mangled names may
not have enough information to form a complete prototype.

The symbol string argument points to the input mangled name.

The prototype argument points to a user-specified output string buffer, of size bytes.

The cplus_demangle() function operates on mangled names generated by
SPARCompilers C++ 3.0.1, 4.0.1, 4.1 and 4.2.

The cplus_demangle() function improves and replaces the demangle() function.

Refer to the cc.1, dem.1, and c++filt.1 manual pages in the
/opt/SUNWspro/man/man1 directory. These pages are only available with the
SPROcc package.

RETURN VALUES
The cplus_demangle() function returns the following values:

0 The symbol argument is a valid mangled name and
   prototype contains a (partial) prototype for the symbol.

DEMANGLE_ENAME The symbol argument is not a valid mangled name and
   the content of prototype is a copy of the symbol.

DEMANGLE_ESPACE The prototype output buffer is too small to contain the
   prototype (or the symbol), and the content of prototype
   is undefined.
NAME
devid_get, devid_free, devid_get_minor_name, devid_deviceid_to_nmlist,
devid_free_nmlist, devid_compare, devid_sizeof – device ID interfaces for user
applications
SYNOPSIS
cc [ flag ... ] file ... -ldevid [ library ... ]
#include <devid.h>
int devid_get(int fd, ddi_devid_t *retdevid);
void devid_free(ddi_devid_t devid);
int devid_get_minor_name(int fd, char **retminor_name);
int devid_deviceid_to_nmlist(char *search_path, ddi_devid_t devid,
char *minor_name, devid_nmlist_t **reclist);
void devid_free_nmlist(devid_nmlist_t *list);
int devid_compare(ddi_devid_t devid1, ddi_devid_t devid2);
size_t devid_sizeof(ddi_devid_t devid);
DESCRIPTION
These functions provide unique identifiers (device IDs) for devices. Applications and
device drivers use these functions to identify and locate devices, independent of the
device’s physical connection or its logical device name or number.

The devid_get() function returns in retdevid the device ID for the device associated
with the open file descriptor fd, which refers to any device. It returns an error if the
device does not have an associated device ID. The caller must free the memory
allocated for retdevid using the devid_free() function.

The devid_free() function frees the space that was allocated for devid by
devid_get().

The devid_get_minor_name() function returns the minor name, in retminor_name,
for the device associated with the open file descriptor fd. This name is specific to the
particular minor number, but is "instance number" specific. The caller of this function
must free the memory allocated for the returned string in retminor_name using the
devid_free() function.

The devid_deviceid_to_nmlist() function returns an array of devid_nmlist
structures, where each entry matches the devid and minor name passed in. The
devid_nmlist structure contains the device name and device number. The last entry of
the array contains a null pointer for the devname and NODEV for the device number.
This function traverses the file tree, starting at search_path. For each device with a
matching device ID and minor name tuple, a device name and device number are
added to the reclist. If no matches are found, an error is returned. The caller of this
function must free the memory allocated for the returned array with the
devid_free_nmlist() function.

The devid_free_nmlist() function frees the memory allocated by the
devid_deviceid_to_nmlist() function.
The `devid_compare()` function compares two device IDs byte-by-byte and determines both equality and sort order. The function returns an integer greater than 0 if the device ID pointed to by `devid1` is greater than the device ID pointed to by `devid2`. It returns 0 if the device ID pointed to by `devid1` is equal to the device ID pointed to by `devid2`. It returns an integer less than 0 if the device ID pointed to by `devid1` is less than the device ID pointed to by `devid2`.

The `devid_sizeof()` function returns the size in number of bytes allocated for the `devid`.

**RETURN VALUES**

Upon successful completion, the `devid_get()`, `devid_get_minor_name()`, and `devid_deviceid_to_nmlist()` functions return 0. Otherwise, they return -1 and set `errno` to indicate the error.

The `devid_compare()` function returns the following values:

- ≤−1 The device ID pointed to by `devid1` is less than the device ID pointed to by `devid2`.
- 0 The device ID pointed to by `devid1` is equal to the device ID pointed to by `devid2`.
- ≥1 The device ID pointed to by `devid1` is greater than the device ID pointed to by `devid2`.

The `devid_sizeof()` function returns the size in number of bytes allocated for the `devid`.

**EXAMPLES**

**EXAMPLE 1 Using devid_get() and devid_get_minor_name()**

The following example shows the proper use of `devid_get()` and `devid_get_minor_name()` to free the space allocated for `devid` and `minor_name`.

```c
int fd;

int fd;

ddi_devid_t devid;
char *minor_name;
if ((fd = open("/dev/dsk/c0t3d0s0", O_RDONLY|O_NDELAY)) < 0) {
    ...
} else {
    if (devid_get(fd, &devid) != 0) {
        ...
    } else if (devid_get_minor_name(fd, &minor_name) != 0) {
        ...
    }
    < process devid and minor_name >
    devid_free(devid);
    free(minor_name);
```
EXAMPLE 2 Using `devid_deviceid_to_nmlist()` and `devid_free_nmlist()` (Continued)

```c
devid_nmlist_t *list = NULL;
int err;
err = devid_deviceid_to_nmlist("/dev/rdsk", devid, minor_name, &list);
if (err)
    return (err);
// loop through list and process device names and device numbers
    devid_free_nmlist(list);
```

FILES
/usr/lib/libdevid.so.1  location of the device ID library interfaces
/usr/lib/libdevid.so  symlink to /usr/lib/libdevid.so.1

ATTRIBUTES
See attributes(5) for description of the following attributes:

<table>
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</thead>
<tbody>
<tr>
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<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
libdevid(3LIB), attributes(5), ddi_devid_compare(9F), ddi_devid_free(9F), ddi_devid_init(9F), ddi_devid_register(9F), ddi_devid_sizeof(9F), ddi_devid_unregister(9F), ddi_devid_valid(9F)
di_binding_name(3DEVINFO)

NAME
   di_binding_name, di_bus_addr, di_compatible_names, di_devid, di_driver_name,
   di_driver_ops, di_instance, di_nodeid, di_node_name – return libdevinfo node
   information

SYNOPSIS
   #include <libdevinfo.h>
   char *di_binding_name(di_node_t node);
   char *di_bus_addr(di_node_t node);
   int di_compatible_names(di_node_t node, char **names);
   ddi_devid_t di_devid(di_node_t node);
   char *di_driver_name(di_node_t node);
   uint_t di_driver_ops(di_node_t node);
   int di_instance(di_node_t node);
   int di_nodeid(di_node_t node);
   char *di_node_name(di_node_t node);

DESCRIPTION
   These functions extract information associated with a device node.

PARAMETERS
   The following parameter descriptions apply to all interfaces:

   node    A handle to a device node.

   The following parameter description applies only to di_compatible_names():

   names    The address of a pointer.

RETURN VALUES
   di_binding_name()
      The di_binding_name() function returns a pointer to the binding name. The
      binding name is the name used by the system to select a driver for the device.

   di_bus_addr()
      The di_bus_addr() function returns a pointer to a null-terminated string
      containing the assigned bus address for the device. NULL is returned if a bus
      address has not been assigned to the device. A zero-length string may be returned
      and is considered a valid bus address.

   di_compatible_names()
      The return value of di_compatible_names() is the number of compatible
      names. names is updated to point to a buffer contained within the snapshot. The
      buffer contains a concatenation of null-terminated strings, for example:

      <name1>/0<name2>/0...<namen>/0

      See the discussion of generic names in Writing Device Drivers for a description of
      how compatible names are used by Solaris to achieve driver binding for the node.
The `di_devid()` function returns the device ID for `node`, if it is registered. Otherwise, a null pointer is returned. Interfaces in the `libdevid(3LIB)` library may be used to manipulate the handle to the device ID.

This function is obsolete and may be removed from a future Solaris release. Applications should use the “devid” property instead.

The `di_driver_name()` function returns the name of the driver bound to the `node`. A null pointer is returned if `node` is not bound to any driver.

The `di_driver_ops()` function returns a bit array of device driver entry points that are supported by the driver bound to this `node`. Possible bit fields supported by the driver are `DI_CB_OPS`, `DI_BUS_OPS`, `DI_STREAM_OPS`.

The `di_instance()` function returns the instance number of the device. A value of -1 indicates an instance number has not been assigned to the device by the system.

The `di_nodeid()` function returns the type of device, which may be one of the following possible values: `DI_PSEUDO_NODEID`, `DI_PROM_NODEID`, and `DI_SID_NODEID`. Devices of type `DI_PROM_NODEID` may have additional properties that are defined by the PROM. See `di_prom_prop_data(3DEVINFO)` and `di_prom_prop_lookup_bytes(3DEVINFO)`.

The `di_node_name()` function returns a pointer to a null-terminated string containing the node name.

See `di_init(3DEVINFO)` for an example showing typical use of these functions.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving (di_devid() is obsolete)</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`di_init(3DEVINFO)`, `di_prom_init(3DEVINFO)`, `di_prom_prop_data(3DEVINFO)`, `di_prom_prop_lookup_bytes(3DEVINFO)`, `libdevinfo(3DEVINFO)`, `libdevid(3LIB)`, `attributes(5)`

*Writing Device Drivers*
di_child_node(3DEVINFO)

NAME

di_child_node, di_parent_node, di_sibling_node, di_drv_first_node, di_drv_next_node

SYNOPSIS

#include <libdevinfo.h>

di_node_t di_child_node(di_node_t node);
di_node_t di_parent_node(di_node_t node);
di_node_t di_sibling_node(di_node_t node);
di_node_t di_drv_first_node(const char *drv_name, di_node_t root);
di_node_t di_drv_next_node(di_node_t node);

DESCRIPTION

The kernel device configuration data may be viewed in two ways, either as a tree of
device configuration nodes or as a list of nodes associated with each driver. In the tree
view, each node may contain references to its parent, the next sibling in a list of
siblings, and the first child of a list of children. In the per-driver view, each node
contains a reference to the next node associated with the same driver.

Both views are captured in the snapshot, and the interfaces are provided for node
access.

di_child_node() obtains a handle to the first child of node. DI_NODE_NIL is
returned and errno is set to ENXIO or ENOTSUP, if no child node exists in the
snapshot.

di_parent_node() obtains a handle to the parent node of node. DI_NODE_NIL is
returned and errno is set to ENXIO or ENOTSUP, if no parent node exists in the
snapshot.

di_sibling_node() obtains a handle to the next sibling node of node. A
DI_NODE_NIL is returned and errno is set to ENXIO or ENOTSUP, if no next sibling
node exists in the snapshot.

di_drv_first_node() obtains a handle to the first node associated with the driver
specified by drv_name. If there is no such driver, DI_NODE_NIL is returned with
errno is set to EINVAL. If the driver exists, but there is no node associated with this
driver, DI_NODE_NIL is returned and errno is set to ENXIO or ENOTSUP.

di_drv_next_node() returns a handle to the next node bound to the same driver.
DI_NODE_NIL is returned if no more nodes exist.

PARAMETERS

The following parameter descriptions apply to di_child_node(),
di_drv_next_node(), di_parent_node(), and di_sibling_node():

node A handle to any node in the snapshot.

drv_name The name of the driver of interest.
**di_child_node(3DEVINFO)**

*root*  The handle of the root node for the snapshot returned by *di_init().*

**RETURN VALUES**
Upon successful completion, a handle is returned. Otherwise, *DI_NODE_NIL* is returned and *errno* is set to indicate the error.

**ERRORS**
These functions set *errno* as listed for the following conditions:

- **EINVAL**  The argument is invalid.
- **ENXIO**  The requested node does not exist.
- **ENOTSUP**  The node was not found in the snapshot, but it may exist in the kernel. This error may occur if the snapshot contains a partial device tree.

**ATTRIBUTES**
See *attributes(5)* for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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<tbody>
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</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

**SEE ALSO**  *libdevinfo(3DEVINFO),attributes(5)*

*Writing Device Drivers*
NAME
di_devfs_path, di_devfs_path_free – generate and free physical path names

SYNOPSIS
#include <libdevinfo.h>

char *di_devfs_path(di_node_t node);
void di_devfs_path_free(char *path_buf);

DESCRIPTION
di_devfs_path() generates the physical path of the device node. The caller is
responsible for freeing the memory allocated to store the physical path by calling
di_devfs_path_free().

di_devfs_path_free() frees memory that was allocated by di_devfs_path().

PARAMETERS
The parameter descriptions for di_devfs_path() are as follows:

node Handle to a device node in the snapshot.

The parameter descriptions for di_devfs_path_free() are as follows:

path_buf Pointer returned by di_devfs_path().

RETURN VALUES
di_devfs_path() returns a pointer to the string containing the physical path of
node.

ERRORS
EINVAL node is not a valid handle.

di_devfs_path() also return any error code from malloc(3C).

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
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</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO
malloc(3C), libdevinfo(3DEVINFO), attributes(5)

Writing Device Drivers
NAME  
di_init, di_fini – create and destroy a snapshot of kernel device tree

SYNOPSIS  
#include <libdevinfo.h>

di_node_t di_init(const char *phys_path, uint_t flags);
void di_fini(di_node_t root);

DESCRIPTION  
di_init() creates a snapshot of the kernel device tree and returns a handle of the root node. The caller specifies the contents of the snapshot by providing flag and phys_path.

di_fini() destroys the snapshot of the kernel device tree and frees the associated memory. All handles associated with this snapshot become invalid after the call to di_fini().

PARAMETERS  

\textbf{di_init()} 

\textbf{phys_path}  
Physical path of the root node of the snapshot. See di_devfs_path(3DEVINFO).

\textbf{flags}  
Snapshot content specification. The possible values may be a bitwise OR of the following:

- DINFOSUBTREE Include subtree.
- DINFOPROP Include properties.
- DINFOMINOR Include minor data.
- DINFOCPYALL Include all of above. If flags is 0, the snapshot contains only a single node without properties or minor nodes.

\textbf{di_fini()} 

\textbf{root}  
Handle obtained by calling \textbf{di_init()}. 

RETURN VALUES  

\textbf{di_init()}  
Upon success, a handle is returned. Otherwise, DI_NODE_NIL is returned and errno is set to indicate the error.

ERRORS  

\textbf{di_init()} may set errno to any error code that may also be set by open(2), ioctl(2) or mmap(2). The most common error codes include:

- EACCESS Insufficient privilege for accessing device configuration data.
- ENXIO Either the device named by \textit{phys_path} is not present in the system, or the devinfo(7D) driver is not installed properly.
- EINVAL Either \textit{phys_path} is incorrectly formed or the flags argument is invalid.

EXAMPLES  

\textbf{EXAMPLE 1 Using the libdevinfo() Interfaces To Print All Device Tree Node Names} 
The following is an example using the libdevinfo() interfaces to print all device tree node names:
EXAMPLE 1 Using the libdevinfo() Interfaces To Print All Device Tree Node Names

(Continued)

/*
 * Code to print all device tree node names
 */
#include <stdio.h>
#include <libdevinfo.h>

int
prt_nodename(di_node_t node, void *arg)
{
  printf("%s\n", di_node_name(node));
  return (DI_WALK_CONTINUE);
}

main()
{
  di_node_t root_node;
  if((root_node = di_init("/", DINFOSUBTREE)) == DI_NODE_NIL) {
    fprintf(stderr, "di_init() failed\n");
    exit(1);
  }
  di_walk_node(root_node, DI_WALK_CLDFIRST, NULL, prt_nodename);
  di_fini(root_node);
}

EXAMPLE 2 Using the libdevinfo() Interfaces To Print The Physical Path Of SCSI Disks

The following example uses the libdevinfo() interfaces to print the physical path of SCSI disks:

/*
 * Code to print physical path of scsi disks
 */
#include <stdio.h>
#include <libdevinfo.h>
#define DISK_DRIVER "sd" /* driver name */

void
prt_diskinfo(di_node_t node)
{
  int instance;
  char *phys_path;

  /*
   * If the device node exports no minor nodes,
   * there is no physical disk.
   */
  if (di_minor_next(node, DI_MINOR_NIL) == DI_MINOR_NIL) {
    return;
  }

EXAMPLE 2 Using the libdevinfo() Interfaces To Print The Physical Path Of SCSI Disks  (Continued)

    instance = di_instance(node);
    phys_path = di_devfs_path(node);
    printf("%s%d: %s\n", DISK_DRIVER, instance, phys_path);
    di_devfs_path_free(phys_path);
}

void
walk_disknodes(di_node_t node)
{
    node = di_drv_first_node(DISK_DRIVER, node);
    while (node != DI_NODE_NIL) {
        prt_diskinfo(node);
        node = di_drv_next_node(node);
    }
}

main()
{
    di_node_t root_node;
    if ((root_node = di_init("/", DINFOCPYALL)) == DI_NODE_NIL) {
        fprintf(stderr, "di_init() failed\n");
        exit(1);
    }
    walk_disknodes(root_node);
    di_fini(root_node);
}

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
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<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO
open(2), ioctl(2), mmap(2), libdevinfo(3DEVINFO), attributes(5)

Writing Device Drivers
di_minor_devt(3DEVIINFO)

NAME
di_minor_devt, di_minor_name, di_minor_nodetype, di_minor_spectype – return libdevinfo minor node information

SYNOPSIS
#include <libdevinfo.h>

dev_t di_minor_devt(di_minor_t minor);
char *di_minor_name(di_minor_t minor);
char *di_minor_nodetype(di_minor_t minor);
int di_minor_spectype(di_minor_t minor);

DESCRIPTION
These interfaces are used to return libdevinfo minor node information.

PARAMETERS
minor A handle to minor data node.

RETURN VALUES
di_minor_name() di_minor_name() returns the minor name. See ddi_create_minor_node(9F) for a description of the name parameter.

di_minor_devt() The function di_minor_devt() returns the dev_t value of the minor node that is specified by SYS V ABI. See getmajor(9F), getminor(9F), and ddi_create_minor_node(9F) for more information.

di_minor_spectype() di_minor_spectype() returns the spec_type of the file, either S_IFCHR or S_IFBLK. See ddi_create_minor_node(9F) for a description of the spec_type parameter.

di_minor_nodetype() di_minor_nodetype() returns the minor node_type of the minor node. See ddi_create_minor_node(9F) for a description of the node_type parameter.

ERRORS
No error codes are returned.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO
attributes(5), ddi_create_minor_node(9F), getmajor(9F), getminor(9F)

Writing Device Drivers
#include <libdevinfo.h>

di_minor_t di_minor_next(di_node_t node, di_minor_t minor);

`di_minor_next()` returns a handle to the next minor node for the device node `node`. If `minor` is `DI_MINOR_NIL`, a handle to the first minor node is returned.

### Parameters
- **node**: Device node with which the minor node is associated.
- **minor**: Handle to the current minor node or `DI_MINOR_NIL`.

### Return Values
Upon successful completion, a handle to the next minor node is returned. Otherwise, `DI_MINOR_NIL` is returned and `errno` is set to indicate the error.

### Errors
`errno` is set as listed for the following conditions:
- **EINVAL**: Invalid argument.
- **ENXIO**: End of minor node list.
- **ENOTSUP**: Minor node information is not available in snapshot.

### Attributes
See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>Attribute Type</th>
<th>Attribute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

### SEE ALSO
- `libdevinfo(3DEVINFO),attributes(5)`
- *Writing Device Drivers*
**di_prom_init(3DEVINFO)**

**NAME**

di_prom_init, di_prom_fini – create and destroy a handle to the PROM device information

**SYNOPSIS**

```c
#include <libdevinfo.h>

di_prom_handle_t di_prom_init();

void di_prom_fini(di_prom_handle_t ph);
```

**DESCRIPTION**

For device nodes whose `nodeid` value is `DI_PROM_NODEID` (see `di_nodeid(3DEVINFO)`), additional properties may be retrieved from the PROM. `di_prom_init()` returns a handle that is used to retrieve such properties. This handle is passed to `di_prom_prop_lookup_bytes(3DEVINFO)` and `di_prom_prop_next(3DEVINFO)`. `di_prom_fini()` destroys the handle and all handles to PROM device information obtained from that handle.

**PARAMETERS**

- `ph` Handle to prom returned by `di_prom_init()`.

**RETURN VALUES**

- `di_prom_init()` Upon successful completion, a handle is returned. Otherwise, `DI_PROM_HANDLE_NIL` is returned and `errno` is set to indicate the error.

**ERRORS**

- `di_prom_init()` sets `errno` to any error code that may also be set by `openprom(7D)` or `malloc(3C)`.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

**SEE ALSO**

di_nodeid(3DEVINFO), di_prom_prop_next(3DEVINFO), di_prom_prop_lookup_bytes(3DEVINFO)
NAME  di_prom_prop_data, di_prom_prop_next, di_prom_prop_name – access PROM device information

SYNOPSIS

```c
#include <libdevinfo.h>

di_prom_prop_t di_prom_prop_next(di_prom_handle_t ph, di_node_t node, di_prom_prop_t prom_prop);

char *di_prom_prop_name(di_prom_prop_t prom_prop);

int di_prom_prop_data(di_prom_prop_t prom_prop, uchar_t **prop_data);
```

DESCRIPTION

di_prom_prop_next() obtains a handle to the next property on the PROM property list associated with `node`. If `prom_prop` is DI_PROM_PROP_NIL, the first property associated with `node` is returned.

di_prom_prop_name() returns the name of the `prom_prop` property.

di_prom_prop_data() returns the value of the `prom_prop` property. The return value is a non-negative integer specifying the size in number of bytes in `prop_data`.

All memory allocated by these functions is managed by the library and must not be freed by the caller.

PARAMETERS

- **All Interfaces**
  - `prom_prop` Handle to a PROM property.
  - `prop_data` Address of a pointer.
  - `ph` PROM handle
  - `node` Handle to a device node in the snapshot of kernel device tree.

RETURN VALUES

- **di_prom_prop_data()** returns the number of bytes in `prop_data` and `prop_data` is updated to point to a byte array containing the property value. If 0 is returned, the property is a boolean property, and the existence of this property indicates the value is true.

- **di_prom_prop_name()** returns a pointer to a string that contains the name of `prom_prop`.

- **di_prom_prop_next()** returns a handle to the next PROM property. DI_PROM_PROP_NIL is returned if no additional properties exist.

ERRORS

See openprom(7D) for a description of possible errors.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:
### di_prom_prop_data(3DEVINFO)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO  
attributes(5), openprom(7D)

*Writing Device Drivers*
# NAME
di_prom_prop_lookup_bytes, di_prom_prop_lookup_ints,
di_prom_prop_lookup_strings – search for a PROM property

## SYNOPSIS

```c
#include <libdevinfo.h>

int di_prom_prop_lookup_bytes(di_prom_handle_t ph, di_node_t node,
                               const char *prop_name, uchar_t **prop_data);

int di_prom_prop_lookup_ints(di_prom_handle_t ph, di_node_t node,
                              const char *prop_name, int **prop_data);

int di_prom_prop_lookup_strings(di_prom_handle_t ph, di_node_t node,
                                 const char *prop_name, char **prop_data);
```

## DESCRIPTION

These functions are used for returning the value of a known PROM property name
and value type. These functions will update the `prop_data` pointer to reference memory
that contains the property value. All memory allocated by these functions is managed
by the library and must not be freed by the caller.

## PARAMETERS

The following parameter descriptions apply to all interfaces:

- `node` Handle to device node in snapshot created by
di_init(3DEVINFO).
- `ph` Handle returned by di_prom_init(3DEVINFO).
- `prop_name` Name of the property being searched.

The following parameter description applies to `di_prom_prop_lookup_bytes()`
only:

- `prop_data` The address of a pointer to an array of unsigned characters.

The following parameter description applies to `di_prom_prop_lookup_ints()`
only:

- `prop_data` The address of a pointer to an integer.

The following parameter description applies to `di_prom_prop_lookup_strings`
only:

- `prop_data` The address of pointer to a buffer.

## RETURN VALUES

If the property is found, the number of entries in `prop_data` is returned. If the property
is a boolean type, 0 is returned, and the existence of this property indicates the value
is true. Otherwise, -1 is returned with `errno` set to indicate the error condition.

For `di_prom_prop_lookup_bytes()`, the number of entries is the number of
unsigned characters contained in the buffer pointed to by `prop_data`.

For `di_prom_prop_lookup_ints()`, the number of entries is the number of
integers contained in the buffer pointed to by `prop_data`. 

---

Extended Library Functions 99
For `di_prom_prop_lookup_strings()`, the number of entries is the number of
null-terminated strings contained in the buffer. The strings are stored in a
concatenated format in the buffer.

**ERRORS**

These functions set `errno` as listed for the following conditions:

- **EINVAL** Invalid argument.
- **ENXIO** The property does not exist.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</thead>
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<td>Safe</td>
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<td>Interface Stability</td>
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</tr>
</tbody>
</table>

**SEE ALSO**

`di_init(3DEVINFO),di_prom_prop_next(3DEVINFO),libdevinfo(3DEVINFO),attributes(5),op

*Writing Device Drivers*
These interfaces are used to access information associated with property values and attributes.

All memory allocated by these functions is managed by the library and must not be freed by the caller.

di_prop_name() returns the name of the property.

di_prop_type() returns the type of the property. The type determines the appropriate interface to access property values. The following is a list of possible types:

- **DI_PROP_TYPE_BOOLEAN**: There is no interface to call since there is no property data associated with boolean properties. The existence of the property defines a TRUE value.
- **DI_PROP_TYPE_INT**: Use di_prop_ints() to access property data.
- **DI_PROP_TYPE_STRING**: Use di_prop_strings() to access property data.
- **DI_PROP_TYPE_BYTE**: Use di_prop_bytes() to access property data.
- **DI_PROP_TYPE_UNKNOWN**: Use di_prop_bytes() to access property data. Since the type of property is unknown, the caller is responsible for interpreting the contents of the data.

**DI_PROP_UNDEFINED**: The property has been undefined by the driver. No property data is available.

di_prop_dev() returns the dev_t with which this property is associated. If the value is DDI_DEV_T_NONE, the property is not defined for a specific minor node.

di_prop_bytes() returns the property data as a series of unsigned characters.
di_prop_bytes(3DEVINFO)

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>di_prop_ints()</td>
<td>returns the property datat as a series of integers.</td>
</tr>
<tr>
<td>di_prop_strings()</td>
<td>returns the property data as a concatenation of null-terminated strings.</td>
</tr>
</tbody>
</table>

PARAMETERS

<table>
<thead>
<tr>
<th>Interface</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Interfaces</td>
<td>prop</td>
<td>Handle to a property returned by di_prop_next(3DEVINFO).</td>
</tr>
<tr>
<td>di_prop_bytes</td>
<td>prop_data</td>
<td>The address of a pointer to an unsigned character.</td>
</tr>
<tr>
<td>di_prop_ints</td>
<td>prop_data</td>
<td>The address of a pointer to an integer.</td>
</tr>
<tr>
<td>di_prop_strings</td>
<td>prop_data</td>
<td>The address of pointer to a character.</td>
</tr>
</tbody>
</table>

RETURN VALUES

Upon successful completion, these interfaces return a non-negative value, indicating the number of entries in the property value buffer. See di_prom_prop_lookup_bytes(3DEVINFO) for a description of the return values. Otherwise, -1 is returned and errno is set to indicate the error condition.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>di_prop_devt</td>
<td>di_prop_devt() returns the dev_t value associated with the property.</td>
</tr>
<tr>
<td>di_prop_name</td>
<td>di_prop_name() returns a pointer to a string containing the name of the property.</td>
</tr>
<tr>
<td>di_prop_type</td>
<td>di_prop_type() may return one of various types described in the DESCRIPTION section.</td>
</tr>
</tbody>
</table>

ERRORS

These functions set errno as listed for the following conditions:

- EINVAL Invalid argument. For example, the property type does not match the interface.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
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</tbody>
</table>

SEE ALSO

di_prom_prop_lookup_bytes(3DEVINFO), di_prop_next(3DEVINFO), libdevinfo(3DEVINFO), a...

Writing Device Drivers
di_prop_lookup_bytes, di_prop_lookup_ints, di_prop_lookup_strings – search for a property

SYNOPSIS

#include <libdevinfo.h>

int di_prop_lookup_bytes(dev_t dev, di_node_t node, const char *prop_name, uchar_t **prop_data);

int di_prop_lookup_ints(dev_t dev, di_node_t node, const char *prop_name, int **prop_data);

int di_prop_lookup_strings(dev_t dev, di_node_t node, const char *prop_name, char **prop_data);

DESCRIPTION

These functions are used for returning the value of a known property name type and dev_t value.

All memory allocated by these functions is managed by the library and must not be freed by the caller.

PARAMETERS

All Interfaces

| dev     | dev_t of minor node with which the property is associated. DDI_DEV_T_ANY is a wild card that matches all dev_t’s, including DDI_DEV_T_NONE. |
| node    | Handle to the device node with which the property is associated. |
| prop_name | Name of the property for which to search. |

| prop_data | Address to a pointer to an array of unsigned characters containing the property data. |
| prop_data | Address to a pointer to an array of integers containing the property data. |
| prop_data | Address to a pointer to a buffer containing a concatenation of null-terminated strings containing the property data. |

RETURN VALUES

If the property is found, the number of entries in prop_data is returned. If the property is a boolean type, 0 is returned, and the existence of this property indicates the value is true. Otherwise, -1 is returned with errno set to indicate the error condition.

ERRORS

These functions set errno as listed for the following conditions:

| EINVAL | Invalid argument. |
| ENOTSUP | The snapshot contains no property information. |
| ENXIO | The property does not exist; try di_prom_prop_lookup_*( ). |
di_prop_lookup_bytes(3DEVINFO)

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO

di_init(3DEVINFO), di_prom_prop_lookup_bytes(3DEVINFO), libdevinfo(3DEVINFO), attributes(5)

Writing Device Drivers
NAME  

  di_prop_next – libdevinfo property traversal function

SYNOPSIS

  #include <libdevinfo.h>

  di_prop_t di_prop_next(di_node_t node, di_prop_t prop);

DESCRIPTION

  The function di_prop_next() returns a handle to the next property on the property
  list. If prop is DI_PROP_NIL, the handle to the first property is returned.

PARAMETERS

  node Handle to a device node.

  prop Handle to a property.

RETURN VALUES

  Upon successful completion, di_prop_next() returns a handle. Otherwise
  DI_PROP_NIL is returned, and errno is set to indicate the error condition.

ERRORS

  The di_prop_next() functions sets errno as listed for the following conditions:

  EINVAL    Invalid argument.

  ENOTSUP   Snapshot does not contain property information.

  ENXIO     There are no more properties.

ATTRIBUTES

  See attributes(5) for descriptions of the following attributes:

  ATTRIBUTE TYPE     ATTRIBUTE VALUE

  MT Level           Safe

  Interface Stability Evolving

SEE ALSO

  di_init(3DEVINFO), libdevinfo(3DEVINFO), attributes(5)

  Writing Device Drivers
DisconnectToServer(3DMI)

NAME
DisconnectToServer – disconnect from a DMI service provider

SYNOPSIS
c [ flag ... ] file ... -ldmici -ldmimi [ library ... ]
#include <dmi/api.hh>

bool_t DisconnectToServer(DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION
The DisconnectToServer() function disconnects a management application or a
component instrumentation from a DMI service provider.

RETURN VALUES
The ConnectToServer() function returns TRUE if successful, otherwise FALSE.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
ConnectToServer(3DMI), attributes(5)
di_walk_minor() visits all minor nodes attached to device nodes in a subtree rooted at root. For each minor node that matches minor_nodetype, the caller-supplied function minor_callback() is invoked. The walk terminates immediately when minor_callback() returns DI_WALK_TERMINATE.

root Root of subtree to visit.
minor_nodetype A character string specifying the minor data type, which may be one of the types defined by the Solaris DDI framework, for example, DDI_NT_BLOCK. NULL matches all minor_node types. See ddi_create_minor_node(9F).
flag Specify 0. Reserved for future use.
arg Pointer to caller–specific user data.
minor_callback node The device node with which the minor node is associated.
minor The minor node visited.
arg Pointer to caller–specific data.

Upon successful completion, 0 is returned. Otherwise, -1 is returned and errno is set to indicate the error.

The allowed return values are:
DI_WALK_CONTINUE Continue to visit subsequent minor data nodes.
DI_WALK_TERMINATE Terminate the walk immediately.

EINVAL Invalid argument.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>
di_walk_minor(3DEVINFO)

SEE ALSO  di_minor_nodetype(3DEVINFO), libdevinfo(3DEVINFO), attributes(5), ddi_create_minor_node(5).

Writing Device Drivers
#include <libdevinfo.h>

int di_walk_node(di_node_t root, uint_t flag, void *arg, int (*node_callback)(di_node_t node, void *arg));

di_walk_node() visits all nodes in the subtree rooted at root. For each node found, the caller-supplied function node_callback() is invoked. The return value of node_callback() specifies subsequent walking behavior.

**root** Handle to the root node of the subtree to visit.

**flag** Specifies walking order, either DI_WALK_CLDFIRST (depth first) or DI_WALK_SIBFIRST (breadth first). DI_WALK_CLDFIRST is the default.

**arg** Pointer to caller–specific data.

**node_callback**

**node** The node being visited.

**arg** Pointer to caller–specific data.

0 is returned upon success. Otherwise, -1 is returned, and errno is set to indicate the error.

The allowed return values are:

- DI_WALK_CONTINUE: Continue walking.
- DI_WALK_PRUNESIB: Continue walking, but skip siblings and their child nodes.
- DI_WALK_PRUNECHILD: Continue walking, but skip subtree rooted at current node.
- DI_WALK_TERMINATE: Terminate the walk immediately.

**EINVAL** Invalid argument.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
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</thead>
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<td>MT Level</td>
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<td>Evolving</td>
</tr>
</tbody>
</table>

**SEE ALSO**

di_init(3DEVINFO), libdevinfo(3DEVINFO), attributes(5)
di_walk_node(3DEVINFO)

Writing Device Drivers
NAME

DmiAddComponent, DmiAddGroup, DmiAddLanguage, DmiDeleteComponent, DmiDeleteGroup, DmiDeleteLanguage – Management Interface database administration functions

SYNOPSIS

cc [ flag ... ] file ... -ldmimi -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/server.h>
#include <dmi/miapi.h>

#include <dmi/server.h>
#include <dmi/miapi.h>
bool_t DmiAddComponent(DmiAddComponentIN argin, DmiAddComponentOUT *result, DmiRpcHandle *dmi_rpc_handle);  
bool_t DmiAddGroup(DmiAddGroupIN argin, DmiAddGroupOUT *result, DmiRpcHandle *dmi_rpc_handle);  
bool_t DmiAddLanguage(DmiAddLanguageIN argin, DmiAddLanguageOUT *result, DmiRpcHandle *dmi_rpc_handle);  
bool_t DmiDeleteComponent(DmiDeleteComponentIN argin, DmiDeleteComponentOUT *result, DmiRpcHandle *dmi_rpc_handle);  
bool_t DmiDeleteGroup(DmiDeleteGroupIN argin, DmiDeleteGroupOUT *result, DmiRpcHandle *dmi_rpc_handle);  
bool_t DmiDeleteLanguage(DmiDeleteLanguageIN argin, DmiDeleteLanguageOUT *result, DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION

The database administration functions add a new component to the database or add a new language mapping for an existing component. You may also remove an existing component, remove a specific language mapping, or remove a group from a component.

The DmiAddComponent() function adds a new component to the DMI database. It takes the name of a file, or the address of memory block containing MIF data, checks the data for adherence to the DMI MIF grammar, and installs the MIF in the database. The procedure returns a unique component ID for the newly installed component. The argin parameter is an instance of a DmiAddComponentIN structure containing the following members:

DmiHandle_t handle;    /* an open session handle */
DmiFileDataList_t *fileData; /* MIF data for component */

The result parameter is a pointer to a DmiAddComponentOUT structure containing the following members:

DmiErrorStatus_t error_status;
DmiId_t compId;  /* SP-allocated component ID */
DmiStringList_t *errors; /* installation error messages */

The DmiAddLanguage() function adds a new language mapping for an existing component in the database. It takes the name of a file, or the address of memory block containing translated MIF data, checks the data for adherence to the DMI MIF grammar, and installs the language MIF in the database. The argin parameter is an instance of a DmiAddLanguageIN structure containing the following members:

DmiHandle_t handle;  /* an open session handle */
DmiFileDataList_t *fileData; /* translated MIF data for component */

The result parameter is a pointer to a DmiAddLanguageOUT structure containing the following members:

DmiErrorStatus_t error_status;
DmiId_t compId;  /* SP-allocated component ID */
DmiStringList_t *errors; /* language mapping installation error messages */

Extended Library Functions  111
The `DmiAddComponent()` function adds a new component to an existing component in the database. It takes the name of a file, or the address of memory block containing the component’s MIF data, checks the data for adherence to the DMI MIF grammar, and installs the component MIF in the database. The `argin` parameter is an instance of a `DmiAddComponentIN` structure containing the following members:

- `DmiHandle_t handle; /* an open session handle */`
- `DmiFileDataList_t *fileData; /* MIF file data for component */`
- `DmiId_t compId; /* component to access */`

The `result` parameter is a pointer to a `DmiAddComponentOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`
- `DmiId_t compId; /* component ID */`
- `DmiStringList_t *errors; /* installation error messages */`

The `DmiDeleteComponent()` function removes an existing component from the database. The `argin` parameter is an instance of a `DmiDeleteComponentIN` structure containing the following members:

- `DmiHandle_t handle; /* an open session handle */`
- `DmiId_t compId; /* component to delete */`

The `result` parameter is a pointer to a `DmiDeleteComponentOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`

The `DmiDeleteLanguage()` function removes a specific language mapping for a component. You specify the language string and component ID. The `argin` parameter is an instance of a `DmiDeleteLanguageIN` structure containing the following members:

- `DmiHandle_t handle; /* an open session handle */`
- `DmiString_t *language; /* language to delete */`
- `DmiId_t compId; /* component to access */`

The `result` parameter is a pointer to a `DmiDeleteLanguageOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`

The `DmiDeleteGroup()` function removes a group from a component. The caller specifies the component and group IDs. The `argin` parameter is an instance of a `DmiDeleteGroupIN` structure containing the following members:

- `DmiHandle_t handle; /* an open session handle */`
- `DmiId_t compId; /* component to access */`
- `DmiString_t *groupName; /* group name to delete */`

The `result` parameter is a pointer to a `DmiDeleteGroupOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`
DmiAddComponent(3DMI)

```
DmiHandle_t handle; /* an open session handle */
DmiId_t compId;   /* component containing group */
DmiId_t groupId; /* group to delete */
```

The `result` parameter is a pointer to a DmiDeleteGroupOUT structure containing the following members:

```
DmiErrorStatus_t error_status;
```

**RETURN VALUES**

The DmiAddComponent() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_FILE_ERROR
- DMIERR_BAD_SCHEMA_DESCRIPTION_FILE

The DmiAddGroup() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_INSUFFICIENT_PRIVILEGES
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR
- DMIERR_BAD_SCHEMA_DESCRIPTION_FILE

The DmiAddLanguage() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR
- DMIERR_BAD_SCHEMA_DESCRIPTION_FILE

The DmiDeleteComponent() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_INSUFFICIENT_PRIVILEGES
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR

The DmiDeleteGroup() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
The DmiDeleteLanguage() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>SUNWsasdk</td>
</tr>
<tr>
<td>MT-level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO

attributes(5)
DmiAddRow(3DMI)

NAME
DmiAddRow, DmiDeleteRow, DmiGetAttribute, DmiGetMultiple, DmiSetAttribute,
DmiSetMultiple – Management Interface operation functions

SYNOPSIS
cc [ flag ... ] file ... -lmdir -ldmi -lnsl -lrwtool [ library ... ]
#include <server.h>
#include <miapi.h>

bool_t DmiAddRow(DmiAddRowIN argin, DmiAddRowOUT *result,
                  DmiRpcHandle *dmi_rpc_handle);

bool_t DmiDeleteRow(DmiDeleteRowIN argin, DmiDeleteRowOUT *result,
                    DmiRpcHandle *dmi_rpc_handle);

bool_t DmiGetAttribute(DmiGetAttributeIN argin, DmiGetAttributeOUT
                        *result, DmiRpcHandle *dmi_rpc_handle);

bool_t DmiGetMultiple(DmiGetMultipleIN argin, DmiGetMultipleOUT
                       *result, DmiRpcHandle *dmi_rpc_handle);

bool_t DmiSetAttribute(DmiSetAttributeIN argin, DmiSetAttributeOUT
                        *result, DmiRpcHandle *dmi_rpc_handle);

bool_t DmiSetMultiple(DmiSetMultipleIN argin, DmiSetMultipleOUT
                      *result, DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION
The operation functions provide a method for retrieving a single value from the
Service Provider and for setting a single attribute value. In addition, you may also
retrieve attribute values from the Service Provider. You may perform a set operation
on an attribute or a list of attributes and add or delete a row from an existing table.

The DmiAddRow() function adds a row to an existing table. The rowData parameter
contains the full data, including key attribute values, for a row. It is an error for the
key list to specify an existing table row. The argin parameter is an instance of a
DmiAddRowIN structure containing the following members:

DmiHandle_t handle; /* An open session handle */
DmiRowData_t **rowData; /* Attribute values to set */

The result parameter is a pointer to a DmiAddRowOUT structure containing the
following members:

DmiErrorStatus_t error_status;

DmiDeleteRow() function removes a row from an existing table. The key list must
specify valid keys for a table row. The argin parameter is an instance of a
DmiDeleteRowIN structure containing the following members:

DmiHandle_t handle; /* An open session handle */
DmiRowData_t rowData; /* Row to delete */

The result parameter is a pointer to a DmiDeleteRowOUT structure containing the
following members:

DmiErrorStatus_t error_status;
The DmiGetAttribute() function provides a simple method for retrieving a single attribute value from the Service Provider. The compId, groupId, attribId, and keyList identify the desired attribute. The resulting attribute value is returned in a newly allocated DmiDataUnion structure. The address of this structure is returned through the value parameter. The argin parameter is an instance of a DmiListComponentsIN structure containing the following members:

- DmiHandle_t handle; /* an open session handle */
- DmiId_t compId; /* Component to access */
- DmiId_t groupId; /* Group within component */
- DmiId_t attribId; /* Attribute within a group */
- DmiAttributeValues_t *keyList; /* Keylist to specify a table row */

The result parameter is a pointer to a DmiGetAttributeOUT structure containing the following members:

- DmiErrorStatus_t error_status;
- DmiDataUnion_t *value; /* Attribute value returned */

The DmiGetMultiple() function retrieves attribute values from the Service Provider. This procedure may get the value for an individual attribute, or for multiple attributes across groups, components, or rows of a table.

The DmiSetAttribute() function provides a simple method for setting a single attribute value. The compId, groupId, attribId, and keyList identify the desired attribute. The setMode parameter defines the procedure call as a Set, Reserve, or Release operation. The new attribute value is contained in the DmiDataUnion structure whose address is passed in the value parameter. The argin parameter is an instance of a DmiSetAttributeIN structure containing the following members:

- DmiHandle_t handle; /* An open session handle */
- DmiId_t compId;
- DmiId_t groupId;
- DmiId_t attribId;
- DmiAttributeValues_t *keyList;
- DmiSetMode_t setMode;
- DmiDataUnion_t *value;

The result parameter is a pointer to a DmiSetAttributeOUT structure containing the following members:

- DmiErrorStatus_t error_status;

The DmiSetMultiple() function performs a set operation on an attribute or list of attributes. Set operations include actually setting the value, testing and reserving the attribute for future setting, or releasing the set reserve. These variations on the set operation are specified by the parameter setMode. The argin parameter is an instance of a DmiSetMultipleIN structure containing the following members:

- DmiHandle_t handle; /* An open session handle */
- DmiSetMode_t setMode; /* set, reserve, or release */
- DmiMultiRowData_t *rowData; /* Attribute values to set */

The result parameter is a pointer to a DmiSetMultipleOUT structure containing the following members:

- DmiErrorStatus_t error_status;
DmiErrorStatus_t error_status;

The rowData array describes the attributes to set, and contains the new attribute values. Each element of rowData specifies a component, group, key list (for table accesses), and attribute list to set. No data is returned from this function.

**RETURN VALUES**

The DmiAddRow() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_VALUE_UNKNOWN
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_VALUE_UNKNOWN
- DMIERR_UNABLE_TO_ADD_ROW

The DmiDeleteRow() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_ATTRIBUTE_NOT_FOUND
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_ILLEGAL_TO_GET
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_ROW_NOT_FOUND
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_VALUE_UNKNOWN
- DMIERR_UNABLE_TO_DELETE_ROW

The DmiGetAttribute() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_ATTRIBUTE_NOT_FOUND
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_ILLEGAL_TO_GET
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_ROW_NOT_FOUND
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_FILE_ERROR
- DMIERR_VALUE_UNKNOWN
The DmiGetMultiple() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_RPC_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_ATTRIBUTE_NOT_FOUND
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_ILLEGAL_TO_GET
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_ROW_NOT_FOUND
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_FILE_ERROR
- DMIERR_VALUE_UNKNOWN

The DmiSetAttribute() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_ATTRIBUTE_NOT_FOUND
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_ILLEGAL_TO_GET
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_ROW_NOT_FOUND
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_FILE_ERROR
- DMIERR_VALUE_UNKNOWN

The DmiSetMultiple() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_ATTRIBUTE_NOT_FOUND
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_GROUP_NOT_FOUND
- DMIERR_ILLEGAL_KEYS
- DMIERR_ILLEGAL_TO_SET
- DMIERR_DIRECT_INTERFACE_NOT_REGISTERED
- DMIERR_ROW_NOT_FOUND
- DMIERR_UNKNOWN_CI_REGISTRY
- DMIERR_FILE_ERROR
- DMIERR_VALUE_UNKNOWN
**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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</tr>
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<tbody>
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<td>MT-level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

attributes(5)
dmi_error(3DMI)

NAME dmi_error – print error in string form

SYNOPSIS cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/dmi_error.hh>

    void dmi_error(DmiErrorStatus_t error_status);

DESCRIPTION For the given error_status, the dmi_error() function prints the corresponding error
in string form. The function prints "unknown dmi errors" if error_status is invalid.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
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</tbody>
</table>

SEE ALSO libdmi(3LIB), attributes(5)
DmiGetConfig(3DMI)

NAME
DmiGetConfig, DmiGetVersion, DmiRegister, DmiSetConfig, DmiUnregister –
Management Interface initialization functions

SYNOPSIS
cc [ flag ... ] file ... -ldmimi -ldmi -lnsl -lrwtool [ library ... ]
#include <server.h>
#include <miapi.h>

bool_t DmiGetConfig(DmiGetConfigIN argin, DmiGetConfigOUT *result,
    DmiRpcHandle *dmi_rpc_handle);

bool_t DmiGetVersion(DmiGetVersionIN argin, DmiGetVersionOUT *result,
    DmiRpcHandle *dmi_rpc_handle);

bool_t DmiRegister(DmiRegisterIN argin, DmiRegisterOUT *result,
    DmiRpcHandle *dmi_rpc_handle);

bool_t DmiSetConfig(DmiSetConfigIN argin, DmiSetConfigOUT *result,
    DmiRpcHandle *dmi_rpc_handle);

bool_t DmiUnregister(DmiUnregisterIN argin, DmiUnregisterOUT *result,
    DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION
The Management Interface initialization functions enable you to register management
applications to the Service Provider. You may also retrieve information about the
Service Provider, get and set session configuration information for your session.

The DmiGetConfig() function retrieves the per-session configuration information.
The configuration information consists of a string describing the current language
being used for the session. The argin parameter is an instance of a DmiGetConfigIN
structure containing the following member:

DmiHandle_t handle; /* an open session handle */

The result parameter is a pointer to a DmiGetConfigOUT structure containing the
following members:

DmiErrorStatus_t error_status;
DmiString_t *language; /* current session language */

The DmiGetVersion() function retrieves information about the Service Provider.
The management application uses the DmiGetVersion() procedure to determine the
DMI specification level supported by the Service Provider. This procedure also returns
the service provided description string, and may contain version information about
the Service Provider implementation. The argin parameter is an instance of a
DmiGetVersionIN structure containing the following member:

DmiHandle_t handle; /* an open session handle */

The result parameter is a pointer to a DmiGetVersionOUT structure containing the
following members:

DmiErrorStatus_t error_status;
DmiString_t *dmiSpecLevel; /* DMI specification version */
DmiString_t *description; /* OS specific DMI SP version */
DmiFileTypeList_t *fileTypes; /* file types for MIF installation */
DmiRegister() function provides the management application with a unique per-session handle. The Service Provider uses this procedure to initialize to an internal state for subsequent procedure calls made by the application. This procedure must be the first command executed by the management application. argin is an instance of a DmiRegisterIN structure containing the following member:

DmiHandle_t handle; /* an open session handle */

The result parameter is a pointer to a DmiRegisterOUT structure containing the following members:

DmiErrorStatus_t error_status;
DmiHandle_t *handle; /* an open session handle */

DmiSetConfig() function sets the per-session configuration information. The configuration information consists of a string describing the language required by the management application. The argin parameter is an instance of a DmiSetConfigIN structure containing the following member:

DmiHandle_t handle; /* an open session handle */
DmiString_t *language; /* current language required */

The result parameter is a pointer to a DmiSetConfigOUT structure containing the following member:

DmiErrorStatus_t error_status;

DmiUnregister() function is used by the Service Provider to perform end-of-session cleanup actions. On return from this function, the session handle is no longer valid. This function must be the last DMI command executed by the management application. The argin parameter is an instance of a DmiUnregisterIN structure containing the following member:

DmiHandle_t handle; /* an open session handle */

The result parameter is a pointer to a DmiUnregisterOUT structure containing the following members:

DmiErrorStatus_t error_status;

RETURN VALUES

The DmiGetConfig() function returns the following possible values:

DMIERR_NO_ERROR
DMIERR_ILLEGAL_RPC_HANDLE
DMIERR_OUT_OF_MEMORY
DMIERR_ILLEGAL_PARAMETER
DMIERR_SP_INACTIVE

The DmiGetVersion() function returns the following possible values:

DMIERR_NO_ERROR
DMIERR_ILLEGAL_RPC_HANDLE
DMIERR_OUT_OF_MEMORY
DMIERR_SP_INACTIVE

The DmiRegister() function returns the following possible values:
The `DmiSetConfig()` function returns the following possible values:

- `DMIERR_NO_ERROR`
- `DMIERR_ILLEGAL_RPC_HANDLE`
- `DMIERR_OUT_OF_MEMORY`
- `DMIERR_ILLEGAL_PARAMETER`
- `DMIERR_SP_INACTIVE`
- `DMIERR_ILLEGAL_TO_SET`

The `DmiUnRegister()` function returns the following possible values:

- `DMIERR_NO_ERROR`
- `DMIERR_ILLEGAL_RPC_HANDLE`
- `DMIERR_OUT_OF_MEMORY`
- `DMIERR_ILLEGAL_PARAMETER`
- `DMIERR_SP_INACTIVE`

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

attributes(5)
The listing functions enables you to retrieve the names and the description of components in a system. You may also list components by class that match a specified criteria. The listing functions retrieve the set of language mappings installed for a specified component, retrieve class name strings for all groups in a component, retrieve a list of groups within a component, and retrieve the properties for one or more attributes in a group.

The DmiListComponents() function retrieves the name and (optionally) the description of components in a system. Use this to interrogate a system to determine what components are installed. The argin parameter is an instance of a DmiListComponentsIN structure containing the following members:

- DmiHandle_t handle; /* an open session handle */
- DmiRequestMode_t requestMode; /* Unique, first, or next */
- DmiUnsigned_t maxCount; /* maximum number to return, 0 for all */
- DmiBoolean_t getPragma; /* get optional pragma string */
- DmiBoolean_t getDescription; /* get optional component description */
- DmiId_t compId; /* component ID to start with */

The result parameter is a pointer to a DmiListComponentsOUT structure containing the following members:

- DmiErrorStatus_t error_status;
- DmiComponentList_t *reply; /* list of components */
An enumeration accesses a specific component or may be used to sequentially access all components in a system. The caller may choose not to retrieve the component description by setting the value getDescription to false. The caller may choose not to retrieve the pragma string by setting the value of gutta-percha to false. The maxCount, requestMode, and compId parameters allow the caller to control the information returned by the Service Provider. When the requestMode is DMI_UNIQUE, compId specifies the first component requested (or only component if maxCount is one). When the requestMode is DMI_NEXT, compId specifies the component just before the one requested. When requestMode is DMI_FIRST, compId is unused.

To control the amount of information returned, the caller sets maxCount to something other than zero. The service provider must honor this limit on the amount of information returned. When maxCount is 0 the service provider returns information for all components, subject to the constraints imposed by requestMode and compId.

The DmiListComponentsByClass() function lists components that match specified criteria. Use this function to determine if a component contains a certain group or a certain row in a table. A filter condition may be that a component contains a specified group class name or that it contains a specific row in a specific group. As with DmiListComponents(), the description and pragma strings are optional return values. argin is an instance of a DmiListComponentsByClassIN structure containing the following members:

```c
DmiHandle_t handle; /* an open session handle */
DmiRequestMode_t requestMode; /* Unique, first or next */
DmiUnsigned_t maxCount; /* maximum number to return, or 0 for all */
DmiBoolean_t getPragma; /* get the optional pragma string */
DmiBoolean_t getDescription; /* get optional component description */
DmiId_t compId; /* component ID to start with */
DmiString_t *className; /* group class name string to match */
DmiAttributeValues_t *keyList; /* group row keys to match */
```

The result parameter is a pointer to a DmiListComponentsbyClassOUT structure containing the following members:

```c
DmiErrorStatus_t error_status;
DmiComponentList_t *reply; /* list of components */
```

The DmiListLanguages() function retrieves the set of language mappings installed for the specified component. The argin parameter is an instance of a DmiListLanguagesIN structure containing the following members:

```c
DmiHandle_t handle; /* An open session handle */
DmiUnsigned_t maxCount; /* maximum number to return, or 0 for all */
DmiId_t compId; /* Component to access */
```

The result parameter is a pointer to a DmiListLanguagesOUT structure containing the following members:
The `DmiListClassNames()` function retrieves the class name strings for all groups in a component. This enables the management application to easily determine if a component contains a specific group, or groups. The `argin` parameter is an instance of a `DmiListClassNamesIN` structure containing the following members:

- `DmiHandle_t handle; /* An open session handle */`
- `DmiUnsigned_t maxCount; /* maximum number to return, or 0 for all */`
- `DmiId_t compId; /* Component to access */`

The `result` parameter is a pointer to a `DmiListClassNamesOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`
- `DmiClassNameList_t *reply; /* List of class names and group IDs */`

The `DmiListGroups()` function retrieves a list of groups within a component. With this function you can access a specific group or sequentially access all groups in a component. All enumerations of groups occur within the specified component and do not span components. The `argin` parameter is an instance of a `DmiListGroupsIN` structure containing the following members:

- `DmiHandle_t handle; /* An open session handle */`
- `DmiRequestMode_t requestMode; /* Unique, first or next group */`
- `DmiUnsigned_t maxCount; /* Maximum number to return, or 0 for all */`
- `DmiBoolean_t getPragma; /* Get the optional pragma string */`
- `DmiBoolean_t getDescription; /* Get optional group description */`
- `DmiId_t compId; /* Component to access */`
- `DmiId_t groupId; /* Group to start with, refer to requestMode */`

The `result` parameter is a pointer to a `DmiListGroupsOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;`
- `DmiGroupList_t *reply;`

The caller may choose not to retrieve the group description by setting the value `getDescription` to false. The caller may choose not to retrieve the pragma string by setting the value of `getPragma` to false. The `maxCount`, `requestMode`, and `groupId` parameters allow the caller to control the information returned by the Service Provider. When the `requestMode` is `DMI_UNIQUE`, `groupId` specifies the first group requested (or only group if `maxCount` is one). When the `requestMode` is `DMI_NEXT`, `groupId` specifies the group just before the one requested. When `requestMode` is `DMI_FIRST`, `groupId` is unused. To control the amount of information returned, the caller sets `maxCount` to something other than zero. The service provider must honor this limit on the amount of information returned. When `maxCount` is zero the service provider returns information for all groups, subject to the constraints imposed by `requestMode` and `groupId`. 
The `DmiListAttributes()` function retrieves the properties for one or more attributes in a group. All enumerations of attributes occur within the specified group, and do not span groups. The `argin` parameter is an instance of a `DmiListAttributesIN` structure containing the following members:

- `DmiHandle_t handle; /* An open session handle */`
- `DmiRequestMode_t requestMode; /* Unique, first or next group */`
- `DmiUnsigned_t maxCount; /* Maximum number to return, or 0 for all */`
- `DmiBoolean_t getPragma; /* Get the optional pragma string */`
- `DmiBoolean_t getDescription; /* Get optional group description */`
- `DmiId_t compId; /* Component to access */`
- `DmiId_t groupId; /* Group to access */`
- `DmiId_t attribId; /* Attribute to start with, refer to requestMode */`

The `result` parameter is a pointer to a `DmiListAttributesOUT` structure containing the following members:

- `DmiErrorStatus_t error_status;
- DmiAttributeList_t *reply; /* List of attributes */`

You may choose not to retrieve the description string by setting the value of `getDescription` to false. Likewise, you may choose not to retrieve the pragma string by setting the value of `getPragma` to false. The `maxCount`, `requestMode`, and `attribId` parameters allow you to control the information returned by the Service Provider. When the `requestMode` is `DMI_UNIQUE`, `attribId` specifies the first attribute requested (or only attribute if `maxCount` is one). When the `requestMode` is `DMI_NEXT`, `attribId` specifies the attribute just before the one requested. When `requestMode` is `DMI_FIRST`, `attribId` is unused. To control the amount of information returned, the caller sets `maxCount` to something other than zero. The Service Provider must honor this limit on the amount of information returned. When `maxCount` is zero the service provider returns information for all attributes, subject to the constraints imposed by `requestMode` and `attribId`.

**RETURN VALUES**

The `DmiListAttributes()` function returns the following possible values:

- `DMIERR_NO_ERROR`
- `DMIERR_ILLEGAL_RPC_HANDLE`
- `DMIERR_OUT_OF_MEMORY`
- `DMIERR_ILLEGAL_PARAMETER`
- `DMIERR_SP_INACTIVE`
- `DMIERR_ATTRIBUTE_NOT_FOUND`
- `DMIERR_COMPONENT_NOT_FOUND`
- `DMIERR_GROUP_NOT_FOUND`
- `DMIERR_FILE_ERROR`

The `DmiListClassNames()` function returns the following possible values:

- `DMIERR_NO_ERROR`
- `DMIERR_ILLEGAL_RPC_HANDLE`
- `DMIERR_OUT_OF_MEMORY`
- `DMIERR_ILLEGAL_PARAMETER`
- `DMIERR_SP_INACTIVE`
- `DMIERR_COMPONENT_NOT_FOUND`
- `DMIERR_FILE_ERROR`
DmiListComponents() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR

DmiListComponentsByClass() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR

DmiListGroups() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR
- DMIERR_GROUP_NOT_FOUND

DmiListLanguages() function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_RPC_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_ILLEGAL_PARAMETER
- DMIERR_SP_INACTIVE
- DMIERR_COMPONENT_NOT_FOUND
- DMIERR_FILE_ERROR

### Attributes

See attributes(5) for descriptions of the following attributes:

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</tr>
</tbody>
</table>

### See also

attributes(5)
DmiRegisterCi, DmiUnRegisterCi, DmiOriginateEvent – Service Provider functions for components

SYNOPSIS

cc [ flag ... ] file ... -lci -ldmi -lnsl -lrwtool [ library ... ]
#include <server.h>
#include <ciapi.h>

extern bool_t DmiRegisterCi(DmiRegisterCiIN argin,
                          DmiRegisterCiOUT *result, DmiRpcHandle *dmi_rpc_handle);

bool_t DmiUnregisterCi(DmiUnregisterCiIN argin, DmiUnregisterCiOUT
                         *result, DmiRpcHandle *dmi_rpc_handle);

bool_t DmiOriginateEvent(DmiOriginateEventIN argin,
                         DmiOriginateEventOUT *result, DmiRpcHandle *dmi_rpc_handle);

DESCRIPTION

These three functions provide component communication with the DMI through the Component Interface (CI).

Component instrumentation code may register with the Service Provider to override its current mechanism for the registered attributes. Instead of manipulating the data in the MIF database or invoking programs, the Service Provider calls the entry points provided in the registration call. Once the component unregisters, the Service Provider returns to a normal method of processing requests for the data as defined in the MIF. Component instrumentation can temporarily interrupt normal processing to perform special functions.

Registering attributes through the direct interface overrides attributes that are already being served through the direct interface. RPC is used for communication from the Service Provider to the component instrumentation.

For all three functions, argin is the parameter passed to initiate an RPC call, result is the result of the RPC call, and dmi_rpc_handle is an open session RPC handle.

The DmiRegisterCi() function registers a callable interface for components that have resident instrumentation code and/or to get the version of the Service Provider.

The DmiUnRegisterCi() function communicates to the Service Provider to remove a direct component instrumentation interface from the Service Provider table of registered interfaces.

The DmiOriginateEvent() function originates an event for filtering and delivery. Any necessary indication filtering is performed by this function (or by subsequent processing) before the event is forwarded to the management applications.

A component ID value of zero (0) specifies the event was generated by something that has not been installed as a component, and has no component ID.

RETURN VALUES

The DmiRegisterCi() function returns the following possible values:

DMIERR_NO_ERROR
DMIERR_ILLEGAL_HANDLE
DMIERR_OUT_OF_MEMORY
The `DmiUnRegisterCi()` function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_INSUFFICIENT_PRIVILEGES
- DMIERR_SP_INACTIVE
- DMIERR_UNKNOWN_CI_REGISTRY

The `DmiOriginateEvent()` function returns the following possible values:

- DMIERR_NO_ERROR
- DMIERR_ILLEGAL_HANDLE
- DMIERR_OUT_OF_MEMORY
- DMIERR_INSUFFICIENT_PRIVILEGES
- DMIERR_SP_INACTIVE
- DMIERR_UNKNOWN_CI_REGISTRY

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</thead>
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<tr>
<td>MT-level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO

attributes(5)
ea_error – error interface to extended accounting library

SYNOPSIS

cc [flag ...] file ... -lexacct [library ...]
#include <exacct.h>

int ea_error(void);

DESCRIPTION

The ea_error() function returns the error value of the last failure recorded by the invocation of one of the functions of the extended accounting library, libexacct.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

read(2), libexacct(3LIB), attributes(5)
The `ea_open()` function provides structured access to exacct files. The `aflags` argument contains the appropriate exacct flags necessary to describe the file. The `oflags` and `mode` arguments contain the appropriate flags and mode to open the file; see `<fcntl.h>`. If `ea_open()` is invoked with `EO_HEAD` specified in `aflags`, the resulting file is opened with the object cursor located at the first object of the file. If `ea_open()` is invoked with `EO_TAIL` specified in `aflags`, the resulting file is opened with the object cursor positioned beyond the last object in the file.

The `ea_close()` function closes an open exacct file.

 Upon successful completion, `ea_open()` and `ea_close()` return 0. Otherwise they return -1 and call `ea_error(3EXACCT)` to return the extended accounting error value describing the error.

The `ea_open()` and `ea_close()` functions may fail if:

- `EXR_SYSCALL_FAIL` A system call invoked by the function failed. The `errno` variable contains the error value set by the underlying call.

The `ea_open()` function may fail if:

- `EXR_CORRUPT_FILE` The file referred to by `name` is not a valid exacct file.
- `EXR_NO_CREATOR` In the case of file creation, the `creator` argument was `NULL`. In the case of opening an existing file, a `creator` argument was specified and does not match the `creator` item of the exacct file.
- `EXR_UNKN_VERSION` The file referred to by `name` uses an exacct file version that cannot be processed by this library.

The exacct file format can be used to represent data other than that in the extended accounting format. By using a unique creator type in the file header, application writers can develop their own format suited to the needs of their application.

### Examples

**EXAMPLE 1 Open and Close the exacct File**

The following example opens the extended accounting data file for processes. The exacct file is then closed.

```c
#include <exacct.h>
```
EXAMPLE 1 Open and Close the exacct File (Continued)

```c
ea_file_t ef;
if (ea_open(&ef, "/var/adm/exacct/proc", NULL, EO_HEAD,
            0_RDONLY, 0) == -1)
    exit(1);
(void) ea_close(ef);
```

ATRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
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<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

ea_error(3EXACCT), ea_pack_object(3EXACCT), ea_set_item(3EXACCT),
libexacct(3LIB), attributes(5)
ea_pack_object(3EXACCT)

NAME  ea_pack_object, ea_unpack_object, ea_get_creator, ea_get_hostname, ea_next_object, ea_previous_object, ea_get_object, ea_write_object – construct, read, and write extended accounting records

SYNOPSIS  cc [flag ...] file ... -lexacct [library ...]
#include <exacct.h>
size_t ea_pack_object(ea_object_t *obj, void *buf, size_t bufsize);
ea_object_type_t ea_unpack_object(ea_object_t **objp, int flag, void *buf, size_t bufsize);
const char *ea_get_creator(ea_file_t *ef);
const char *ea_get_hostname(ea_file_t *ef);
ea_object_type_t ea_next_object(ea_file_t *ef, ea_object_t *obj);
ea_object_type_t ea_previous_object(ea_file_t *ef, ea_object_t *obj);
ea_object_type_t ea_get_object(ea_file_t *ef, ea_object_t *obj);
int ea_write_object(ea_file_t *ef, ea_object_t *obj);

DESCRIPTION  The ea_pack_object() function converts exacct objects from their in-memory representation to their file representation. It is passed an object pointer that points to the top of an exacct object hierarchy representing one or more exacct records. It returns the size of the buffer required to contain the packed buffer representing the object hierarchy.

The ea_unpack_object() function reverses the packing process performed by ea_pack_object(). A packed buffer passed to ea_unpack_object() is unpacked into the original hierarchy of objects. If the unpack operation fails (presumably due to a corrupted or incomplete buffer), it returns −1; otherwise, the object type of the first object in the hierarchy is returned. If ea_unpack_object() is invoked with flag equal to EUP_ALLOC, it allocates memory for the variable length data in the included objects. Otherwise, with flag equal to EUP_NOALLOC, it sets the variable length data pointers within the unpacked object structures to point within the buffer indicated by buf. In both cases, ea_unpack_object() allocates all the necessary exacct objects to represent the unpacked record. The resulting object hierarchy can be freed using ea_free_object(3EXACCT) with the same flag value.

The ea_get_creator() function returns a pointer to a string representing the recorded creator of the exacct file. The ea_get_hostname() function returns a pointer to a string representing the recorded hostname on which the exacct file was created. These functions will return NULL if their respective field was not recorded in the exacct file header.

The ea_next_object() function reads the basic fields into the ea_object_t indicated by obj from the exacct file referred to by ef, and rewinds to the head of the record. If the read object is corrupted, ea_next_object() returns −1 and records the extended accounting error code.
The \texttt{ea_previous_object()} function skips back one object in the file and reads its basic fields into the indicated \texttt{ea_object_t}. If the read object is corrupted, \texttt{ea_previous_object()} returns $-1$ and records the extended accounting error code.

The \texttt{ea_get_object()} function reads the value fields into the \texttt{ea_object_t} indicated by \texttt{obj}, allocating memory as necessary, and advances to the head of the next record. Once a record group object is retrieved using \texttt{ea_get_object()}, a call to \texttt{ea_next_object()} will track through the objects within the record group. If the read object is corrupted, \texttt{ea_get_object()} returns $-1$ and records the extended accounting error code.

The \texttt{ea_write_object()} function appends the given object to the open \texttt{exact} file indicated by \texttt{ef}. If the write fails, \texttt{ea_write_object()} returns $-1$ and sets the extended accounting error code to indicate the error.

### RETURN VALUES

<table>
<thead>
<tr>
<th>Function</th>
<th>Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{ea_pack_object()}</td>
<td>The number of bytes associated with the \texttt{exact} object being operated upon. If the returned size exceeds \texttt{bufsize}, the pack operation will not complete.</td>
</tr>
<tr>
<td>\texttt{ea_get_object()}</td>
<td>1 if the object was retrieved successfully. Otherwise, 0 and sets \texttt{errno} to indicate the error. If the error occurred during the execution of \texttt{read(2)}, \texttt{errno} will be unchanged.</td>
</tr>
<tr>
<td>\texttt{ea_next_object()}</td>
<td>The \texttt{ea_object_type} of the next \texttt{exact} object in the file. It returns $-1$ if the \texttt{exact} file is corrupted.</td>
</tr>
<tr>
<td>\texttt{ea_unpack_object()}</td>
<td>The \texttt{ea_object_type} of the first \texttt{exact} object unpacked from the buffer. It returns $-1$ if the \texttt{exact} file is corrupted.</td>
</tr>
<tr>
<td>\texttt{ea_write_object()}</td>
<td>0 on success and $-1$ on failure.</td>
</tr>
</tbody>
</table>

In the case of failure, these functions will set an extended accounting error code reflecting one of the errors described below. The extended account error code can be retrieved using \texttt{ea_error(3EXACCT)}.

### ERRORS

These functions may fail if:

- \texttt{EXR_SYSCALL_FAIL} A system call invoked by the function failed. The \texttt{errno} variable contains the error value set by the underlying call.

- \texttt{EXR_CORRUPT_FILE} The file referred to by \texttt{name} is not a valid \texttt{exact} file, or is unparsable, and therefore appears corrupted. This error is also used by \texttt{ea_unpack_buffer()} to indicate a corrupted buffer.

- \texttt{EXR_NO_MEMORY} A memory allocation required to complete the operation failed.

- \texttt{EXR_EOF} The end of the file has been reached. In the case of \texttt{ea_previous_record()}, the previous record could...
The exact file format can be used to represent data other than that in the extended accounting format. By using a unique creator type in the file header, application writers can develop their own format suited to the needs of their application.

**EXAMPLE 1** Open and close exact file.

The following example opens the extended accounting data file for processes. The exact file is then closed.

```c
#include <stdio.h>
#include <exacct.h>

ea_file_t ef;
ea_object_t obj;
...
e_open(&ef, "foo", O_RDONLY, ...);

while (ea_next_object(&ef, &obj) != -1) {
    if (ea_get_object(&ef, &obj) == -1) {
        (void) fprintf(stderr, "unrecognized exact object");
        break;
    }
    if (obj.eo_type == EO_ITEM) {
        /* handle item */
    } else {
        /* handle group */
    }
}
e_close(&ef);
```

**EXAMPLE 2** Construct an exact file consisting of a single object containing the current process ID.

```c
#include <sys/types.h>
#include <unistd.h>
#include <exacct.h>
...
e_file_t ef;
ea_object_t obj;
pid_t my_pid;
e_open(&ef, "foo", O_CREAT | O_WRONLY, ...);

my_pid = getpid();
e_set_item(&obj, EXD_UINT32 | EXC_DEFAULT | EXT_PROC_PID, &my_pid, 0);
```
EXAMPLE 2 Construct an exact file consisting of a single object containing the current process ID.  

(Continued)

```c
( void ) ea_write_object ( &ef , &obj );

ea_close ( &ef );

...
```

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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<th>ATTRIBUTE VALUE</th>
</tr>
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</table>

SEE ALSO  read(2), ea_error(3EXACCT), ea_open(3EXACCT), ea_set_item(3EXACCT), libexacct(3LIB), attributes(5)
The `ea_set_item()` function assigns the given exactct object to be a data item with value set according to the remaining arguments. For buffer-based data values, no copy is taken. The `ea_set_group()` function assigns the given exactct object to be a record group with 0 elements.

The `ea_match_object_catalog()` function returns TRUE if the exactct object specified by `obj` has a catalog tag that matches the mask specified by `catmask`.

The `ea_attach_to_object()` function attaches an object to the given object. The `ea_attach_to_group()` function attaches a chain of objects as member items of the given group. Objects are inserted into the list of any previously attached objects.

The `ea_free_item()` function frees the value fields in the `ea_object_t` indicated by `obj`, if EUP_ALLOC is specified. The object itself is not freed. The `ea_free_object()` function frees the specified object and any attached hierarchy of objects. If the `flag` argument is set to EUP_ALLOC, `ea_free_object()` will also free any variable-length data in the object hierarchy; if set to EUP_NOALLOC, `ea_free_object()` will not free variable-length data. In particular, these flags should correspond to those specified in calls to `ea_unpack_object(3EXACCT)`.

The `ea_set_item()` and `ea_set_group()` functions return 0 if the object was assigned successfully. Otherwise these functions return -1 and set the extended accounting error code appropriately.

The `ea_match_object_catalog()` function returns 0 if the object’s catalog tag does not match the given mask, and 1 if there is a match.

The `ea_set_item()`, `ea_set_group()`, and `ea_match_object_catalog()` functions may fail if:
EXR_SYSCALL_FAIL  A system call invoked by the function failed. The
errno variable contains the error value set by the
underlying call.

EXR_NO_MEMORY  A memory allocation required to complete the
operation failed.

USAGE
The exacct file format can be used to represent data other than that in the extended
accounting format. By using a unique creator type in the file header, application
writers can develop their own format suited to the needs of their application.

EXAMPLES
EXAMPLE 1 Open and close exacct file.

Construct an exacct file consisting of a single object containing the current process ID.

```
#include <sys/types.h>
#include <unistd.h>
#include <exacct.h>
...

eaf_file_t ef;
eaf_object_t obj;
pid_t my_pid;

my_pid = getpid();
eaf_set_item(&obj, EXD_UINT32 | EXC_DEFAULT | EXT_PROC_PID, &my_pid, 0);
...
```

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  read(2), ea_error(3EXACCT), ea_open(3EXACCT), ea_pack_object(3EXACCT),
libexacct(3LIB), attributes(5)
elf32_checksum(3ELF)

NAME    elf32_checksum, elf64_checksum – return checksum of elf image

SYNOPSIS cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>
long elf32_checksum(Elf *elf);
long elf64_checksum(Elf *elf);

DESCRIPTION The elf32_checksum() function returns a simple checksum of selected sections of
the image identified by elf. The value is typically used as the .dynamic tag
DT_CHECKSUM, recorded in dynamic executables and shared objects.

Selected sections of the image are used to calculate the checksum in order that its
value is not affected by utilities such as strip(1).

For the 64–bit class, replace 32 with 64 as appropriate.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO elf(3ELF), elf_version(3ELF), gelf(3ELF), attributes(5)
NAME
elf32_fsize, elf64_fsize – return the size of an object file type

SYNOPSIS
cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

size_t elf32_fsize(Elf_Type type, size_t count, unsigned ver);
size_t elf64_fsize(Elf_Type type, size_t count, unsigned ver);

DESCRIPTION
elf32_fsize() gives the size in bytes of the 32-bit file representation of count data objects with the given type. The library uses version ver to calculate the size. See elf(3ELF) and elf_version(3ELF).

Constant values are available for the sizes of fundamental types:

<table>
<thead>
<tr>
<th>Elf_Type</th>
<th>File Size</th>
<th>Memory Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELF_T_ADDR</td>
<td>ELF32_FSZ_ADDR</td>
<td>sizeof(Elf32_Addr)</td>
</tr>
<tr>
<td>ELF_T_BYTE</td>
<td>1</td>
<td>sizeof(unsigned char)</td>
</tr>
<tr>
<td>ELF_T_HALF</td>
<td>ELF32_FSZ_HALF</td>
<td>sizeof(Elf32_Half)</td>
</tr>
<tr>
<td>ELF_T_OFF</td>
<td>ELF32_FSZ_OFF</td>
<td>sizeof(Elf32_Off)</td>
</tr>
<tr>
<td>ELF_T_SWORD</td>
<td>ELF32_FSZ_SWORD</td>
<td>sizeof(Elf32_Sword)</td>
</tr>
<tr>
<td>ELF_T_WORD</td>
<td>ELF32_FSZ_WORD</td>
<td>sizeof(Elf32_Word)</td>
</tr>
</tbody>
</table>

elf32_fsize() returns 0 if the value of type or ver is unknown. See elf32_xlatetof(3ELF) for a list of the type values.

For the 64-bit class, replace 32 with 64 as appropriate.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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<th>ATTRIBUTE TYPE</th>
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</thead>
<tbody>
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<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
elf(3ELF), elf32_xlatetof(3ELF), elf_version(3ELF), attributes(5)
elf32_getehdr(3ELF)

NAME    elf32_getehdr, elf32_newehdr, elf64_getehdr, elf64_newehdr – retrieve class-dependent object file header

SYNOPSIS    cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

Elf32_Ehdr *elf32_getehdr(Elf *elf);
Elf32_Ehdr *elf32_newehdr(Elf *elf);
Elf64_Ehdr *elf64_getehdr(Elf *elf);
Elf64_Ehdr *elf64_newehdr(Elf *elf);

DESCRIPTION    For a 32-bit class file, elf32_getehdr() returns a pointer to an ELF header, if one is available for the ELF descriptor elf. If no header exists for the descriptor, elf32_newehdr() allocates a clean one, but it otherwise behaves the same as elf32_getehdr(). It does not allocate a new header if one exists already. If no header exists for elf32_getehdr(), one cannot be created for elf32_newehdr(), a system error occurs, the file is not a 32-bit class file, or elf is null, both functions return a null pointer.

For the 64-bit class, replace 32 with 64 as appropriate.

The header includes the following members:

unsigned char  e_ident[Elf32_NIDENT];
Elf32_Half e_type;
Elf32_Half e_machine;
Elf32_Word e_version;
Elf32.Addr e_entry;
Elf32_Off e_poff;
Elf32_Off e_shoff;
Elf32_Word e_flags;
Elf32_Half e_ehsize;
Elf32_Half e_phentsize;
Elf32_Half e_phnum;
Elf32_Half e_shentsize;
Elf32_Half e_shnum;
Elf32_Half e_shstrndx;

elf32_newehdr() automatically sets the ELF_F_DIRTY bit. See elf_flagdata(3ELF). A program may use elf_getident() to inspect the identification bytes from a file.

ATTRIBUTES    See attributes(5) for descriptions of the following attributes:

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<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
SEE ALSO

elf(3ELF), elf_begin(3ELF), elf_flagdata(3ELF), elf_getident(3ELF),
attributes(5)
elf32_getphdr(3ELF)

NAME
elf32_getphdr, elf32_newphdr, elf64_getphdr, elf64_newphdr – retrieve
class-dependent program header table

SYNOPSIS
cc [ flag ... ] file... -lelf [ library ... ]
#include <libelf.h>
Elf32_Phdr *elf32_getphdr(EIff *elf);
Elf32_Phdr *elf32_newphdr(EIff *elf, size_t count);
Elf64_Phdr *elf64_getphdr(EIff *elf);
Elf64_Phdr *elf64_newphdr(EIff *elf, size_t count);

DESCRIPTION
For a 32-bit class file, elf32_getphdr() returns a pointer to the program execution
header table, if one is available for the ELF descriptor elf.

e1f32_newphdr() allocates a new table with count entries, regardless of whether one
existed previously, and sets the ELF_P_DIRTY bit for the table. See
elf_flagdata(3ELF). Specifying a zero count deletes an existing table. Note this
behavior differs from that of elf32_newehdr() allowing a program to replace or
delete the program header table, changing its size if necessary. See
elf32_getehdr(3ELF).
If no program header table exists, the file is not a 32-bit class file, an error occurs, or elf
is NULL, both functions return a null pointer. Additionally, elf32_newphdr() returns a null pointer if count is 0.

The table is an array of Elf32_Phdr structures, each of which includes the following
members:

Elf32_Word p_type;
Elf32_Off p_offset;
Elf32_Addr p_vaddr;
Elf32_Addr p_paddr;
Elf32_Word p_filesz;
Elf32_Word p_memsz;
Elf32_Word p_flags;
Elf32_Word p_align;

The Elf64_Phdr structures include the following members:

Elf64_Word p_type;
Elf64_Word p_flags;
Elf64_Off p_offset;
Elf64_Addr p_vaddr;
Elf64_Addr p_paddr;
Elf64_Xword p_filesz;
Elf64_Xword p_memsz;
Elf64_Xword p_align;

For the 64–bit class, replace 32 with 64 as appropriate.
The ELF header’s e_phnum member tells how many entries the program header table has. See elf32_getehdr(3ELF). A program may inspect this value to determine the size of an existing table; elf32_newphdr() automatically sets the member’s value to count. If the program is building a new file, it is responsible for creating the file’s ELF header before creating the program header table.

**ATTRIBUTES**  
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**  
elf(3ELF), elf32_getehdr(3ELF), elf_begin(3ELF), elf_flagdata(3ELF), attributes(5)
elf32_getshdr(3ELF)

NAME    elf32_getshdr, elf64_getshdr – retrieve class-dependent section header

SYNOPSIS    cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

Elf32_Shdr *elf32_getshdr(Elf_Scn *scn);
Elf64_Shdr *elf64_getshdr(Elf_Scn *scn);

DESCRIPTION    For a 32-bit class file, elf32_getshdr() returns a pointer to a section header for the section descriptor scn. Otherwise, the file is not a 32-bit class file, scn was NULL, or an error occurred; elf32_getshdr() then returns NULL.

The elf32_getshdr header includes the following members:

Elf32_Word sh_name;
Elf32_Word sh_type;
Elf32_Word sh_flags;
Elf32.Addr sh_addr;
Elf32_Off sh_offset;
Elf32_Word sh_size;
Elf32_Word sh_link;
Elf32_Word sh_info;
Elf32_Word sh_addralign;
Elf32_Word sh_entsize;

while the elf64_getshdr header includes the following members:

Elf64_Word sh_name;
Elf64_Word sh_type;
Elf64_Xword sh_flags;
Elf64.Addr sh_addr;
Elf64_Off sh_offset;
Elf64_Xword sh_size;
Elf64_Word sh_link;
Elf64_Word sh_info;
Elf64_Xword sh_addralign;
Elf64_Xword sh_entsize;

For the 64-bit class, replace 32 with 64 as appropriate.

If the program is building a new file, it is responsible for creating the file’s ELF header before creating sections.

ATTRIBUTES    See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO    elf(3ELF), elf_flagdata(3ELF), elf_getscn(3ELF), elf_strptr(3ELF), attributes(5)
elf32_xlatetof, elf32_xlatetom, elf64_xlatetof, elf64_xlatetom – class-dependent data translation

SYNOPSIS

cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

Elf_Data *elf32_xlatetof(Elf_Data *dst, const Elf_Data *src, unsigned encode);
Elf_Data *elf32_xlatetom(Elf_Data *dst, const Elf_Data *src, unsigned encode);
Elf_Data *elf64_xlatetof(Elf_Data *dst, const Elf_Data *src, unsigned encode);
Elf_Data *elf64_xlatetom(Elf_Data *dst, const Elf_Data *src, unsigned encode);

DESCRIPTION

elf32_xlatetom() translates various data structures from their 32-bit class file representations to their memory representations; elf32_xlatetof() provides the inverse. This conversion is particularly important for cross development environments. src is a pointer to the source buffer that holds the original data; dst is a pointer to a destination buffer that will hold the translated copy. encode gives the byte encoding in which the file objects are to be represented and must have one of the encoding values defined for the ELF header’s e_ident[EI_DATA] entry (see elf_getident(3ELF)). If the data can be translated, the functions return dst. Otherwise, they return NULL because an error occurred, such as incompatible types, destination buffer overflow, etc.

elf_getdata(3ELF) describes the Elf_Data descriptor, which the translation routines use as follows:

d_buf
Both the source and destination must have valid buffer pointers.
d_type
This member’s value specifies the type of the data to which d_buf points and the type of data to be created in the destination. The program supplies a d_type value in the source; the library sets the destination’s d_type to the same value. These values are summarized below.
d_size
This member holds the total size, in bytes, of the memory occupied by the source data and the size allocated for the destination data. If the destination buffer is not large enough, the routines do not change its original contents. The translation routines reset the destination’s d_size member to the actual size required, after the translation occurs. The source and destination sizes may differ.
d_version
This member holds the version number of the objects (desired) in the buffer. The source and destination versions are independent.

Translation routines allow the source and destination buffers to coincide. That is, dst→d_buf may equal src→d_buf. Other cases where the source and destination buffers overlap give undefined behavior.
elf32_xlatetof(3ELF)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

Translating buffers of type ELF_T_BYTE does not change the byte order.

For the 64-bit class, replace 32 with 64 as appropriate.

**ATTRIBUTES**
See attributes(5) for descriptions of the following attributes:

**SEE ALSO**
elf(3ELF), elf32_fsize(3ELF), elf_getdata(3ELF), elf_getident(3ELF),
attributes(5)
Functions in the ELF access library let a program manipulate ELF (Executable and Linking Format) object files, archive files, and archive members. The header provides type and function declarations for all library services.

Programs communicate with many of the higher-level routines using an *ELF descriptor*. That is, when the program starts working with a file, `elf_begin(3ELF)` creates an ELF descriptor through which the program manipulates the structures and information in the file. These ELF descriptors can be used both to read and to write files. After the program establishes an ELF descriptor for a file, it may then obtain *section descriptors* to manipulate the sections of the file (see `elf_getscn(3ELF)`).

Sections hold the bulk of an object file’s real information, such as text, data, the symbol table, and so on. A section descriptor “belongs” to a particular ELF descriptor, just as a section belongs to a file. Finally, *data descriptors* are available through section descriptors, allowing the program to manipulate the information associated with a section. A data descriptor “belongs” to a section descriptor.

Descriptors provide private handles to a file and its pieces. In other words, a data descriptor is associated with one section descriptor, which is associated with one ELF descriptor, which is associated with one file. Although descriptors are private, they give access to data that may be shared. Consider programs that combine input files, using incoming data to create or update another file. Such a program might get data descriptors for an input and an output section. It then could update the output descriptor to reuse the input descriptor’s data. That is, the descriptors are distinct, but they could share the associated data bytes. This sharing avoids the space overhead for duplicate buffers and the performance overhead for copying data unnecessarily.

**File Classes**

ELF provides a framework in which to define a family of object files, supporting multiple processors and architectures. An important distinction among object files is the *class*, or capacity, of the file. The 32-bit class supports architectures in which a 32-bit object can represent addresses, file sizes, and so on, as in the following:

<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elf32_Addr</td>
<td>Unsigned address</td>
</tr>
<tr>
<td>Elf32_Half</td>
<td>Unsigned medium integer</td>
</tr>
<tr>
<td>Elf32_Off</td>
<td>Unsigned file offset</td>
</tr>
<tr>
<td>Elf32_Sword</td>
<td>Signed large integer</td>
</tr>
<tr>
<td>Elf32_Word</td>
<td>Unsigned large integer</td>
</tr>
<tr>
<td>unsigned char</td>
<td>Unsigned small integer</td>
</tr>
</tbody>
</table>
The 64-bit class works the same as the 32-bit class, substituting 64 for 32 as necessary. Other classes will be defined as necessary, to support larger (or smaller) machines. Some library services deal only with data objects for a specific class, while others are class-independent. To make this distinction clear, library function names reflect their status, as described below.

Conceptually, two parallel sets of objects support cross compilation environments. One set corresponds to file contents, while the other set corresponds to the native memory image of the program manipulating the file. Type definitions supplied by the headers work on the native machine, which may have different data encodings (size, byte order, and so on) than the target machine. Although native memory objects should be at least as big as the file objects (to avoid information loss), they may be bigger if that is more natural for the host machine.

Translation facilities exist to convert between file and memory representations. Some library routines convert data automatically, while others leave conversion as the program’s responsibility. Either way, programs that create object files must write file-typed objects to those files; programs that read object files must take a similar view. See `elf32_xlatetof(3ELF)` and `elf32_fsize(3ELF)` for more information.

Programs may translate data explicitly, taking full control over the object file layout and semantics. If the program prefers not to have and exercise complete control, the library provides a higher-level interface that hides many object file details. `elf_begin()` and related functions let a program deal with the native memory types, converting between memory objects and their file equivalents automatically when reading or writing an object file.

Object file versions allow ELF to adapt to new requirements. *Three independent versions* can be important to a program. First, an application program knows about a particular version by virtue of being compiled with certain headers. Second, the access library similarly is compiled with header files that control what versions it understands. Third, an ELF object file holds a value identifying its version, determined by the ELF version known by the file’s creator. Ideally, all three versions would be the same, but they may differ.

If a program’s version is newer than the access library, the program might use information unknown to the library. Translation routines might not work properly, leading to undefined behavior. This condition merits installing a new library.

The library’s version might be newer than the program’s and the file’s. The library understands old versions, thus avoiding compatibility problems in this case.

Finally, a file’s version might be newer than either the program or the library understands. The program might or might not be able to process the file properly, depending on whether the file has extra information and whether that information can be safely ignored. Again, the safe alternative is to install a new library that understands the file’s version.
To accommodate these differences, a program must use `elf_version(3ELF)` to pass its version to the library, thus establishing the working version for the process. Using this, the library accepts data from and presents data to the program in the proper representations. When the library reads object files, it uses each file’s version to interpret the data. When writing files or converting memory types to the file equivalents, the library uses the program’s working version for the file data.

System Services

As mentioned above, `elf_begin()` and related routines provide a higher-level interface to ELF files, performing input and output on behalf of the application program. These routines assume a program can hold entire files in memory, without explicitly using temporary files. When reading a file, the library routines bring the data into memory and perform subsequent operations on the memory copy. Programs that wish to read or write large object files with this model must execute on a machine with a large process virtual address space. If the underlying operating system limits the number of open files, a program can use `elfcntl(3ELF)` to retrieve all necessary data from the file, allowing the program to close the file descriptor and reuse it.

Although the `elf_begin()` interfaces are convenient and efficient for many programs, they might be inappropriate for some. In those cases, an application may invoke the `elf32_xlatetom(3ELF)` or `elf32_xlatetof(3ELF)` data translation routines directly. These routines perform no input or output, leaving that as the application’s responsibility. By assuming a larger share of the job, an application controls its input and output model.

Library Names

Names associated with the library take several forms.

- **elf_name**: These class-independent names perform some service, `name`, for the program.
- **elf32_name**: Service names with an embedded class, 32 here, indicate they work only for the designated class of files.
- **Elf_Type**: Data types can be class-independent as well, distinguished by `Type`.
- **Elf32_Type**: Class-dependent data types have an embedded class name, 32 here.
- **ELF_C_CMD**: Several functions take commands that control their actions. These values are members of the `Elf_Cmd` enumeration; they range from zero through `ELF_C_NUM-1`.
- **ELF_F_FLAG**: Several functions take flags that control library status and/or actions. Flags are bits that may be combined.
- **ELF32_FSZ_TYPE**: These constants give the file sizes in bytes of the basic ELF types for the 32-bit class of files. See `elf32_fsize()` for more information.
- **ELF_K_KIND**: The function `elf_kind()` identifies the `KIND` of file associated with an ELF descriptor. These values are
EXAMPLE 1 An interpretation of elf file.

The basic interpretation of an ELF file consists of:

- opening an ELF object file
- obtaining an ELF descriptor
- analyzing the file using the descriptor.

The following example opens the file, obtains the ELF descriptor, and prints out the names of each section in the file.

```c
#include <fcntl.h>
#include <stdio.h>
#include <libelf.h>
#include <stdlib.h>
#include <string.h>
static void failure(void);

void
main(int argc, char ** argv)
{
    Elf32_Shdr * shdr;
    Elf32_Ehdr * ehdr;
    Elf * elf;
    Elf_Scn * scn;
    Elf_Data * data;
    int fd;
    unsigned int cnt;

    /* Open the input file */
    if ((fd = open(argv[1], O_RDONLY)) == -1)
        exit(1);

    /* Obtain the ELF descriptor */
    (void) elf_version(EV_CURRENT);
    if ((elf = elf_begin(fd, ELF_C_READ, NULL)) == NULL)
        failure();

    /* Obtain the .shstrtab data buffer */
    if (((ehdr = elf32_getehdr(elf)) == NULL) ||
        ((scn = elf_getscn(elf, ehdr->e_shstrndx)) == NULL) ||
        ((data = elf_getdata(scn, NULL)) == NULL))
        failure();

    /* Traverse input filename, printing each section */
```
EXAMPLE 1 An interpretation of elf file.  (Continued)

  for (cnt = 1, scn = NULL; scn = elf_nextscn(elf, scn); cnt++) {
    if ((shdr = elf32_getshdr(scn)) == NULL)
      failure();
    (void) printf("[%d] %s
", cnt,
       (char *)data->d_buf + shdr->sh_name);
  } /* end main */

static void
failure()
{
  (void) fprintf(stderr, "%s
", elf_errmsg(elf_errno()));
  exit(1);
}

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO  elf32_checksum(3ELF), elf32_fsize(3ELF), elf32_getshdr(3ELF),
elf32_xlatetof(3ELF), elf_begin(3ELF), elfcntl(3ELF), elf_errno(3ELF),
elf_fill(3ELF), elf_getarhdr(3ELF), elf_getarsym(3ELF),
elf_getbase(3ELF), elf_getdata(3ELF), elf_getident(3ELF),
elf_getscn(3ELF), elf_hash(3ELF), elf_kind(3ELF), elf_memory(3ELF),
elf_rawfile(3ELF), elf_strptr(3ELF), elf_update(3ELF),
elf_version(3ELF), gelf(3ELF), ar(3HEAD), attributes(5)

ANSI C Programmer’s Guide

SPARC only  a.out(4)

NOTES  Information in the ELF headers is separated into common parts and processor-specific parts. A program can make a processor’s information available by including the appropriate header: <sys/elf_NAME.h> where NAME matches the processor name as used in the ELF file header.

<table>
<thead>
<tr>
<th>Name</th>
<th>Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td>M32</td>
<td>AT&amp;T WE 32100</td>
</tr>
<tr>
<td>SPARC</td>
<td>SPARC</td>
</tr>
<tr>
<td>386</td>
<td>Intel 80386, 80486, Pentium</td>
</tr>
</tbody>
</table>
Other processors will be added to the table as necessary.

To illustrate, a program could use the following code to "see" the processor-specific information for the SPARC based system.

```c
#include <libelf.h>
#include <sys/elf_SPARC.h>
```

Without the `<sys/elf_SPARC.h>` definition, only the common ELF information would be visible.

A program could use the following code to "see" the processor-specific information for the Intel 80386:

```c
#include <libelf.h>
#include <sys/elf_386.h>
```

Without the `<sys/elf_386.h>` definition, only the common ELF information would be visible.

Although reading the objects is rather straightforward, writing/updating them can corrupt the shared offsets among sections. Upon creation, relationships are established among the sections that must be maintained even if the object’s size is changed.
NAME
elf_begin, elf_end, elf_memory, elf_next, elf_rand – process ELF object files

SYNOPSIS
cc [ flags... ] file ... -lelf [ library ... ]
#include <elf.h>
Elf *elf_begin(int fildes, Elf_Cmd cmd, Elf *ref);
int elf_end(Elf *elf);
Elf *elf_memory(char *image, size_t sz);
Elf_Cmd elf_next(Elf *elf);
sz_t elf_rand(Elf *elf, size_t offset);

DESCRIPTION
elf_begin(), elf_end(), elf_memory(), elf_next(), and elf_rand() work
together to process Executable and Linking Format (ELF) object files, either
individually or as members of archives. After obtaining an ELF descriptor from
elf_begin() or elf_memory(), the program may read an existing file, update an
existing file, or create a new file. fildes is an open file descriptor that elf_begin()
uses for reading or writing. elf is an ELF descriptor previously returned from
elf_begin(). The initial file offset (see lseek(2)) is unconstrained, and the resulting
file offset is undefined.

cmd may have the following values:

ELF_C_NULL     When a program sets cmd to this value, elf_begin() returns a
                null pointer, without opening a new descriptor. ref is ignored for
                this command. See the examples below for more information.

ELF_C_READ     When a program wishes to examine the contents of an existing file,
                it should set cmd to this value. Depending on the value of ref, this
                command examines archive members or entire files. Three cases
                can occur.

                First, if ref is a null pointer, elf_begin() allocates a new ELF
descriptor and prepares to process the entire file. If the file being
read is an archive, elf_begin() also prepares the resulting
descriptor to examine the initial archive member on the next call to
elf_begin(), as if the program had used elf_next() or
elf_rand() to “move” to the initial member.

                Second, if ref is a non-null descriptor associated with an archive
file, elf_begin() lets a program obtain a separate ELF descriptor
associated with an individual member. The program should have
used elf_next() or elf_rand() to position ref appropriately
(except for the initial member, which elf_begin() prepares; see
the example below). In this case, fildes should be the same file
descriptor used for the parent archive.
Finally, if ref is a non-null ELF descriptor that is not an archive, elf_begin() increments the number of activations for the descriptor and returns ref, without allocating a new descriptor and without changing the descriptor’s read/write permissions. To terminate the descriptor for ref, the program must call elf_end() once for each activation. See the examples below for more information.

**ELF_C_RDWR**

This command duplicates the actions of ELF_C_READ and additionally allows the program to update the file image (see elf_update(3ELF)). That is, using ELF_C_READ gives a read-only view of the file, while ELF_C_RDWR lets the program read and write the file. ELF_C_RDWR is not valid for archive members. If ref is non-null, it must have been created with the ELF_C_RDWR command.

**ELF_C_WRITE**

If the program wishes to ignore previous file contents, presumably to create a new file, it should set cmd to this value. ref is ignored for this command.

elf_begin() “works” on all files (including files with zero bytes), providing it can allocate memory for its internal structures and read any necessary information from the file. Programs reading object files thus may call elf_kind(3ELF) or elf32_getehdr(3ELF) to determine the file type (only object files have an ELF header). If the file is an archive with no more members to process, or an error occurs, elf_begin() returns a null pointer. Otherwise, the return value is a non-null ELF descriptor.

Before the first call to elf_begin(), a program must call elf_version() to coordinate versions.

elf_end() is used to terminate an ELF descriptor, elf, and to deallocate data associated with the descriptor. Until the program terminates a descriptor, the data remain allocated. A null pointer is allowed as an argument, to simplify error handling. If the program wishes to write data associated with the ELF descriptor to the file, it must use elf_update() before calling elf_end().

Calling elf_end() removes one activation and returns the remaining activation count. The library does not terminate the descriptor until the activation count reaches 0. Consequently, a 0 return value indicates the ELF descriptor is no longer valid.

elf_memory() returns a pointer to an ELF descriptor, the ELF image has read operations enabled (ELF_C_READ). image is a pointer to an image of the Elf file mapped into memory, sz is the size of the ELF image. An ELF image that is mapped in with elf_memory() may be read and modified, but the ELF image size may not be changed.
elf_next() provides sequential access to the next archive member. That is, having an ELF descriptor, elf, associated with an archive member, elf_next() prepares the containing archive to access the following member when the program calls elf_begin(). After successfully positioning an archive for the next member, elf_next() returns the value ELF_C_READ. Otherwise, the open file was not an archive, elf was NULL, or an error occurred, and the return value is ELF_C_NULL. In either case, the return value may be passed as an argument to elf_begin(), specifying the appropriate action.

elf_rand() provides random archive processing, preparing elf to access an arbitrary archive member. elf must be a descriptor for the archive itself, not a member within the archive. offset gives the byte offset from the beginning of the archive to the archive header of the desired member. See elf_getarsym(3ELF) for more information about archive member offsets. When elf_rand() works, it returns offset. Otherwise, it returns 0, because an error occurred, elf was NULL, or the file was not an archive (no archive member can have a zero offset). A program may mix random and sequential archive processing.

System Services

When processing a file, the library decides when to read or write the file, depending on the program’s requests. Normally, the library assumes the file descriptor remains usable for the life of the ELF descriptor. If, however, a program must process many files simultaneously and the underlying operating system limits the number of open files, the program can use elf_cntl() to let it reuse file descriptors. After calling elf_cntl() with appropriate arguments, the program may close the file descriptor without interfering with the library.

All data associated with an ELF descriptor remain allocated until elf_end() terminates the descriptor’s last activation. After the descriptors have been terminated, the storage is released; attempting to reference such data gives undefined behavior. Consequently, a program that deals with multiple input (or output) files must keep the ELF descriptors active until it finishes with them.

EXAMPLES

**EXAMPLE 1** A sample program of calling the elf_begin() function.

A prototype for reading a file appears on the next page. If the file is a simple object file, the program executes the loop one time, receiving a null descriptor in the second iteration. In this case, both elf and arf will have the same value, the activation count will be 2, and the program calls elf_end() twice to terminate the descriptor. If the file is an archive, the loop processes each archive member in turn, ignoring those that are not object files.

```c
if (elf_version(EV_CURRENT) == EV_NONE)
{
    /* library out of date */
    /* recover from error */
}

cmd = ELF_C_READ;
arf = elf_begin(fildes, cmd, (Elf *)0);
while ((elf = elf_begin(fildes, cmd, arf)) != 0) 
```

Extended Library Functions 157
EXAMPLE 1 A sample program of calling the elf_begin() function. (Continued)

    if ((ehdr = elf32_getehdr(elf)) != 0)
    {
        /* process the file ... */
        cmd = elf_next[elf];
        elf_end(elf);
    }
    elf_end(elf);

Alternatively, the next example illustrates random archive processing. After identifying the file as an archive, the program repeatedly processes archive members of interest. For clarity, this example omits error checking and ignores simple object files. Additionally, this fragment preserves the ELF descriptors for all archive members, because it does not call elf_end() to terminate them.

    elf_version(EV_CURRENT);
    arf = elf_begin(fildes, ELF_C_READ, (Elf *)0);
    if (elf_kind(arf) != ELF_K_AR)
        /* not an archive */
    /* initial processing */
    /* set offset = ... for desired member header */
    while (elf_rand(arf, offset) == offset)
    {
        if ((elf = elf_begin(fildes, ELF_C_READ, arf)) == 0)
            break;
        if ((ehdr = elf32_getehdr(elf)) != 0)
            /* process archive member ... */
    }
    /* set offset = ... for desired member header */

An archive starts with a “magic string” that has SARMAG bytes; the initial archive member follows immediately. An application could thus provide the following function to rewind an archive (the function returns −1 for errors and 0 otherwise).

    #include <ar.h>
    #include <libelf.h>
    int
    rewindelf(Elf *elf)
    {
        if (elf_rand(elf, (size_t)SARMAG) == SARMAG)
            return 0;
        return -1;
    }

The following outline shows how one might create a new ELF file. This example is simplified to show the overall flow.

    elf_version(EV_CURRENT);
    fildes = open("path/name", O_RDWR|O_TRUNC|O_CREAT, 0666);
EXAMPLE 1 A sample program of calling the `elf_begin()` function. (Continued)

```c
if ((elf = elf_begin(fildes, ELF_C_WRITE, (Elf *)0)) == 0)  
    return;
  
ehdr = elf32_newehdr(elf);
  phdr = elf32_newphdr(elf, count);
  scn = elf_newscn(elf);
  shdr = elf32_getshdr(scn);
  data = elf_newdata(scn);
  elf_update(elf, ELF_C_WRITE);
  elf_end(elf);
```

Finally, the following outline shows how one might update an existing ELF file. Again, this example is simplified to show the overall flow.

```c
elf_version(EV_CURRENT);
  fildes = open("path/name", O_RDWR);
  elf = elf_begin(fildes, ELF_C_RDWR, (Elf *)0);
  /* add new or delete old information */
  ...  
  /* ensure that the memory image of the file is complete */
  elf_update(elf, ELF_C_NULL);
  elf_update(elf, ELF_C_WRITE); /* update file */
  elf_end(elf);
```

Notice that both file creation examples open the file with write and read permissions. On systems that support `mmap(2)`, the library uses it to enhance performance, and `mmap(2)` requires a readable file descriptor. Although the library can use a write-only file descriptor, the application will not obtain the performance advantages of `mmap(2)`.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

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<tr>
<th>ATTRIBUTE TYPE</th>
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<td>MT-Level</td>
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</table>

**SEE ALSO**

`creat(2), lseek(2), mmap(2), open(2), elf(3ELF), elf32_getehdr(3ELF), elf_cntl(3ELF), elf_getarhdr(3ELF), elf_getarsym(3ELF), elf_getbase(3ELF), elf_getdata(3ELF), elf_getscn(3ELF), elf_kind(3ELF), elf_rawfile(3ELF), elf_update(3ELF), elf_version(3ELF), ar(3HEAD), attributes(5)`
elf_cntl(3ELF)

NAME
elf_cntl – control an elf file descriptor

SYNOPSIS
cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

int elf_cntl(Elf *elf, Elf_Cmd cmd);

DESCRIPTION
elf_cntl() instructs the library to modify its behavior with respect to an ELF
descriptor, elf. As elf_begin(3ELF) describes, an ELF descriptor can have multiple
activations, and multiple ELF descriptors may share a single file descriptor. Generally,
elf_cntl() commands apply to all activations of elf. Moreover, if the ELF descriptor
is associated with an archive file, descriptors for members within the archive will also
be affected as described below. Unless stated otherwise, operations on archive
members do not affect the descriptor for the containing archive.

The cmd argument tells what actions to take and may have the following values:

ELF_C_FDDONE This value tells the library not to use the file descriptor associated
with elf. A program should use this command when it has
requested all the information it cares to use and wishes to avoid
the overhead of reading the rest of the file. The memory for all
completed operations remains valid, but later file operations, such
as the initial elf_getdata() for a section, will fail if the data are
not in memory already.

ELF_C_FDREAD This command is similar to ELF_C_FDDONE, except it forces the
library to read the rest of the file. A program should use this
command when it must close the file descriptor but has not yet
read everything it needs from the file. After elf_cntl() completes the ELF_C_FDREAD command, future operations, such
as elf_getdata(), will use the memory version of the file
without needing to use the file descriptor.

If elf_cntl() succeeds, it returns 0. Otherwise elf was NULL or an error occurred,
and the function returns -1.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO elf(3ELF), elf_begin(3ELF), elf_getdata(3ELF), elf_rawfile(3ELF),
attributes(5)
If the program wishes to use the "raw" operations (see `elf_rawdata()`, which `elf_getdata(3ELF)` describes, and `elf_rawfile(3ELF)` after disabling the file descriptor with `ELF_C_FDDONE` or `ELF_C_FDFREAD`, it must execute the raw operations explicitly beforehand. Otherwise, the raw file operations will fail. Calling `elf_rawfile()` makes the entire image available, thus supporting subsequent `elf_rawdata()` calls.
elf_errmsg(3ELF)

NAME     elf_errmsg, elf_errno – error handling

SYNOPSIS cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

const char *elf_errmsg(int err);
int elf_errno(void);

DESCRIPTION If an ELF library function fails, a program may call elf_errno() to retrieve
the library’s internal error number. As a side effect, this function resets the internal error
number to 0, which indicates no error.

elf_errmsg() takes an error number, err, and returns a null-terminated error
message (with no trailing new-line) that describes the problem. A zero err retrieves a
message for the most recent error. If no error has occurred, the return value is a null
pointer (not a pointer to the null string). Using err of −1 also retrieves the most recent
error, except it guarantees a non-null return value, even when no error has occurred. If
no message is available for the given number, elf_errmsg() returns a pointer to an
appropriate message. This function does not have the side effect of clearing the
internal error number.

EXAMPLES EXAMPLE 1 A sample program of calling the elf_errmsg() function.

The following fragment clears the internal error number and checks it later for errors.
Unless an error occurs after the first call to elf_errno(), the next call will return 0.

(void)elf_errno( );
/* processing . . . */
while (more_to_do)
{
  if ((err = elf_errno( )) != 0)
  {
    /* print msg */
    msg = elf_errmsg(err);
  }
}

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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SEE ALSO elf(3ELF), attributes(5)
elf_fill(3ELF)

NAME
elf_fill – set fill byte

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

void elf_fill(int fill);

DESCRIPTION
Alignment constraints for ELF files sometimes require the presence of “holes.” For example, if the data for one section are required to begin on an eight-byte boundary, but the preceding section is too “short,” the library must fill the intervening bytes. These bytes are set to the fill character. The library uses zero bytes unless the application supplies a value. See elf_getdata(3ELF) for more information about these holes.

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SEE ALSO
elf(3ELF), elf_flagdata(3ELF), elf_getdata(3ELF), elf_update(3ELF), attributes(5)

NOTES
An application can assume control of the object file organization by setting the ELF_F_LAYOUT bit (see elf_flagdata(3ELF)). When this is done, the library does not fill holes.
elf_flagdata(3ELF)

NAME

elf_flagdata, elf_flagehdr, elf_flagelf, elf_flagphdr, elf_flagscn, elf_flagshdr – manipulate flags

SYNOPSIS

cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

unsigned elf_flagdata(Elf_Data *data, Elf_Cmd cmd, unsigned flags);
unsigned elf_flagehdr(Elf *elf, Elf_Cmd cmd, unsigned flags);
unsigned elf_flagelf(Elf *elf, Elf_Cmd cmd, unsigned flags);
unsigned elf_flagphdr(Elf *elf, Elf_Cmd cmd, unsigned flags);
unsigned elf_flagscn(Elf_Scn *scn, Elf_Cmd cmd, unsigned flags);
unsigned elf_flagshdr(Elf_Scn *scn, Elf_Cmd cmd, unsigned flags);

DESCRIPTION

These functions manipulate the flags associated with various structures of an ELF file. Given an ELF descriptor (elf), a data descriptor (data), or a section descriptor (scn), the functions may set or clear the associated status bits, returning the updated bits. A null descriptor is allowed, to simplify error handling; all functions return 0 for this degenerate case.

cmd may have the following values:

ELF_C_CLR  The functions clear the bits that are asserted in flags. Only the non-zero bits in flags are cleared; zero bits do not change the status of the descriptor.

ELF_C_SET  The functions set the bits that are asserted in flags. Only the non-zero bits in flags are set; zero bits do not change the status of the descriptor.

Descriptions of the defined flags bits appear below:

ELF_F_DIRTY  When the program intends to write an ELF file, this flag asserts the associated information needs to be written to the file. Thus, for example, a program that wished to update the ELF header of an existing file would call elf_flagehdr() with this bit set in flags and cmd equal to ELF_C_SET. A later call to elf_update() would write the marked header to the file.

ELF_F_LAYOUT  Normally, the library decides how to arrange an output file. That is, it automatically decides where to place sections, how to align them in the file, etc. If this bit is set for an ELF descriptor, the program assumes responsibility for determining all file positions. This bit is meaningful only for elf_flagelf() and applies to the entire file associated with the descriptor.

When a flag bit is set for an item, it affects all the subitems as well. Thus, for example, if the program sets the ELF_F_DIRTY bit with elf_flagelf(), the entire logical file is "dirty."
EXAMPLES

EXAMPLE 1 A sample display of calling the `elf_flagdata(3ELF)` function.

The following fragment shows how one might mark the ELF header to be written to the output file:

```c
/* dirty ehdr ... */
ehdr = elf32_getehdr(elf);
elf_flaghdr(elf, ELF_C_SET, ELF_F_DIRTY);
```

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SEE ALSO

`elf(3ELF), elf32_getehdr(3ELF), elf_getdata(3ELF), elf_update(3ELF), attributes(5)`
Elf_getarhdr(3ELF)

NAME
elf_getarhdr – retrieve archive member header

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>
Elf_Arhdr *elf_getarhdr(Elf *elf);

DESCRIPTION
elf_getarhdr() returns a pointer to an archive member header, if one is available for the ELF descriptor elf. Otherwise, no archive member header exists, an error occurred, or elf was null; elf_getarhdr() then returns a null value. The header includes the following members.

char *ar_name;
time_t ar_date;
uid_t ar_uid;
gid_t ar_gid;
mode_t ar_mode;
off_t ar_size;
char *ar_rawname;

An archive member name, available through ar_name, is a null-terminated string, with the ar format control characters removed. The ar_rawname member holds a null-terminated string that represents the original name bytes in the file, including the terminating slash and trailing blanks as specified in the archive format.

In addition to “regular” archive members, the archive format defines some special members. All special member names begin with a slash (/), distinguishing them from regular members (whose names may not contain a slash). These special members have the names (ar_name) defined below.

/ This is the archive symbol table. If present, it will be the first archive member. A program may access the archive symbol table through elf_getarsym(). The information in the symbol table is useful for random archive processing (see elf_rand() on elf_begin(3ELF)).

// This member, if present, holds a string table for long archive member names. An archive member’s header contains a 16-byte area for the name, which may be exceeded in some file systems. The library automatically retrieves long member names from the string table, setting ar_name to the appropriate value.

Under some error conditions, a member’s name might not be available. Although this causes the library to set ar_name to a null pointer, the ar_rawname member will be set as usual.

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elf_getarhdr(3ELF)

SEE ALSO elf(3ELF), elf_begin(3ELF), elf_getarsym(3ELF), ar(3HEAD), attributes(5)
elf_getarsym(3ELF)

NAME
elf_getarsym – retrieve archive symbol table

SYNOPSIS
cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

Elf_Arsym *elf_getarsym(Elf *elf, size_t *ptr);

DESCRIPTION
elf_getarsym() returns a pointer to the archive symbol table, if one is available for
the ELF descriptor elf. Otherwise, the archive doesn’t have a symbol table, an error
occurred, or elf was null; elf_getarsym() then returns a null value. The symbol
table is an array of structures that include the following members.

char   *as_name;
size_t as_off;
unsigned long as_hash;

These members have the following semantics:

as_name A pointer to a null-terminated symbol name resides here.
as_off This value is a byte offset from the beginning of the archive to the
       member’s header. The archive member residing at the given offset
       defines the associated symbol. Values in as_off may be passed as
       arguments to elf_rand(). See elf_begin(3ELF) to access the
       desired archive member.
as_hash This is a hash value for the name, as computed by elf_hash().

If ptr is non-null, the library stores the number of table entries in the location to which
ptr points. This value is set to 0 when the return value is NULL. The table’s last entry,
which is included in the count, has a null as_name, a zero value for as_off, and
~0UL for as_hash.

The hash value returned is guaranteed not to be the bit pattern of all ones ( ~0UL).

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SEE ALSO
elf(3ELF), elf_begin(3ELF), elf_getarhdr(3ELF), elf_hash(3ELF),
ar(3HEAD), attributes(5)
NAME
elf_getbase – get the base offset for an object file

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

off_t elf_getbase(E1f *elf);

DESCRIPTION
elf_getbase() returns the file offset of the first byte of the file or archive member
associated with elf, if it is known or obtainable, and -1 otherwise. A null elf is allowed,
to simplify error handling; the return value in this case is -1. The base offset of an
archive member is the beginning of the member’s information, not the beginning of
the archive member header.

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SEE ALSO
elf(3ELF), elf_begin(3ELF), ar(3HEAD), attributes(5)
## NAME
elf_getdata, elf_newdata, elf_rawdata – get section data

## SYNOPSIS
```
cc [ flag ... ] file ... -lelf [ library ... ]
#include <libelf.h>

Elf_Data *elf_getdata(Elf_Scn *scn, Elf_Data *data);
Elf_Data *elf_newdata(Elf_Scn *scn);
Elf_Data *elf_rawdata(Elf_Scn *scn, Elf_Data *data);
```

## DESCRIPTION
These functions access and manipulate the data associated with a section descriptor, `scn`. When reading an existing file, a section will have a single data buffer associated with it. A program may build a new section in pieces, however, composing the new data from multiple data buffers. For this reason, the data for a section should be viewed as a list of buffers, each of which is available through a data descriptor.

`elf_getdata()` lets a program step through a section’s data list. If the incoming data descriptor, `data`, is null, the function returns the first buffer associated with the section. Otherwise, `data` should be a data descriptor associated with `scn`, and the function gives the program access to the next data element for the section. If `scn` is null or an error occurs, `elf_getdata()` returns a null pointer.

`elf_getdata()` translates the data from file representations into memory representations (see `elf32_xlatetof(3ELF)`) and presents objects with memory data types to the program, based on the file's `class` (see `elf(3ELF)`). The working library version (see `elf_version(3ELF)`) specifies what version of the memory structures the program wishes `elf_getdata()` to present.

`elf_newdata()` creates a new data descriptor for a section, appending it to any data elements already associated with the section. As described below, the new data descriptor appears empty, indicating the element holds no data. For convenience, the descriptor’s type (`d_type` below) is set to `ELF_T_BYTE`, and the version (`d_version` below) is set to the working version. The program is responsible for setting (or changing) the descriptor members as needed. This function implicitly sets the `ELF_F_DIRTY` bit for the section’s data (see `elf_flagdata(3ELF)`). If `scn` is null or an error occurs, `elf_newdata()` returns a null pointer.

`elf_rawdata()` differs from `elf_getdata()` by returning only uninterpreted bytes, regardless of the section type. This function typically should be used only to retrieve a section image from a file being read, and then only when a program must avoid the automatic data translation described below. Moreover, a program may not close or disable (see `elf_cntl(3ELF)`) the file descriptor associated with `elf` before the initial raw operation, because `elf_rawdata()` might read the data from the file to ensure it doesn’t interfere with `elf_getdata()`. See `elf_rawfile(3ELF)` for a related facility that applies to the entire file. When `elf_getdata()` provides the right translation, its use is recommended over `elf_rawdata()`. If `scn` is null or an error occurs, `elf_rawdata()` returns a null pointer.

The `Elf_Data` structure includes the following members:
These members are available for direct manipulation by the program. Descriptions appear below.

**d_buf**
A pointer to the data buffer resides here. A data element with no data has a null pointer.

**d_type**
This member’s value specifies the type of the data to which *d_buf* points. A section’s type determines how to interpret the section contents, as summarized below.

**d_size**
This member holds the total size, in bytes, of the memory occupied by the data. This may differ from the size as represented in the file. The size will be zero if no data exist. (See the discussion of SHT_NOBITS below for more information.)

**d_off**
This member gives the offset, within the section, at which the buffer resides. This offset is relative to the file’s section, not the memory object’s.

**d_align**
This member holds the buffer’s required alignment, from the beginning of the section. That is, *d_off* will be a multiple of this member’s value. For example, if this member’s value is 4, the beginning of the buffer will be four-byte aligned within the section. Moreover, the entire section will be aligned to the maximum of its constituents, thus ensuring appropriate alignment for a buffer within the section and within the file.

**d_version**
This member holds the version number of the objects in the buffer. When the library originally read the data from the object file, it used the working version to control the translation to memory objects.

### Data Alignment
As mentioned above, data buffers within a section have explicit alignment constraints. Consequently, adjacent buffers sometimes will not abut, causing “holes” within a section. Programs that create output files have two ways of dealing with these holes.

First, the program can use *elf_fill()* to tell the library how to set the intervening bytes. When the library must generate gaps in the file, it uses the fill byte to initialize the data there. The library’s initial fill value is 0, and *elf_fill()* lets the application change that.
Second, the application can generate its own data buffers to occupy the gaps, filling the gaps with values appropriate for the section being created. A program might even use different fill values for different sections. For example, it could set text sections’ bytes to no-operation instructions, while filling data section holes with zero. Using this technique, the library finds no holes to fill, because the application eliminated them.

`elf_getdata()` interprets sections’ data according to the section type, as noted in the section header available through `elf32_getshdr()`. The following table shows the section types and how the library represents them with memory data types for the 32-bit file class. Other classes would have similar tables. By implication, the memory data types control translation by `elf32_xlateto()`. The following table shows the section types and how the library represents them with memory data types for the 32-bit file class. Other classes would have similar tables. By implication, the memory data types control translation by `elf32_xlateto()`.

<table>
<thead>
<tr>
<th>Section Type</th>
<th>Elf_Type</th>
<th>32-Bit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHT_DYNAMIC</td>
<td>ELF_T_DYN</td>
<td>Elf32_Dyn</td>
</tr>
<tr>
<td>SHT_DYNSYM</td>
<td>ELF_T_SYM</td>
<td>Elf32_Sym</td>
</tr>
<tr>
<td>SHT_HASH</td>
<td>ELF_T_WORD</td>
<td>Elf32_Word</td>
</tr>
<tr>
<td>SHT_NOBITS</td>
<td>ELF_T_BYTE</td>
<td>unsigned char</td>
</tr>
<tr>
<td>SHT_NOTE</td>
<td>ELF_T_BYTE</td>
<td>unsigned char</td>
</tr>
<tr>
<td>SHT_NULL</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>SHT_PROGBITS</td>
<td>ELF_T_BYTE</td>
<td>unsigned char</td>
</tr>
<tr>
<td>SHT_REL</td>
<td>ELF_T_REL</td>
<td>Elf32_Rel</td>
</tr>
<tr>
<td>SHT_RELA</td>
<td>ELF_T_RELA</td>
<td>Elf32_Rel</td>
</tr>
<tr>
<td>SHT_SYMTAB</td>
<td>ELF_T_BYTE</td>
<td>unsigned char</td>
</tr>
<tr>
<td>SHT_SYMTAB</td>
<td>ELF_T_SYM</td>
<td>Elf32_Sym</td>
</tr>
<tr>
<td>SHT_SUNW_verdef</td>
<td>ELF_T_VDEF</td>
<td>Elf32_Verdef</td>
</tr>
<tr>
<td>SHT_SUNW_verneed</td>
<td>ELF_T_VNEED</td>
<td>Elf32_Verneed</td>
</tr>
<tr>
<td>SHT_SUNW_versym</td>
<td>ELF_T_HALF</td>
<td>Elf32_Versym</td>
</tr>
<tr>
<td>other</td>
<td>ELF_T_BYTE</td>
<td>unsigned char</td>
</tr>
</tbody>
</table>

`elf_rawdata()` creates a buffer with type ELF_T_BYTE.

As mentioned above, the program’s working version controls what structures the library creates for the application. The library similarly interprets section types according to the versions. If a section type belongs to a version newer than the application’s working version, the library does not translate the section data. Because the application cannot know the data format in this case, the library presents an untranslated buffer of type ELF_T_BYTE, just as it would for an unrecognized section type.

A section with a special type, SHT_NOBITS, occupies no space in an object file, even when the section header indicates a non-zero size. `elf_getdata()` and `elf_rawdata()` work on such a section, setting the data structure to have a null buffer pointer and the type indicated above. Although no data are present, the d_size value is set to the size from the section header. When a program is creating a new section of type SHT_NOBITS, it should use `elf_newdata()` to add data buffers to the section. These empty data buffers should have the d_size members set to the desired size and the d_buf members set to NULL.
EXAMPLE

A sample program of calling `elf_getdata()`.

The following fragment obtains the string table that holds section names (ignoring error checking). See `elf_strptr(3ELF)` for a variation of string table handling.

```c
ehdr = elf32_getehdr(elf);
scn = elf_getscn(elf, (size_t)ehdr->e_shstrndx);
shdr = elf32_getshdr(scn);
if (shdr=&sh_type != SHT_STRTAB) {
    /* not a string table */
data = 0;
if ((data = elf_getdata(scn, data)) == 0 || data->d_size == 0) {
    /* error or no data */
}
```

The `e_shstrndx` member in an ELF header holds the section table index of the string table. The program gets a section descriptor for that section, verifies it is a string table, and then retrieves the data. When this fragment finishes, `data->d_buf` points at the first byte of the string table, and `data->d_size` holds the string table's size in bytes.

ATTRIBUTES

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

`elf(3ELF), elf32_getehdr(3ELF), elf32_getshdr(3ELF), elf32_xlatetof(3ELF), elf_cntl(3ELF), elf_fill(3ELF), elf_flagdata(3ELF), elf_getscn(3ELF), elf_rawfile(3ELF), elf_strptr(3ELF), elf_version(3ELF)`, `attributes(5)`
elf_getident(3ELF)

NAME
elf_getident – retrieve file identification data

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

char *elf_getident(Elf *elf, size_t *ptr);

DESCRIPTION
As elf(3ELF) explains, ELF provides a framework for various classes of files, where basic objects may have 32 bits, 64 bits, etc. To accommodate these differences, without forcing the larger sizes on smaller machines, the initial bytes in an ELF file hold identification information common to all file classes. Every ELF header’s e_ident has EI_NIDENT bytes with the following interpretation:

<table>
<thead>
<tr>
<th>e_ident Index</th>
<th>Value</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>EI_MAG0</td>
<td>ELFMAG0</td>
<td>File identification</td>
</tr>
<tr>
<td>EI_MAG1</td>
<td>ELFMAG1</td>
<td></td>
</tr>
<tr>
<td>EI_MAG2</td>
<td>ELFMAG2</td>
<td></td>
</tr>
<tr>
<td>EI_MAG3</td>
<td>ELFMAG3</td>
<td></td>
</tr>
<tr>
<td>EI_CLASS</td>
<td>ELFCLASSNONE</td>
<td>File class</td>
</tr>
<tr>
<td></td>
<td>ELFCLASS32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELFCLASS64</td>
<td></td>
</tr>
<tr>
<td>EI_DATA</td>
<td>ELFDATANONE</td>
<td>Data encoding</td>
</tr>
<tr>
<td></td>
<td>ELFDATA2LSB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELFDATA2MSB</td>
<td></td>
</tr>
<tr>
<td>EI_VERSION</td>
<td>EV_CURRENT</td>
<td>File version</td>
</tr>
<tr>
<td>7-15</td>
<td>0</td>
<td>Unused, set to zero</td>
</tr>
</tbody>
</table>

Other kinds of files (see elf_kind(3ELF)) also may have identification data, though they would not conform to e_ident.

elf_getident() returns a pointer to the file’s “initial bytes.” If the library recognizes the file, a conversion from the file image to the memory image may occur. In any case, the identification bytes are guaranteed not to have been modified, though
the size of the unmodified area depends on the file type. If \textit{ptr} is non-null, the library stores the number of identification bytes in the location to which \textit{ptr} points. If no data are present, \textit{elf} is null, or an error occurs, the return value is a null pointer, with 0 stored through \textit{ptr}, if \textit{ptr} is non-null.

\textbf{ATTRIBUTES} See \texttt{attributes(5)} for descriptions of the following attributes:

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
\textbf{ATTRIBUTE TYPE} & \textbf{ATTRIBUTE VALUE} \\
\hline
MT-Level & MT-Safe \\
\hline
\end{tabular}
\end{table}

\textbf{SEE ALSO} \texttt{elf(3ELF), elf32_getehdr(3ELF), elf_begin(3ELF), elf_kind(3ELF), elf_rawfile(3ELF), attributes(5)}}
### NAME
elf_getscn, elf_ndxscn, elf_newscn, elf_nextscn – get section information

### SYNOPSIS
```c
#include <libelf.h>

Elf_Scn *elf_getscn(Elf *elf, size_t index);
size_t elf_ndxscn(Elf_Scn *scn);
Elf_Scn *elf_newscn(Elf *elf);
Elf_Scn *elf_nextscn(Elf *elf, Elf_Scn *scn);
```

### DESCRIPTION
These functions provide indexed and sequential access to the sections associated with the ELF descriptor `elf`. If the program is building a new file, it is responsible for creating the file’s ELF header before creating sections; see `elf32_getehdr(3ELF).

**elf_getscn()** returns a section descriptor, given an `index` into the file’s section header table. Note that the first “real” section has an index of 1. Although a program can get a section descriptor for the section whose `index` is 0 (`SHN_UNDEF`, the undefined section), the section has no data and the section header is “empty” (though present). If the specified section does not exist, an error occurs, or `elf` is null, `elf_getscn()` returns a null pointer.

**elf_newscn()** creates a new section and appends it to the list for `elf`. Because the `SHN_UNDEF` section is required and not “interesting” to applications, the library creates it automatically. Thus the first call to `elf_newscn()` for an ELF descriptor with no existing sections returns a descriptor for section 1. If an error occurs or `elf` is null, `elf_newscn()` returns a null pointer.

After creating a new section descriptor, the program can use `elf32_getshdr()` to retrieve the newly created, “clean” section header. The new section descriptor will have no associated data (see `elf_getdata(3ELF)`). When creating a new section in this way, the library updates the `e_shnum` member of the ELF header and sets the ELF_F_DIRTY bit for the section (see `elf_flagdata(3ELF)`). If the program is building a new file, it is responsible for creating the file’s ELF header (see `elf32_getehdr(3ELF)`) before creating new sections.

**elf_nextscn()** takes an existing section descriptor, `scn`, and returns a section descriptor for the next higher section. One may use a null `scn` to obtain a section descriptor for the section whose index is 1 (skipping the section whose index is `SHN_UNDEF`). If no further sections are present or an error occurs, `elf_nextscn()` returns a null pointer.

**elf_ndxscn()** takes an existing section descriptor, `scn`, and returns its section table index. If `scn` is null or an error occurs, `elf_ndxscn()` returns `SHN_UNDEF`.

### EXAMPLES
**EXAMPLE 1** A sample of calling `elf_getscn()` function.

An example of sequential access appears below. Each pass through the loop processes the next section in the file; the loop terminates when all sections have been processed.
EXAMPLE 1 A sample of calling `elf_getscn()` function.  (Continued)

```c
scn = 0;
while ((scn = elf_nextscn(elf, scn)) != 0)
{
    /* process section */
}
```

ATTRIBUTES  See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  `elf(3ELF), elf32_getehdr(3ELF), elf32_getshdr(3ELF), elf_begin(3ELF), elf_flagdata(3ELF), elf_getdata(3ELF), attributes(5)`
elf_hash(3ELF)

NAME    elf_hash – compute hash value

SYNOPSIS cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

unsigned long elf_hash(const char *name);

DESCRIPTION elf_hash() computes a hash value, given a null terminated string, name. The returned hash value, h, can be used as a bucket index, typically after computing h mod x to ensure appropriate bounds.

Hash tables may be built on one machine and used on another because elf_hash() uses unsigned arithmetic to avoid possible differences in various machines’ signed arithmetic. Although name is shown as char* above, elf_hash() treats it as unsigned char* to avoid sign extension differences. Using char* eliminates type conflicts with expressions such as elf_hash(name).

ELF files’ symbol hash tables are computed using this function (see elf_getdata(3ELF) and elf32_xlatetof(3ELF)). The hash value returned is guaranteed not to be the bit pattern of all ones (~0UL).

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO elf(3ELF), elf32_xlatetof(3ELF), elf_getdata(3ELF), attributes(5)
elf_kind(3ELF)

NAME
elf_kind – determine file type

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>
Elf_Kind elf_kind(Elf *elf);

DESCRIPTION
This function returns a value identifying the kind of file associated with an ELF descriptor (elf). Defined values are below:

ELF_K_AR The file is an archive [see ar(3HEAD)]. An ELF descriptor may also be associated with an archive member, not the archive itself, and then elf_kind() identifies the member’s type.

ELF_K_COFF The file is a COFF object file. elf_begin(3ELF) describes the library’s handling for COFF files.

ELF_K_ELF The file is an ELF file. The program may use elf_getident() to determine the class. Other functions, such as elf32_getehdr(), are available to retrieve other file information.

ELF_K_NONE This indicates a kind of file unknown to the library.

Other values are reserved, to be assigned as needed to new kinds of files. elf should be a value previously returned by elf_begin(). A null pointer is allowed, to simplify error handling, and causes elf_kind() to return ELF_K_NONE.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
elf(3ELF), elf32_getehdr(3ELF), elf_begin(3ELF), elf_getident(3ELF), ar(3HEAD), attributes(5)
elf_rawfile(3ELF)

NAME   | elf_rawfile – retrieve uninterpreted file contents
SYNOPSIS | cc [ flag... ] file ... -l elf [ library ... ]
          | #include <libelf.h>
          | char *elf_rawfile(Elf *elf, size_t *ptr);
DESCRIPTION | elf_rawfile() returns a pointer to an uninterpreted byte image of the file. This function should be used only to retrieve a file being read. For example, a program might use elf_rawfile() to retrieve the bytes for an archive member.

A program may not close or disable (see elf_cntl(3ELF)) the file descriptor associated with elf before the initial call to elf_rawfile(), because elf_rawfile() might have to read the data from the file if it does not already have the original bytes in memory. Generally, this function is more efficient for unknown file types than for object files. The library implicitly translates object files in memory, while it leaves unknown files unmodified. Thus, asking for the uninterpreted image of an object file may create a duplicate copy in memory.

elf_rawdata() is a related function, providing access to sections within a file. See elf_getdata(3ELF).

If ptr is non-null, the library also stores the file's size, in bytes, in the location to which ptr points. If no data are present, elf is null, or an error occurs, the return value is a null pointer, with 0 stored through ptr, if ptr is non-null.

ATTRIBUTES | See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO | elf(3ELF), elf32_getehdr(3ELF), elf_begin(3ELF), elf_cntl(3ELF), elf_getdata(3ELF), elf_getident(3ELF), elf_kind(3ELF), attributes(5)

NOTES | A program that uses elf_rawfile() and that also interprets the same file as an object file potentially has two copies of the bytes in memory. If such a program requests the raw image first, before it asks for translated information (through such functions as elf32_getehdr(), elf_getdata(), and so on), the library “freezes” its original memory copy for the raw image. It then uses this frozen copy as the source for creating translated objects, without reading the file again. Consequently, the application should view the raw file image returned by elf_rawfile() as a read-only buffer, unless it wants to alter its own view of data subsequently translated. In any case, the application may alter the translated objects without changing bytes visible in the raw image.

Multiple calls to elf_rawfile() with the same ELF descriptor return the same value; the library does not create duplicate copies of the file.
NAME    elf_strptr – make a string pointer

SYNOPSIS  
cc [ flag ... ] file ... -elf [ library ... ]
#include <libelf.h>

char *elf_strptr(Elf *, size_t section, size_t offset);

DESCRIPTION  
This function converts a string section offset to a string pointer. elf identifies the file in which the string section resides, and section identifies the section table index for the strings. elf_strptr() normally returns a pointer to a string, but it returns a null pointer when elf is null, section is invalid or is not a section of type SHT_STRTAB, the section data cannot be obtained, offset is invalid, or an error occurs.

EXAMPLES  
EXAMPLE 1 A sample program of calling elf_strptr() function.

A prototype for retrieving section names appears below. The file header specifies the section name string table in the e_shstrndx member. The following code loops through the sections, printing their names.

/* handle the error */
if ((ehdr = elf32_getehdr(elf)) == 0) {
    return;
}
ndx = ehdr->e_shstrndx;
scn = 0;
while ((scn = elf_nextscn(elf, scn)) != 0) {
    char *name = 0;
    if ((shdr = elf32_getshdr(scn)) != 0)
        name = elf_strptr(elf, ndx, (size_t)shdr->sh_name);
    printf("%s
", name? name: "(null)");
}

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  
elf(3ELF), elf32_getshdr(3ELF), elf32_xlatetof(3ELF), elf_getdata(3ELF), attributes(5)

NOTES  
A program may call elf_getdata() to retrieve an entire string table section. For some applications, that would be both more efficient and more convenient than using elf_strptr().
elf_update(3ELF)

NAME
elf_update – update an ELF descriptor

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

off_t elf_update(Elf *elf, Elf_Cmd cmd);

DESCRIPTION
elf_update() causes the library to examine the information associated with an ELF descriptor, elf, and to recalculate the structural data needed to generate the file’s image.

cmd may have the following values:

ELF_C_NULL This value tells elf_update() to recalculate various values, updating only the ELF descriptor’s memory structures. Any modified structures are flagged with the ELF_F_DIRTY bit. A program thus can update the structural information and then reexamine them without changing the file associated with the ELF descriptor. Because this does not change the file, the ELF descriptor may allow reading, writing, or both reading and writing (see elf_begin(3ELF)).

ELF_C_WRITE If cmd has this value, elf_update() duplicates its ELF_C_NULL actions and also writes any “dirty” information associated with the ELF descriptor to the file. That is, when a program has used elf_getdata(3ELF) or the elf_flagdata(3ELF) facilities to supply new (or update existing) information for an ELF descriptor, those data will be examined, coordinated, translated if necessary (see elf32_xlatetof(3ELF)), and written to the file. When portions of the file are written, any ELF_F_DIRTY bits are reset, indicating those items no longer need to be written to the file (see elf_flagdata(3ELF)). The sections’ data are written in the order of their section header entries, and the section header table is written to the end of the file. When the ELF descriptor was created with elf_begin(), it must have allowed writing the file. That is, the elf_begin() command must have been either ELF_C_RDWR or ELF_C_WRITE.

If elf_update() succeeds, it returns the total size of the file image (not the memory image), in bytes. Otherwise an error occurred, and the function returns –1.

When updating the internal structures, elf_update() sets some members itself. Members listed below are the application’s responsibility and retain the values given by the program.

The following table shows ELF Header members:

<table>
<thead>
<tr>
<th>Member</th>
<th>Notes</th>
</tr>
</thead>
</table>


182  man pages section 3: Extended Library Functions • Last Revised 29 Dec 1996
e_ident[ELDATA] Library controls other e_ident values

e_type

e_machine

e_version

e_entry

e_phoff Only when ELF_F_LAYOUT asserted

e_shoff Only when ELF_F_LAYOUT asserted

e_flags

e_shstrndx

The following table shows the Program Header members:

<table>
<thead>
<tr>
<th>Member</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>p_type</td>
<td>The application controls all</td>
</tr>
<tr>
<td>p_offset</td>
<td>program header entries</td>
</tr>
<tr>
<td>p_vaddr</td>
<td></td>
</tr>
<tr>
<td>p_paddr</td>
<td></td>
</tr>
<tr>
<td>p_filesz</td>
<td></td>
</tr>
<tr>
<td>p_memsz</td>
<td></td>
</tr>
<tr>
<td>p_flags</td>
<td></td>
</tr>
<tr>
<td>p_align</td>
<td></td>
</tr>
</tbody>
</table>

The following table shows the Section Header members:

<table>
<thead>
<tr>
<th>Member</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>sh_name</td>
<td></td>
</tr>
<tr>
<td>sh_type</td>
<td></td>
</tr>
<tr>
<td>sh_flags</td>
<td></td>
</tr>
</tbody>
</table>
The following table shows the Data Descriptor members:

<table>
<thead>
<tr>
<th>Member</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>d_buf</td>
<td></td>
</tr>
<tr>
<td>d_type</td>
<td></td>
</tr>
<tr>
<td>d_size</td>
<td></td>
</tr>
<tr>
<td>d_off</td>
<td>Only when ELF_F_LAYOUT asserted</td>
</tr>
<tr>
<td>d_align</td>
<td></td>
</tr>
<tr>
<td>d_version</td>
<td></td>
</tr>
</tbody>
</table>

Note that the program is responsible for two particularly important members (among others) in the ELF header. The e_version member controls the version of data structures written to the file. If the version is EV_NONE, the library uses its own internal version. The e_ident[EI_DATA] entry controls the data encoding used in the file. As a special case, the value may be ELFDATANONE to request the native data encoding for the host machine. An error occurs in this case if the native encoding doesn’t match a file encoding known by the library.

Further note that the program is responsible for the sh_entsize section header member. Although the library sets it for sections with known types, it cannot reliably know the correct value for all sections. Consequently, the library relies on the program to provide the values for unknown section types. If the entry size is unknown or not applicable, the value should be set to 0.

When deciding how to build the output file, elf_update()obeys the alignments of individual data buffers to create output sections. A section’s most strictly aligned data buffer controls the section’s alignment. The library also inserts padding between buffers, as necessary, to ensure the proper alignment of each buffer.
elf_update(3ELF)

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

elf(3ELF), elf32_fsize(3ELF), elf32_getehdr(3ELF), elf32_getshdr(3ELF), elf32_xlatetof(3ELF), elf_begin(3ELF), elf_flagdata(3ELF), elf_getdata(3ELF), attributes(5)

**NOTES**

As mentioned above, the ELF_C_WRITE command translates data as necessary, before writing them to the file. This translation is *not* always transparent to the application program. If a program has obtained pointers to data associated with a file (for example, see elf32_getehdr(3ELF) and elf_getdata(3ELF)), the program should reestablish the pointers after calling elf_update().
elf_version(3ELF)

NAME
elf_version — coordinate ELF library and application versions

SYNOPSIS
cc [ flag ... ] file ... -l elf [ library ... ]
#include <libelf.h>

unsigned elf_version(unsigned ver);

DESCRIPTION
As elf(3ELF) explains, the program, the library, and an object file have independent
notions of the latest ELF version. elf_version() lets a program query the ELF
library’s internal version. It further lets the program specify what memory types it uses
by giving its own working version, ver, to the library. Every program that uses the ELF
library must coordinate versions as described below.

The header <libelf.h> supplies the version to the program with the macro
EV_CURRENT. If the library’s internal version (the highest version known to the
library) is lower than that known by the program itself, the library may lack semantic
knowledge assumed by the program. Accordingly, elf_version() will not accept a
working version unknown to the library.

Passing ver equal to EV_NONE causes elf_version() to return the library’s internal
version, without altering the working version. If ver is a version known to the library,
elf_version() returns the previous (or initial) working version number. Otherwise,
the working version remains unchanged and elf_version() returns
EV_NONE.

EXAMPLES
EXAMPLE 1 A sample display of using the elf_version() function.

The following excerpt from an application program protects itself from using an older
library:

if (elf_version(EV_CURRENT) == EV_NONE) {
    /* library out of date */
    /* recover from error */
}

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO
elf(3ELF), elf32_xlatetof(3ELF), elf_begin(3ELF), attributes(5)

NOTES
The working version should be the same for all operations on a particular ELF
descriptor. Changing the version between operations on a descriptor will probably not
give the expected results.
erf(3M)

NAME erf, erfc – error and complementary error functions

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
    #include <math.h>
    double erf(double x);
    double erfc(double x);

DESCRIPTION The erf() function computes the error function of x, defined as:

\[ \frac{2}{\sqrt{\pi}} \int_{0}^{x} e^{-t^2} dt \]

The erfc() function computes \( 1.0 - \text{erf}(x) \).

RETURN VALUES Upon successful completion, erf() and erfc() return the value of the error function
and complementary error function, respectively.

If x is NaN, NaN is returned.

ERRORS No errors will occur.

USAGE The erfc() function is provided because of the extreme loss of relative accuracy if
erf(x) is called for large x and the result subtracted from 1.0.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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<tr>
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</tbody>
</table>

SEE ALSO isnan(3M), attributes(5)
exp(3M)

NAME  exp – exponential function

SYNOPSIS  cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double exp(double x);

DESCRIPTION  The exp() function computes the exponential of \( x \), defined as \( e^x \).

RETURN VALUES  Upon successful completion, exp() returns the exponential of \( x \).

If the correct value would cause overflow, exp() returns HUGE_VAL and sets errno to ERANGE.

If the correct value would cause underflow to zero, exp() returns 0 and may set errno to ERANGE.

If \( x \) is NaN, NaN is returned.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS  The exp() function will fail if:

ERANGE       The result overflows.

The exp() function may fail if:

ERANGE       The result underflows.

USAGE  An application wishing to check for error situations should set errno to 0 before calling exp(). If errno is non-zero on return, or the return value is NaN an error has occurred.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO  isnan(3M), log(3M), matherr(3M), mp(3MP), attributes(5), standards(5)

NOTES  Prior to Solaris 2.6, there was a conflict between the pow function in this library and the pow function in the libmp library. This conflict was resolved by prepending mp_ to all functions in the libmp library. See mp(3MP) for details.
expm1 – computes exponential functions

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double expm1(double x);

DESCRIPTION
The expm1() function computes \( e^x - 1 \).

RETURN VALUES
If \( x \) is NaN, then the function returns NaN.

If \( x \) is positive infinity, expm1() returns positive infinity.

If \( x \) is negative infinity, expm1() returns -1.0.

If the value overflows, expm1() returns HUGE_VAL.

ERRORS
No errors will occur.

USAGE
The value of \( \expm1(x) \) may be more accurate than \( \exp(x) - 1 \) for small values of \( x \).

The \( \expm1() \) and \( \log1p(3M) \) functions are useful for financial calculations of
\( (1+x)^n - 1 \)/\( x \), namely:

\[ \frac{\expm1(n \cdot \log1p(x))}{x} \]

when \( x \) is very small (for example, when performing calculations with a small daily
interest rate). These functions also simplify writing accurate inverse hyperbolic
functions.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
exp(3M), ilogb(3M), log1p(3M), attributes(5)
fabs(3M)

NAME    fabs – absolute value function

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
          #include <math.h>

          double fabs(double x);

DESCRIPTION The fabs() function computes the absolute value of x, |x|.

RETURN VALUES Upon successful completion, fabs() returns the absolute value of x.
If x is NaN, NaN is returned.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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SEE ALSO isnan(3M), attributes(5)
The `floor()` function computes the largest integral value not greater than `x`.

Upon successful completion, `floor()` returns the largest integral value not greater than `x`, expressed as a `double`.

- If `x` is NaN, NaN is returned.
- If `x` is ±Inf or ±0, `x` is returned.

No errors will occur.

The integral value returned by `floor()` as a `double` might not be expressible as an `int` or `long int`. The return value should be tested before assigning it to an integer type to avoid the undefined results of an integer overflow.

See `attributes(5)` for descriptions of the following attributes:

```
<table>
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</tbody>
</table>
```

SEE ALSO `ceil(3M)`, `isnan(3M)`, `attributes(5)`
fmod(3M)

NAME  fmod – floating-point remainder value function

SYNOPSIS  cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double fmod(double x, double y);

DESCRIPTION  The fmod() function returns the floating-point remainder of the division of x by y.

RETURN VALUES  The fmod() function returns the value \( x - i \cdot y \), for some integer \( i \) such that, if \( y \) is non-zero, the result has the same sign as \( x \) and magnitude less than the magnitude of \( y \).

If \( x \) or \( y \) is NaN, NaN is returned. If \( y \) is 0, NaN is returned and errno is set to EDOM. If \( x \) is ±Inf, NaN is returned. If \( y \) is non-zero, fmod(±0, y) returns the value of \( x \). If \( x \) is not ±Inf, fmod(\( x, ±Inf \)) returns the value of \( x \).

ERRORS  The fmod() function may fail if:

EDOM  \( y \) is 0.

No other errors will occur.

USAGE  Portable applications should not call fmod() with \( y \) equal to 0, because the result is implementation-dependent. The application should verify \( y \) is non-zero before calling fmod().

An application wishing to check for error situations should set errno to 0 before calling fmod(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO  isnan(3M), attributes(5)
NAME  freeDmiString – free dynamic memory allocated for input DmiString structure

SYNOPSIS  cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
           #include <dmi/util.hh>

           void freeDmiString(DmiString_t *dstr);

DESCRIPTION  The freeDmiString() function frees dynamic memory allocated for the input DmiString structure.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  newDmiString(3DMI), libdmi(3LIB), attributes(5)
NAME
gelf, gelf_checksum, gelf_fsize, gelf_getclass, gelf_getdyn, gelf_getehdr, gelf_getphdr,
gelf_getrel, gelf_getrela, gelf_getshdr, gelf_getsym, gelf_getsyminfo, gelf_newehdr,
gelf_newphdr, gelf_update_dyn, gelf_update_ehdr, gelf_update_phdr,
gelf_update_rel, gelf_update_rela, gelf_update_shdr, gelf_update_sym,
gelf_update_syminfo, gelf_xlatetof, gelf_xslatetom – generic class-independent ELF interface

SYNOPSIS
c
cc [flag ...] file ... -lelf [library ...]
#include <gelf.h>
long gelf_checksum(Elf *elf);
int gelf_getclass(Elf *elf);
size_t gelf_fsize(Elf *elf, Elf_Type type, size_t cnt, unsigned ver);
GElf_Ehdr *gelf_getehdr(Elf *elf, GElf_Ehdr *dst);
int gelf_update_ehdr(Elf *elf, GElf_Ehdr *src);
unsigned long gelf_newehdr(Elf *elf, int class);
GElf_Phdr *gelf_getphdr(Elf *elf, int ndx, GElf_Phdr *src);
int gelf_update_phdr(Elf *elf, int ndx, GElf_Phdr *src);
unsigned long gelf_newphdr(Elf *elf, size_t phnum);
GElf_Shdr *gelf_getshdr(Elf_Scn *scn, Elf_Data *dst);
int gelf_update_shdr(Elf_Scn *scn, GElf_Shdr *src);
Elf_Data *gelf_xlatetof(Elf *elf, Elf_Data *dst, const Elf_Data *src,
unsigned encode);
Elf_Data *gelf_xlatetom(Elf *elf, Elf_Data *dst, const Elf_Data *src,
unsigned encode);
GElf_Sym *gelf_getsym(Elf_Data *data, int ndx, GElf_Sym *dst);
int gelf_update_sym(Elf_Data *dest, int ndx, GElf_Sym *src);
GElf_Dyn *gelf_getdyn(Elf_Data *src, int ndx, GElf_Dyn *src);
int gelf_update_dyn(Elf_Data *src, int ndx, GElf_Dyn *src);
GElf_Rela *gelf_getrela(Elf_Data *src, int ndx, GElf_Rela *dst);
int gelf_update_rela(Elf_Data *dst, int ndx, GElf_Rela *src);
GElf_Rel *gelf_getrel(Elf_Data *src, int ndx, GElf_Rel *src);
int gelf_update_rel(Elf_Data *dst, int ndx, GElf_Rel *src);
GElf_Syminfo *gelf_getsyminfo(Elf_Data *src, int ndx, GElf_Syminfo *dst);
int gelf_update_syminfo(Elf_Data *dst, int ndx, GElf_Syminfo *src);
DESCRIPTION

GElf is a generic, ELF class-independent API, for manipulating ELF object files. GElf provides a single, common interface for handling 32-bit and 64-bit ELF format object files. GElf is a translation layer between the application and the class-dependent parts of the ELF library. Thus, the application can use GElf, which in turn, will call the corresponding elf32_ or elf64_ functions on behalf of the application. The data structures returned are all large enough to hold 32-bit and 64-bit data.

GElf provides a simple, class-independent layer of indirection over the class-dependent ELF32 and ELF64 APIs. GElf is stateless, and may be used alongside the ELF32 and ELF64 API's.

GElf always returns a copy of the underlying ELF32 or ELF64 structure, and therefore the programming practice of using the address of an ELF header as the base offset for the ELF's mapping into memory should be avoided. Also, data accessed by type-casting the Elf_Data buffer to a class-dependent type and treating it like an array, for example, a symbol table, will not work under GElf, and the gelf_get functions must be used instead. See the EXAMPLE section.

Programs which create or modify ELF files using libelf(3LIB) need to perform an extra step when using GElf. Modifications to GElf values must be explicitly flushed to the underlying ELF32 or ELF64 structures by way of the the gelf_update_ interfaces. Use of elf_update or elf_flagelf and the like remains the same.

The sizes of versioning structures remains the same between ELF32 and ELF64. The GElf API only defines types for versioning, rather than a functional API. The processing of versioning information will stay the same in the GElf environment as it was in the class-dependent ELF environment.

List of Functions

- gelf_checksum() An analog to elf32_checksum(3ELF) and elf64_checksum(3ELF).
- gelf_getclass() Returns one of the constants ELFCLASS32, ELFCLASS64 or ELFCLASSNONE.
- gelf_fsize() An analog to elf32_fsize(3ELF) and elf64_fsize(3ELF).
- gelf_getehdr() An analog to elf32_getehdr(3ELF) and elf64_getehdr(3ELF).
- gelf_update_ehdr() Copies the contents of the GElf_Ehdr ELF header to the underlying Elf32_Ehdr or Elf64_Ehdr structure.
- gelf_newehdr() An analog to elf32_newehdr(3ELF) and elf64_newehdr(3ELF).
gelf(3ELF)

- **gelf_getphdr()**: An analog to `elf32_getphdr(3ELF)` and `elf64_getphdr(3ELF)`.
- **gelf_update_phdr()**: Copies of the contents of GElf_Phdr program header to underlying the Elf32_Phdr or Elf64_Phdr structure.
- **gelf_newphdr()**: An analog to `elf32_newphdr(3ELF)` and `elf64_newphdr(3ELF)`.
- **gelf_getshdr()**: An analog to `elf32_getshdr(3ELF)` and `elf64_getshdr(3ELF)`.
- **gelf_update_shdr()**: Copies of the contents of GElf_Shdr section header to underlying the Elf32_Shdr or Elf64_Shdr structure.
- **gelf_xlatetof()**: An analog to `elf32_xlatetof(3ELF)` and `elf64_xlatetof(3ELF)`.
- **gelf_xlatetom()**: An analog to `elf32_xlatetom(3ELF)` and `elf64_xlatetom(3ELF)`.
- **gelf_getsym()**: Retrieves the Elf32_Sym or Elf64_Sym information from the symbol table at the given index.
- **gelf_update_sym()**: Copies the GElf_Sym information back into the underlying Elf32_Sym or Elf64_Sym structure at the given index.
- **gelf_getdyn()**: Retrieves the Elf32_Dyn or Elf64_Dyn information from the dynamic table at the given index.
- **gelf_update_dyn()**: Copies the GElf_Dyn information back into the underlying Elf32_Dyn or Elf64_Dyn structure at the given index.
- **gelf_getrela()**: Retrieves the Elf32_Rela or Elf64_Rela information from the relocation table at the given index.
- **gelf_update_rela()**: Copies the GElf_Rela information back into the underlying Elf32_Rela or Elf64_Rela structure at the given index.
- **gelf_getrel()**: Retrieves the Elf32_Rel or Elf64_Rel information from the relocation table at the given index.
- **gelf_update_rel()**: Copies the GElf_Rel information back into the underlying Elf32_Rel or Elf64_Rel structure at the given index.
gelf_getsyminfo() Retrieves the Elf32_Syminfo or Elf64_Syminfo information from the relocation table at the given index.

gelf_update_syminfo() Copies the GElf_Syminfo information back into the underlying Elf32_Syminfo or Elf64_Syminfo structure at the given index.

gelf_getmove() Retrieves the Elf32_Move or Elf64_Move information from the move table at the given index.

gelf_update_move() Copies the GElf_Move information back into the underlying Elf32_Move or Elf64_Move structure at the given index.

RETURN VALUES Upon failure, all GElf functions return 0 and set elf_errno. See elf_errno(3ELF)

EXAMPLE 1 Printing the ELF Symbol Table

```c
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <libelf.h>
#include <gelf.h>

void main(int argc, char **argv)
{
    Elf *elf
    Elf_Scn *scn = NULL;
    GElf_Shdr shdr;
    Elf_Data *data;
    int fd, ii, count;

    elf_version(EV_CURRENT);

    fd = open(argv[1], O_RDONLY);
    elf = elf_begin(fd, ELF_C_READ, NULL);

    while ((scn = elf_nextscn(elf, scn)) != NULL) {
        gelf_getshdr(scn, &shdr);
        if (shdr.sh_type == SHT_SYMTAB) {
            /* found a symbol table, go print it. */
            break;
        }
    }

    data = elf_getdata(scn, NULL);
    count = shdr.sh_size / shdr.sh_entsize;

    /* print the symbol names */
    for (ii=0; ii < count; ++ii) {
        GElf_Sym sym;
        gelf_getsym(data, ii, &sym);
        printf("%s\n", elf_strptr(elf, shdr.sh_link, sym.st_name));
    }
}
```
EXAMPLE 1 Printing the ELF Symbol Table  (Continued)

    }
    elf_end(elf);
    close(fd);
}

FILES
/usr/lib/libelf.so.1  Shared object.
/usr/lib/sparcv9/libelf.so.1  64-bit shared object.
/usr/lib//libelf.a  Archive library.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</thead>
<tbody>
<tr>
<td>MT Level</td>
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</table>

SEE ALSO elf(3ELF), elf32_checksum(3ELF), elf32_fsize(3ELF), elf32_getehdr(3ELF),
elf32_newehdr(3ELF), elf32_getphdr(3ELF), elf32_newphdr(3ELF),
elf32_getshdr(3ELF), elf32_xlatetof(3ELF), elf32_xlatetom(3ELF),
elf_errno(3ELF), libelf(3LIB), attributes(5)
NAME
getacinfo, getacdir, getacflg, getacmin, getacna, setac, endac – get audit control file information

SYNOPSIS
cc [ flag ... ] file ... -lbsm -lsocket -lnsl -lintl [ library ... ]
#include <bsm/libbsm.h>

int getacdir( char *dir, int len);
int getacmin( int *min_val);
int getacflg( char *auditstring, int len);
int getacna( char *auditstring, int len);
void setac( void);

void endac( void);

DESCRIPTION
When first called, getacdir() provides information about the first audit directory in the audit_control file; thereafter, it returns the next directory in the file. Successive calls list all the directories listed in audit_control(4) The parameter len specifies the length of the buffer dir. On return, dir points to the directory entry.

getacmin() reads the minimum value from the audit_control file and returns the value in min_val. The minimum value specifies how full the file system to which the audit files are being written can get before the script audit_warn(1M) is invoked.

getacflg() reads the system audit value from the audit_control file and returns the value in auditstring. The parameter len specifies the length of the buffer auditstring.

getacna() reads the system audit value for non-attributable audit events from the audit_control file and returns the value in auditstring. The parameter len specifies the length of the buffer auditstring. Non-attributable events are events that cannot be attributed to an individual user. inetd(1M) and several other daemons record non-attributable events.

Calling setac rewinds the audit_control file to allow repeated searches.

Calling endac closes the audit_control file when processing is complete.

FILES
/etc/security/audit_control contains default parameters read by the audit daemon, auditd(1M)

RETURN VALUES
getacdir(), getacflg(), getacna() and getacmin() return:
0 on success.
-2 on failure and set errno to indicate the error.

getacmin() and getacflg() return:
1 on EOF.

getacdir() returns:
getacinfo(3BSM)

-1  on EOF.

2  if the directory search had to start from the beginning because one of the
other functions was called between calls to getacdir().

These functions return:

-3  if the directory entry format in the audit_control file is incorrect.

getacdir(), getacflg() and getacna() return:

-3  if the input buffer is too short to accommodate the record.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO  audit_warn(1M), bsmconv(1M), inetd(1M), audit_control(4), attributes(5)

NOTES  The functionality described in this man page is available only if the Basic Security
Module (BSM) has been enabled. See bsmconv(1M) for more information.
getauclassent(3BSM)

NAME
getauclassent, getauclassnam, setauclass, endauclass, getauclassnam_r, getauclassent_r
- get audit_class entry

SYNOPSIS
cc [ flag ... ] file ... -lbsm -lsocket -lnsl -lintl [ library ... ]
#include <sys/param.h>
#include <bsm/libbsm.h>

struct au_class_ent *getauclassnam( const char *name);
struct au_class_ent *getauclassnam_r( au_class_ent_t *class_int,
    const char *name);
struct au_class_ent *getauclassent( void);
struct au_class_ent *getauclassent_r( au_class_ent_t *class_int);
void setauclass( void);
void endauclass( void);

DESCRIPTION
getauclassent() and getauclassnam() each return an audit_class entry.

getauclassnam() searches for an audit_class entry with a given class name name.

getauclassent() enumerates audit_class entries: successive calls to
getauclassent() will return either successive audit_class entries or NULL.

setauclass() “rewinds” to the beginning of the enumeration of audit_class entries.
Calls to getauclassnam() may leave the enumeration in an indeterminate state, so
setauclass() should be called before the first getauclassent().

endauclass() may be called to indicate that audit_class processing is complete; the
system may then close any open audit_class file, deallocate storage, and so forth.

getauclassent_r() and getauclassnam_r() both return a pointer to an
audit_class entry as do their similarly named counterparts. They each take an
additional argument, a pointer to pre-allocated space for an au_class_ent_t, which
is returned if the call is successful. To assure there is enough space for the information
returned, the applications programmer should be sure to allocate
AU_CLASS_NAME_MAX and AU_CLASS_DESC_MAX bytes for the ac_name and ac_desc
elements of the au_class_ent_t data structure.

The internal representation of an audit_user entry is an au_class_ent structure
defined in <bsm/libbsm.h> with the following members:

char *ac_name;
au_class_t ac_class;
char *ac_desc;

RETURN VALUES
getauclassnam() and getauclassnam_r() return a pointer to a struct
au_class_ent if they successfully locate the requested entry; otherwise they return
NULL.
getauclassent(3BSM)

getauclassent() and getauclassent_r() return a pointer to a struct au_class_ent if they successfully enumerate an entry; otherwise they return NULL, indicating the end of the enumeration.

FILES
/etc/security/audit_class
Maps audit class numbers to audit class names

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions.</td>
</tr>
</tbody>
</table>

All of the functions described in this man-page are MT-Safe except getauclassent() and getauclassnam. The two functions, getauclassent_r() and getauclassnam_r() have the same functionality as the unsafe functions, but have a slightly different function call interface in order to make them MT-Safe.

SEE ALSO
bsmconv(1M), audit_class(4), audit_event(4), attributes(5)

NOTES
All information is contained in a static area, so it must be copied if it is to be saved.

The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See bsmconv(1M) for more information.
getauditflags(3BSM)

NAME
getauditflags, getauditflagsbin, getauditflagschar – convert audit flag specifications

SYNOPSIS
cc [ flag ... ] file ... -lbsm -lsocket -lnsl -lintl [ library ... ]
#include <sys/param.h>
#include <bsm/libbsm.h>

int getauditflagsbin(char *auditstring, au_mask_t *masks);

int getauditflagschar(char *auditstring, au_mask_t *masks, int verbose);

DESCRIPTION
getauditflagsbin() converts the character representation of audit values pointed to by auditstring into au_mask_t fields pointed to by masks. These fields indicate which events are to be audited when they succeed and which are to be audited when they fail. The character string syntax is described in audit_control(4).

getauditflagschar() converts the au_mask_t fields pointed to by masks into a string pointed to by auditstring. If verbose is zero, the short (2-character) flag names are used. If verbose is non-zero, the long flag names are used. auditstring should be large enough to contain the ASCII representation of the events.

auditstring contains a series of event names, each one identifying a single audit class, separated by commas. The au_mask_t fields pointed to by masks correspond to binary values defined in <bsm/audit.h>, which is read by <bsm/libbsm.h>.

RETURN VALUES
getauditflagsbin() and getauditflagschar(): -1 is returned on error and 0 on success.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe.</td>
</tr>
</tbody>
</table>

SEE ALSO
bsmconv(1M), audit.log(4), audit_control(4), attributes(5)

BUGS
This is not a very extensible interface.

NOTES
The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See bsmconv(1M) for more information.
These interfaces document the programming interface for obtaining entries from the
audit_event(4) file. getauevent(), getauevnam(), getauevnum(), getauevnonam(),
setauevent(), and getauevent_r(), getauevnam_r(), getauevnum_r() each return a pointer to an
audit_event structure.

goingauevent() and getauevent_r() enumerate audit_event entries; successive
calls to these functions will return either successive audit_event entries or NULL.

goingauevnam() and getauevnam_r() search for an audit_event entry with a
given event_name.

goingauevnum() and getauevnum_r() search for an audit_event entry with a
given event_number.

goingauevnonam() searches for an audit_event entry with a given event_name and
returns the corresponding event number.

goingauevent() “rewinds” to the beginning of the enumeration of audit_event
entries. Calls to getauevnam(), getauevnum(), getauevnonum(),
goingauevnam_r(), or getauevnum_r() may leave the enumeration in an
indeterminate state; getauevent() should be called before the first getauevent()
or getauevent_r().

endauevent() may be called to indicate that audit_event processing is complete;
the system may then close any open audit_event file, deallocate storage, and so
forth.
The three functions getauevent_r(), getauevnam_r(), and getauevnum_r() each take an argument e which is a pointer to an au_event_ent_t. This pointer is returned on a successful function call. To assure there is enough space for the information returned, the applications programmer should be sure to allocate AU_EVENT_NAME_MAX and AU_EVENT_DESC_MAX bytes for the ae_name and ac_desc elements of the au_event_ent_t data structure.

The internal representation of an audit_event entry is an struct au_event_ent structure defined in <bsm/libbsm.h> with the following members:

- au_event_t ae_number
- char *ae_name;
- char *ae_desc*;
- au_class_t ae_class;

RETURN VALUES
getauevent(), getauevnam(), getauevnum(), getauevent_r(), getauevnam_r(), and getauevnum_r() return a pointer to a struct au_event_ent if the requested entry is successfully located; otherwise it returns NULL.

getauevnonam() returns an event number of type au_event_t if it successfully enumerates an entry; otherwise it returns NULL, indicating it could not find the requested event name.

FILES
/etc/security/audit_event Maps audit event numbers to audit event names.
/etc/passwd Stores user-ID to username mappings.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions.</td>
</tr>
</tbody>
</table>

The functions getauevent(), getauevnam(), and getauevnum() are not MT-Safe; however, there are equivalent functions: getauevent_r(), getauevnam_r(), and getauevnum_r() — all of which provide the same functionality and a MT-Safe function call interface.

SEE ALSO
bsmconv(1M), getauclassent(3BSM), getpwnam(3C), audit_class(4), audit_event(4), passwd(4), attributes(5)

NOTES
All information for the functions getauevent(), getauevnam(), and getauevnum() is contained in a static area, so it must be copied if it is to be saved.

The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See bsmconv(1M) for more information.
DESCRIPTION

The `getauthattr()` and `getauthnam()` functions each return an `auth_attr` entry. Entries can come from any of the sources specified in the `nsswitch.conf` file.

The `getauthattr()` function enumerates `auth_attr` entries. The `getauthnam()` function searches for an `auth_attr` entry with a given authorization name `name`. Successive calls to these functions return either successive `auth_attr` entries or `NULL`.

The internal representation of an `auth_attr` entry is an `authattr_t` structure defined in `<auth_attr.h>` with the following members:

- `char name;` /* name of the authorization */
- `char res1;` /* reserved for future use */
- `char res2;` /* reserved for future use */
- `char short_desc;` /* short description */
- `char long_desc;` /* long description */
- `kva_t *attr;` /* array of key-value pair attributes */

The `setauthattr()` function “rewinds” to the beginning of the enumeration of `auth_attr` entries. Calls to `getauthnam()` can leave the enumeration in an indeterminate state. Therefore, `setauthattr()` should be called before the first call to `getauthattr()`.

The `endauthattr()` function may be called to indicate that `auth_attr` processing is complete; the system may then close any open `auth_attr` file, deallocate storage, and so forth.

The `chkauthattr()` function verifies whether or not a user has a given authorization. It first reads the `AUTHS_GRANTED` key in the `/etc/security/policy.conf` file and returns `1` if it finds a match for the given authorization. If `chkauthattr()` does not find a match, it reads the `user_attr` database. If it does not find a match in `user_attr`, `chkauthattr()` reads the
prof_attr(4) database, using the list of profiles assigned to the user, and checks if any of the profiles assigned to the user has the given authorization. The
chkauthattr() function returns 0 if it does not find a match in any of the three sources.

A user is considered to have been assigned an authorization if either of the following are true:
- The authorization name matches exactly any authorization assigned in the user_attr or prof_attr databases (authorization names are case-sensitive).
- The authorization name suffix is not the key word grant and the authorization name matches any authorization up to the asterisk (*) character assigned in the user_attr or prof_attr databases.

The examples in the following table illustrate the conditions under which a user is assigned an authorization.

<table>
<thead>
<tr>
<th>Authorization name</th>
<th>/etc/security/policy.conf or user_attr or prof_attr entry</th>
<th>Is user authorized?</th>
</tr>
</thead>
<tbody>
<tr>
<td>com.sun.printer.postscript</td>
<td>com.sun.printer.postscript</td>
<td>Yes</td>
</tr>
<tr>
<td>com.sun.printer.postscript</td>
<td>com.sun.printer.*</td>
<td>Yes</td>
</tr>
<tr>
<td>com.sun.printer.grant</td>
<td>com.sun.printer.*</td>
<td>No</td>
</tr>
</tbody>
</table>

The free_authattr() function releases memory allocated by the getauthnam() and getauthattr() functions.

RETURN VALUES
The getauthattr() function returns a pointer to an authattr_t if it successfully enumerates an entry; otherwise it returns NULL, indicating the end of the enumeration.

The getauthnam() function returns a pointer to an authattr_t if it successfully locates the requested entry; otherwise it returns NULL.

The chkauthattr() function returns 1 if the user is authorized and 0 otherwise.

USAGE
The getauthattr() and getauthnam() functions both allocate memory for the pointers they return. This memory should be de-allocated with the free_authattr() call.

Applications that use the interfaces described in this manual page cannot be linked statically, since the implementations of these functions employ dynamic loading and linking of shared objects at run time. Note that these interfaces are reentrant even though they do not use the _r suffix naming convention.

Individual attributes in the attr structure can be referred to by calling the kva_match(3SECDB) function.
Because the list of legal keys is likely to expand, code must be written to ignore unknown key-value pairs without error.

FILES

/etc/nsswitch.conf  configuration file lookup information for the name server switch
/etc/user_attr  extended user attributes
/etc/security/auth_attr  authorization attributes
/etc/security/policy.conf  policy definitions
/etc/security/prof_attr  profile information

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

getexecattr(3SECDB), getprofattr(3SECDB), getuserattr(3SECDB), auth_attr(4), nsswitch.conf(4), prof_attr(4), user_attr(4), attributes(5), rbac(5)
The `getauuserent()`, `getauusernam()`, `getauuserent_r()`, and `getauusernam_r()` functions each return an `audit_user` entry. Entries can come from any of the sources specified in the `/etc/nsswitch.conf` file (see `nsswitch.conf(4)`).

The `getauusernam()` and `getauusernam_r()` functions search for an `audit_user` entry with a given login name `name`.

The `getauuserent()` and `getauuserent_r()` functions enumerate `audit_user` entries; successive calls to these functions will return either successive `audit_user` entries or NULL.

The `setauuser()` function "rewinds" to the beginning of the enumeration of `audit_user` entries. Calls to `getauusernam()` and `getauusernam_r()` may leave the enumeration in an indeterminate state, so `setauuser()` should be called before the first call to `getauuserent()` or `getauuserent_r()`.

The `endauuser()` function may be called to indicate that `audit_user` processing is complete; the system may then close any open `audit_user` file, deallocate storage, and so forth.

The `getauuserent_r()` and `getauusernam_r()` functions both take an argument `u`, which is a pointer to an `au_user_ent`. This is the pointer that is returned on successful function calls.

The internal representation of an `audit_user` entry is an `au_user_ent` structure defined in `<bsm/libbsm.h>` with the following members:

```
cchar        *au_name;
au_mask_t    au_always;
au_mask_t    au_never;
```

The `getauusernam()` function returns a pointer to a `struct au_user_ent` if it successfully locates the requested entry; otherwise it returns NULL.
getauusernam(3BSM)

The `getauuserent()` function returns a pointer to a `struct au_user_ent` if it successfully enumerates an entry; otherwise it returns `NULL`, indicating the end of the enumeration.

**USAGE**
The functionality described in this manual page is available only if the Basic Security Module (BSM) has been enabled. See `bsmconv(1M)` for more information.

**FILES**
- `/etc/security/audit_user` stores per-user audit event mask
- `/etc/passwd` stores user-id to username mappings
- `/etc/security/audit_user` stores per-user audit event mask

**ATTRIBUTES**
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</table>

**SEE ALSO**
`bsmconv(1M), getpwnam(3C), audit_user(4), nsswitch.conf(4), passwd(4), attributes(5)`

**NOTES**
All information for the `getauuserent()` and `getauusernam()` functions is contained in a static area, so it must be copied if it is to be saved.

The `getauusernam()` and `getauuserent()` functions are not MT-safe. The `getauusernam_r()` and `getauuserent_r()` functions provide the same functionality with interfaces that are MT-Safe.
NAME
getexecattr, free_execattr, setexecattr, endexecattr, getexecuser, getexecprof,
macth_execattr – get execution profile entry

SYNOPSIS
cc [ flag... ] file... -lsecdb -lsocket -lnsl -lintl [ library... ]
#include <exec_attr.h>
#include <secdb.h>

execattr_t *getexecattr(void);
void free_execattr(execattr_t *ep);
void setexecattr(void);
void endexecattr(void);

execattr_t *getexecuser(const char *username, const char *type,
const char *id, int search_flag);

execattr_t *getexecprof(const char *profname, const char *type,
const char *id, int search_flag);

execattr_t *match_execattr(execattr_t *ep, char *profname, char
*type, char *id);

DESCRIPTION
The getexecattr() function returns a single exec_attr entry. Entries can come
from any of the sources specified in the naswitch.conf(4) file.

Successive calls to getexecattr() return either successive exec_attr entries or
NULL. Because getexecattr() always returns a single entry, the next pointer in the
execattr_t data structure points to NULL.

The internal representation of an exec_attr entry is an execattr_t structure
declared in <exec_attr.h> with the following members:

char name; /* name of the profile */
char type; /* type of profile */
char policy; /* policy under which the attributes are */
/* relevant*/
char res1; /* reserved for future use */
char res2; /* reserved for future use */
char id; /* unique identifier */
kva_t attr; /* attributes */
struct execattr_s next; /* optional pointer to next profile */

The free_execattr() function releases memory. It follows the next pointers in the
execattr_t structure so that the entire linked list is released.

The setexecattr() function “rewinds” to the beginning of the enumeration of
exec_attr entries. Calls to getexecuser() can leave the enumeration in an
indeterminate state. Therefore, setexecattr() should be called before the first call
to getexecattr().

The endexecattr() function can be called to indicate that exec_attr processing is
complete; the library can then close any open exec_attr file, deallocate any internal
storage, and so forth.
getexecattr(3SECDB)

The `getexecuser()` function returns a linked list of entries filtered by the function’s arguments. Only entries assigned to the specified `username`, as described in the `passwd(4)` database, and containing the specified `type` and `id`, as described in the `exec_attr(4)` database, are placed in the list. The `getexecuser()` function is different from the other functions in its family because it spans two databases. It first looks up the list of profiles assigned to a user in the `user_attr` database, then looks up each profile in the `exec_attr` database.

The `getexecprof()` function returns a linked list of entries that have components matching the function’s arguments. Only entries in the database matching the argument `profilename`, as described in `exec_attr`, and containing the `type` and `id`, also described in `exec_attr`, are placed in the list.

Using `getexecuser()` and `getexecprof()`, programmers can search for any `type` argument, such as the manifest constant `KV_COMMAND`. The arguments are logically AND-ed together so that only entries exactly matching all of the arguments are returned. Wildcard matching applies if there is no exact match for an ID. Any argument can be assigned the NULL value to indicate that it is not used as part of the matching criteria. The `search_flag` controls whether the function returns the first match (`GET_ONE`), setting the `next` pointer to NULL or all matching entries (`GET_ALL`), using the `next` pointer to create a linked list of all entries that meet the search criteria. See EXAMPLES.

Once a list of entries is returned by `getexecuser()` or `getexecprof()`, the convenience function `match_execattr()` can be used to identify an individual entry. It returns a pointer to the individual element with the same profile name (`profilename`), type name (`type`), and `id`. Function parameters set to NULL are not used as part of the matching criteria. In the event that multiple entries meet the matching criteria, only a pointer to the first entry is returned. The `kva_match(3SECDB)` function can be used to look up a key in a key-value array.

**RETURN VALUES**

Those functions returning data only return data related to the active policy. The `getexecattr()` function returns a pointer to a `execattr_t` if it successfully enumerates an entry; otherwise it returns NULL, indicating the end of the enumeration.

**USAGE**

The `getexecattr()`, `getexecuser()`, and `getexecprof()` functions all allocate memory for the pointers they return. This memory should be deallocated with the `free_execattr()` call. The `match_execattr()` function does not allocate any memory. Therefore, pointers returned by this function should not be deallocated.

Applications that use the interfaces described in this manual page cannot be linked statically, since the implementations of these functions employ dynamic loading and linking of shared objects at run time. Note that these interfaces are reentrant even though they do not use the `_r` suffix naming convention.

Individual attributes may be referenced in the `attr` structure by calling the `kva_match(3SECDB)` function.
EXAMPLES

EXAMPLE 1 The following finds all profiles that have the ping command:

```c
if ((execprof=getexecprof(NULL, KV_COMMAND, "/usr/sbin/ping", GET_ONE)) == NULL) {
    /* do error */
}
```

EXAMPLE 2 The following finds the entry for the ping command in the Network Administration Profile:

```c
if ((execprof=getexecprof("Network Administration", KV_COMMAND, "/usr/sbin/ping", GET_ALL)) == NULL) {
    /* do error */
}
```

EXAMPLE 3 The following tells everything that can be done in the Filesystem Security profile:

```c
if ((execprof=getexecprof("Filesystem Security", KV_NULL, NULL, GET_ALL)) == NULL) {
    /* do error */
}
```

EXAMPLE 4 The following tells if the tar command is in a profile assigned to user wetmore. If there is no exact profile entry, the wildcard (*), if defined, is returned:

```c
if ((execprof=getexecuser("wetmore", KV_COMMAND, "/usr/bin/tar", GET_ONE)) == NULL) {
    /* do error */
}
```

FILES

/etc/nsswitch.conf configuration file lookup information for the name server switch

/etc/user_attr extended user attributes

/etc/security/exec_attr execution profiles

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

getauthattr(3SECDB), getuserattr(3SECDB), kva_match(3SECDB), exec_attr(4), user_attr(4), attributes(5)
getfauditflags(3BSM)

NAME
getfauditflags – generates the process audit state

SYNOPSIS
cct flag ... file ... -lasm -lsocket -lsl -lintl [ library ... ]
#include <sys/param.h>
#include <bsm/libbsm.h>
int getfauditflags (au_mask_t *usremasks, au_mask_t *usrdmasks,
  au_mask_t *lastmasks);

DESCRIPTION
getfauditflags() generates a process audit state by combining the audit masks passed as parameters with the system audit masks specified in the audit_control(4) file. getfauditflags() obtains the system audit value by calling getacflg() (see getacinfo(3BSM)).

usremasks points to au_mask_t fields which contains two values. The first value defines which events are always to be audited when they succeed. The second value defines which events are always to be audited when they fail.

usrdmasks also points to au_mask_t fields which contains two values. The first value defines which events are never to be audited when they succeed. The second value defines which events are never to be audited when they fail.

The structures pointed to by usremasks and usrdmasks may be obtained from the audit_user(4) file by calling getauusernam() which returns a pointer to a structure containing all audit_user(4) fields for a user.

The output of this function is stored in lastmasks which is a pointer of type au_mask_t as well. The first value defines which events are to be audited when they succeed and the second defines which events are to be audited when they fail.

Both usremasks and usrdmasks override the values in the system audit values.

RETURN VALUES
-1 is returned on error and 0 on success.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe.</td>
</tr>
</tbody>
</table>

SEE ALSO
bsmconv(1M), getacinfo(3BSM), getauditflags(3BSM), getauusernam(3BSM), audit.log(4), audit_control(4), audit_user(4), attributes(5)

NOTES
The functionality described in this man page is available only if the Basic Security Module (BSM) has been enabled. See bsmconv(1M) for more information.

214 man pages section 3: Extended Library Functions • Last Revised 29 Dec 1996
### NAME
getprofattr, getprofnam, free_profattr, setprofattr, endprofattr – get profile description and attributes

### SYNOPSIS
```c
#include <prof.h>

profattr_t *getprofattr(void);
profattr_t *getprofnam(const char *name);
void free_profattr(profattr_t *pd);
void setprofattr(void);
void endprofattr(void);
```

### DESCRIPTION
The `getprofattr()` and `getprofnam()` functions each return a `prof_att` entry. Entries can come from any of the sources specified in the `nsswitch.conf(4)` file.

The `getprofattr()` function enumerates `prof_att` entries. The `getprofnam()` function searches for a `prof_att` entry with a given `name`. Successive calls to these functions return either successive `prof_att` entries or NULL.

The internal representation of a `prof_att` entry is a `profattr_t` structure defined in `<prof_att.h>` with the following members:

```c
cchar name;  /* Name of the profile */
cchar res1;  /* Reserved for future use */
cchar res2;  /* Reserved for future use */
cchar desc;  /* Description/Purpose of the profile */
c kva_t attr;  /* Profile attributes */
```

The `free_profattr()` function releases memory allocated by the `getprofattr()` and `getprofnam()` functions.

The `setprofattr()` function “rewinds” to the beginning of the enumeration of `prof_att` entries. Calls to `getprofnam()` can leave the enumeration in an indeterminate state. Therefore, `setprofattr()` should be called before the first call to `getprofattr()`.

The `endprofattr()` function may be called to indicate that `prof_att` processing is complete; the system may then close any open `prof_att` file, deallocate storage, and so forth.

### RETURN VALUES
The `getprofattr()` function returns a pointer to a `profattr_t` if it successfully enumerates an entry; otherwise it returns NULL, indicating the end of the enumeration.

The `getprofnam()` function returns a pointer to a `profattr_t` if it successfully locates the requested entry; otherwise it returns NULL.

### USAGE
Individual attributes in the `prof_att` structure can be referred to by calling the `kva_match(3SECDB)` function.
Because the list of legal keys is likely to expand, any code must be written to ignore unknown key-value pairs without error.

The `getprofattr()` and `getprofnam()` functions both allocate memory for the pointers they return. This memory should be deallocated with the `free_profatt()` function.

Applications that use the interfaces described in this manual page cannot be linked statically, since the implementations of these functions employ dynamic loading and linking of shared objects at run time. Note that these interfaces are reentrant even though they do not use the `_r` suffix naming convention.

/etc/security/prof_attr    profiles and their descriptions

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO
`auths(1)`, `profiles(1)`, `getexecattr(3SECDB)`, `getauthattr(3SECDB)`, `prof_attr(4)`
These functions are used to obtain entries describing user projects. Entries can come from any of the sources for a project specified in the `/etc/nsswitch.conf` file (see `nsswitch.conf(4)`).

The `setprojent()`, `getprojent()`, and `endprojent()` functions are used to enumerate project entries from the database.

The `setprojent()` function effectively rewinds the project database to allow repeated searches. It sets (or resets) the enumeration to the beginning of the set of project entries. This function should be called before the first call to `getprojent()`.

The `getprojent()` function returns a pointer to a structure containing the broken-out fields of an entry in the project database. When first called, `getprojent()` returns a pointer to a project structure containing the first project structure in the project database. Successive calls may be used to read the entire database.

The `endprojent()` function closes the project database and deallocates resources when processing is complete. It is permissible, though possibly less efficient, for the process to call more project functions after calling `endprojent()`.

The `getprojbyname()` function searches the project database for an entry with the project name specified by the character string `name`. 
The `getprojbyid()` function searches the project database for an entry with the (numeric) project ID specified by `projid`.

The `getdefaultproj()` function first looks up the project key word in the `user_attr` database used to define user attributes in restricted Solaris environments. If the database is available and the keyword is present, the function looks up the named project, returning `NULL` if it cannot be found or if the user is not a member of the named project. If absent, the function looks for a match in the project database for the special project `user.username`. If no match is found, the function looks at the default group entry of the `passwd` database for the user, and looks for a match in the project database for the special name `group.groupname`, where `groupname` is the default group associated with the password entry corresponding to the given `username`. If no match is found, the function returns `NULL`. A special project entry called 'default' can be looked up and used as a last resort. By convention, machines with no entry for default do not allow access to non-root users without a default project. On successful lookup, this function returns a pointer to the valid project structure.

The `inproj()` function checks if the user specified by `username` is able to use the project specified by `projname`. This function returns 1 if the user belongs to the list of project's users, if there is a project's group that contains the specified user, or if project is a user's default project; otherwise it returns 0.

The `getprojidbyname()` function searches the project database for an entry with the project name specified by the character string name. This function returns the project ID if the requested entry is found; otherwise it returns −1.

The `fgetprojent()` function, unlike the other functions described above, does not use `nsswitch.conf`; it reads and parses the next line from the stream `f`, which is assumed to have the format of the `project(4)` file. This function returns the same values as `getprojent()`.

The `getprojent()`, `getprojbyname()`, `getprojbyid()`, `getdefaultproj()`, and `inproj()` functions are reentrant interfaces for operations with the project database. These functions use buffers supplied by the caller to store returned results and are safe for use in both single-threaded and multithreaded applications.

Reentrant interfaces require the additional arguments `proj`, `buffer`, and `bufsize`. The `proj` argument must be a pointer to a `struct project` structure allocated by the caller. On successful completion, the function returns the project entry in this structure. Storage referenced by the `project` structure is allocated from the memory provided with the `buffer` argument, which is `bufsize` bytes in size.

For enumeration in multithreaded applications, the position within the enumeration is a process-wide property shared by all threads. The `setprojent()` function may be used in a multithreaded application but resets the enumeration position for all threads. If multiple threads interleave calls to `getprojent()`, the threads will enumerate disjoint subsets of the project database. The `inproj()`, `getprojbyname()`, `getprojbyid()`, and `getdefaultproj()` functions leave the enumeration position in an indeterminate state.
Project entries are represented by the `struct project` structure defined in `<project.h>`. 

```c
struct project {
    char *pj_name; /* name of the project */
    projid_t pj_projid; /* numerical project id */
    char *pj_comment; /* project comment */
    char **pj_users; /* vector of pointers to project user names */
    char **pj_groups; /* vector of pointers to project group names */
    char *pj_attr; /* project attributes */
};
```

The `getprojbyname()` and `getprojbyid()` functions each return a pointer to a `struct project` if they successfully locate the requested entry; otherwise they return `NULL`.

The `getprojent()` function returns a pointer to a `struct project` if it successfully enumerates an entry; otherwise it returns `NULL`, indicating the end of the enumeration.

The `getprojidbyname()` function returns the project ID if the requested entry is found; otherwise it returns `-1` and sets `errno` to indicate the error.

When the pointer returned by the reentrant functions `getprojbyname()`, `getprojbyid()`, and `getprojent()` is non-null, it is always equal to the `proj` pointer that was supplied by the caller.

Upon failure, `NULL` is returned and `errno` is set to indicate the error.

**ERRORS**

The `getprojent()`, `getprojbyname()`, `getprojbyid()`, `inproj()`, `getprojidbyname()`, `fgetprojent()`, and `getdefaultproj()` functions will fail if:

- **EINTR** A signal was caught during the operation.
- **EIO** An I/O error has occurred.
- **EMFILE** There are `OPEN_MAX` file descriptors currently open in the calling process.
- **ENFILE** The maximum allowable number of files is currently open in the system.
- **ERANGE** Insufficient storage was supplied by `buffer` and `bufsize` to contain the data to be referenced by the resulting `project` structure.

**USAGE**

When compiling multithreaded applications, see `intro(3)`, Notes On Multithreaded Applications.

Applications that use the interfaces described on this manual page cannot be linked statically, since the implementations of these functions employ dynamic loading and linking of shared objects at run time.
Use of the enumeration interface `getprojent()` is discouraged; enumeration is supported for the project file, NIS, and LDAP but in general is not efficient. The semantics of enumeration are discussed further in `nsswitch.conf(4)`.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>See &quot;Reentrant Interfaces&quot; in Description</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`intro(3), sysconf(3C), nsswitch.conf(4), project(4), attributes(5)`
NAME
getuserattr, getusernam, getuserid, free_userattr, setuserattr, enduserattr – get
user_attr entry

SYNOPSIS
cc [ flag... ] file... -lsecd -lssocket -lnsl -lint1 [ library... ]
#include <user_attr.h>
userattr_t *getuserattr(void);
userattr_t *getusernam(const char *name);
userattr_t *getuserid(uid_t uid);
void free_userattr(userattr_t *userattr);
void setuserattr(void);
void enduserattr(void);

DESCRIPTION
The getuserattr(), getusernam(), and getuserid() functions each return a
user_attr(4) entry. Entries can come from any of the sources specified in the
nsswitch.conf(4) file. The getuserattr() function enumerates user_attr
entries. The getusernam() function searches for a user_attr entry with a given
user name name. The getuserid() function searches for a user_attr entry with a
given user id uid. Successive calls to these functions return either successive
user_attr entries or NULL.

The free_userattr() function releases memory allocated by the getusernam() and
getuserattr() functions.

The internal representation of a user_attr entry is a userattr_t structure defined
in <user_attr.h> with the following members:
char name; /* name of the user */
char qualifier; /* reserved for future use */
char res1; /* reserved for future use */
char res2; /* reserved for future use */
kva_t attr; /* list of attributes */

The setuserattr() function “rewinds” to the beginning of the enumeration of
user_attr entries. Calls to getusernam() may leave the enumeration in an
indeterminate state, so setuserattr() should be called before the first call to
getuserattr().

The enduserattr() function may be called to indicate that user_attr processing
is complete; the library may then close any open user_attr file, deallocate any
internal storage, and so forth.

RETURN VALUES
The getuserattr() function returns a pointer to a userattr_t if it successfully
enumerates an entry; otherwise it returns NULL, indicating the end of the enumeration.

The getusernam() function returns a pointer to a userattr_t if it successfully
locates the requested entry; otherwise it returns NULL.
The `getuserattr()` and `getusername()` functions both allocate memory for the
pointers they return. This memory should be deallocated with the `free_userattr()`
function.

Applications that use the interfaces described in this manual page cannot be linked
statically, since the implementations of these functions employ dynamic loading and
linking of shared objects at run time. Note that these interfaces are reentrant even
though they do not use the `_r` suffix naming convention.

Individual attributes may be referenced in the `attr` structure by calling the
`kva_match(3SECDB)` function.

Because the list of legal keys is likely to expand, code must be written to ignore
unknown key-value pairs without error.

`/etc/user_attr` extended user attributes
`/etc/nsswitch.conf` configuration file lookup information for
the name server switch

See attributes(5) for descriptions of the following attributes:

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</table>

getauthattr(3SECDB), getexecattr(3SECDB), getprofattr(3SECDB),
user_attr(4), attributes(5)
NAME  gmatch – shell global pattern matching

SYNOPSIS  cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

int gmatch(const char *str, const char *pattern);

DESCRIPTION  gmatch() checks whether the null-terminated string str matches the null-terminated
pattern string pattern. See the sh(1), section File Name Generation, for a
discussion of pattern matching. A backslash (\) is used as an escape character in
pattern strings.

RETURN VALUES  gmatch() returns non-zero if the pattern matches the string, zero if the pattern does
not.

EXAMPLES  EXAMPLE 1 Examples of gmatch() function.
In the following example, gmatch() returns non-zero (true) for all strings with “a” or
“-” as their last character.

    char *s;
    gmatch (s, "*[a-]" )

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO  sh(1), attributes(5)

NOTES  When compiling multithreaded applications, the _REENTRANT flag must be defined
on the compile line. This flag should only be used in multithreaded applications.
# hypot(3M)

## NAME
hypot – Euclidean distance function

## SYNOPSIS
c{ [ flag ... ] file ... -lm [ library ... ]
#include <math.h>
double hypot(double x, double y);

## DESCRIPTION
The hypot() function computes the length of the hypotenuse of a right-angled triangle:

\[ \sqrt{x^2 + y^2} \]

Upon successful completion, hypot() returns the length of the hypotenuse of a right angled triangle with sides of length \( x \) and \( y \).

If the result would cause overflow, HUGE_VAL is returned and errno may be set to ERANGE.

If \( x \) or \( y \) is NaN, NaN is returned.

## ERRORS
The hypot() function may fail if:

- **ERANGE** The result overflows.

## USAGE
The hypot() function takes precautions against underflow and overflow during intermediate steps of the computation.

An application wishing to check for error situations should set errno to 0 before calling hypot(). If errno is non-zero on return, or the return value is HUGE_VAL or NaN, an error has occurred.

## ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

## SEE ALSO
isnan(3M), sqrt(3M), attributes(5)
ilogb – returns an unbiased exponent

SYNOPSIS

cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

int ilogb(double x);

DESCRIPTION

The ilogb() function returns the exponent part of x. Formally, the return value is the integral part of \( \log_r|x| \) as a signed integral value, for non-zero finite x, where \( r \) is the radix of the machine’s floating point arithmetic.

RETURN VALUES

Upon successful completion, ilogb() returns the exponent part of x.

If x is 0, ilogb() returns -INT_MAX.

If x is NaN or ±Inf, ilogb() returns INT_MAX.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO

logb(3M), attributes(5)
isencrypt – determine whether a buffer of characters is encrypted

**SYNOPSIS**

```c
#include<libgen.h>

int isencrypt(const char *fbuf, size_t ninbuf);
```

**DESCRIPTION**

`isencrypt()` uses heuristics to determine whether a buffer of characters is encrypted. It requires two arguments: a pointer to an array of characters and the number of characters in the buffer.

`isencrypt()` assumes that the file is not encrypted if all the characters in the first block are ASCII characters. If there are non-ASCII characters in the first `ninbuf` characters, and if the `setlocale()` `LC_CTYPE` category is set to `C` or `ascii`, `isencrypt()` assumes that the buffer is encrypted.

If the `LC_CTYPE` category is set to a value other than `C` or `ascii`, then `isencrypt()` uses a combination of heuristics to determine if the buffer is encrypted. If `ninbuf` has at least 64 characters, a chi-square test is used to determine if the bytes in the buffer have a uniform distribution; if it does, then `isencrypt()` assumes the buffer is encrypted. If the buffer has less than 64 characters, a check is made for null characters and a terminating new-line to determine whether the buffer is encrypted.

**RETURN VALUES**

If the buffer is encrypted, 1 is returned; otherwise, zero is returned.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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</table>

**SEE ALSO**

`setlocale(3C)`, `attributes(5)`

**NOTES**

When compiling multithreaded applications, the `REENTRANT` flag must be defined on the compile line. This flag should only be used in multithreaded applications.
#include <math.h>

int isnan(double x);

The isnan() function tests whether x is NaN.

The isnan() function returns non-zero if x is NaN. Otherwise, 0 is returned.

On systems not supporting NaN, isnan() always returns 0.

See attributes(5) for descriptions of the following attributes:

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See also attributes(5)
NAME
j0, j1, jn – Bessel functions of the first kind

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double j0(double x);
double j1(double x);
double jn(int n, double x);

DESCRIPTION
The j0(), j1() and jn() functions compute Bessel functions of x of the first kind of orders 0, 1 and n respectively.

RETURN VALUES
Upon successful completion, j0(), j1() and jn() return the relevant Bessel value of x of the first kind.

If the x argument is too large in magnitude, 0 is returned and errno may be set to ERANGE.

If x is NaN, NaN is returned.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS
The j0(), j1() and jn() functions may fail if:

ERANGE The value of x was too large in magnitude.

USAGE
An application wishing to check for error situations should set errno to 0 before calling j0(), j1() or jn(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
isnan(3M), matherr(3M), y0(3M), attributes(5), standards(5)
kstat – tied hash interface to the kstat facility

SYNOPSIS

use Sun::Solaris::Kstat;
Sun::Solaris::Kstat->new();
Sun::Solaris::Kstat->update();
Sun::Solaris::Kstat->{module}{instance}{name}{statistic}

DESCRIPTION

Kernel statistics are categorized using a 3-part key consisting of the module, the instance, and the statistic name. For example, CPU information can be found under cpu_stat:0:cpu_stat0, as in the above example. The method Sun::Solaris::Kstat->new() creates a new 3-layer tree of Perl hashes with the same structure; that is, the statistic for CPU 0 can be accessed as $ks->{cpu_stat}{0}{cpu_stat0}. The fourth and lowest layer is a tied hash used to hold the individual statistics values for a particular system resource.

For performance reasons, the creation of a Sun::Solaris::Kstat object is not accompanied by a following read of all possible statistics. Instead, the 3-layer structure described above is created, but reads of a statistic’s values are done only when referenced. For example, accessing $ks->{cpu_stat}{0}{cpu_stat0}{syscall} will read in all the statistics for CPU 0, including user, system, and wait times, and the other CPU statistics, as well as the number of system call entries. Once you have accessed a lowest level statistics value, calling $ks->update will automatically update all the individual values of any statistics you have accessed.

Note that there are two values of the lowest-level hash that can be read without causing the full set of statistics to be read from the kernel. These are "class", which is the kstat class of the statistics, and "crtime", which is the time that the kstat was created. See kstat(3KSTAT) for full details of these fields.

Methods

new() Create a new kstat statistics hierarchy and return a reference to the top-level hash. Use it like any normal hash to access the statistics.

update() Update all the statistics that have been accessed so far. In scalar context, update() returns 1 if the kstat structure has changed, and 0 otherwise. In list context, update() returns references to two arrays: the first holds the keys of any kstats that have been added, and the second holds the keys of any kstats that have been deleted. Each key will be returned in the form "module:instance:name".

EXAMPLES

EXAMPLE 1 Sun::Solaris::Kstat example

use Sun::Solaris::Kstat;
my $kstat = Sun::Solaris::Kstat->new();
my ($usr1, $sys1, $wio1, $idle1) = @{$kstat->{cpu_stat}{0}{cpu_stat0}}{qw(user kernel wait idle)};
print("usr sys wio idle\n");
while (1) {
    sleep 5;
    if ($kstat->update()) {
        
    
}
EXAMPLE 1  Sun::Solaris::Kstat example  

    (Continued)

    print("Configuration changed\n")
    }
my ($usr2, $sys2, $wio2, $idle2) =
    @{$kstat->{cpu_stat}{0}{cpu_stat0}}{qw(user kernel wait idle)};
printf(" %.2d %.2d %.2d %.2d
",
    ($usr2 - $usr1) / 5, ($sys2 - $sys1) / 5,
    ($wio2 - $wio1) / 5, ($idle2 - $idle1) / 5);
    $usr1 = $usr2;
    $sys1 = $sys2;
    $wio1 = $wio2;
    $idle1 = $idle2;
}

SEE ALSO
perl(1), kstat(1M), kstat(3KSTAT), kstat_chain_update(3KSTAT),
kstat_close(3KSTAT), kstat_open(3KSTAT), kstat_read(3KSTAT)

NOTES
As the statistics are stored in a tied hash, taking additional references of members of
the hash, such as
my $ref = \$ks->{cpu_stat}{0}{cpu_stat0}{syscall};
printf("$ref\n");
will be recorded as a hold on that statistic's value, preventing it from being updated
by refresh(). Copy the values explicitly if persistence is necessary.

Several of the statistics provided by the kstat facility are stored as 64-bit integer
values. Perl 5 does not yet internally support 64-bit integers, so these values are
approximated in this module. There are two classes of 64-bit value to be dealt with:

64-bit intervals and times
These are the crtime and snaptime fields of all the
statistics hashes, and the wtime, wlen time, wlastupdate, rtime, rlentime and rlastupdate
fields of the kstat I/O statistics structures. These are
measured by the kstat facility in nanoseconds,
meaning that a 32-bit value would represent
approximately 4 seconds. The alternative is to store the
values as floating-point numbers, which offer
approximately 53 bits of precision on present hardware.
64-bit intervals and timers as floating point values
expressed in seconds, meaning that time-related kstats
are being rounded to approximately microsecond
resolution.

64-bit counters
It is not useful to store these values as 32-bit values. As
noted above, floating-point values offer 53 bits of
precision. Accordingly, all 64-bit counters are stored as
floating-point values.
The kstat facility is a general-purpose mechanism for providing kernel statistics to users.

The kernel maintains a linked list of statistics structures, or kstats. Each kstat has a common header section and a type-specific data section. The header section is defined by the kstat_t structure:

```c
typedef int kid_t; /* unique kstat id */
typedef struct kstat {
    hrtime_t ks_crtime; /* creation time */
    struct kstat *ks_next; /* kstat chain linkage */
    kid_t ks_kid; /* unique kstat ID */
    char ks_module[KSTAT_STRLEN]; /* module name */
    uchar_t ks_resv; /* reserved */
    int ks_instance; /* module's instance */
    char ks_name[KSTAT_STRLEN]; /* kstat name */
    uchar_t ks_type; /* kstat data type */
    char ks_class[KSTAT_STRLEN]; /* kstat class */
    uchar_t ks_flags; /* kstat flags */
    void *ks_data; /* kstat type-specific data */
    uint_t ks_ndata; /* # of data records */
    size_t ks_data_size; /* size of kstat data section */
    hrtime_t ks_snaptime; /* time of last data snapshot */
    int (*ks_update)(struct kstat *, int);
    void *ks_private;
    int (*ks_snapshot)(struct kstat *, void *, int);
    void *ks_lock;
} kstat_t;
```

The fields that are of significance to the user are:

- **ks_crtime**: The time the kstat was created. This allows you to compute the rates of various counters since the kstat was created; "rate since boot" is replaced by the more general concept of "rate since kstat creation". All times associated with kstats (such as creation time, last snapshot time, kstat_timer_t and kstat_io_t timestamps, and the like) are 64-bit nanosecond values. The accuracy of kstat timestamps is machine dependent, but the precision (units) is the same across all platforms. See gethrtime(3C) for general information about high-resolution timestamps.
ks_next: Kstats are stored as a linked list, or chain. ks_next points to the next kstat in the chain.

ks_kid: A unique identifier for the kstat.

ks_module, ks_instance: Contain the name and instance of the module that created the kstat. In cases where there can only be one instance, ks_instance is 0.

ks_name: Gives a meaningful name to a kstat. The full kstat namespace is <ks_module, ks_instance, ks_name>, so the name only need be unique within a module.

ks_type: The type of data in this kstat. Kstat data types are discussed below.

ks_class: Each kstat can be characterized as belonging to some broad class of statistics, such as disk, tape, net, vm, and streams. This field can be used as a filter to extract related kstats. The following values are currently in use: disk, tape, controller, net, rpc, vm, kvm, hat, streams, kmem, kmem_cache, kstat, and misc. (The kstat class encompasses things like kstat_types.)

ks_data, ksndata, ks_data_size: Ks_data is a pointer to the kstat's data section. The type of data stored there depends on ks_type. ksndata indicates the number of data records. Only some kstat types support multiple data records. Currently, KSTAT_TYPE_RAW, KSTAT_TYPE_NAMED and KSTAT_TYPE_TIMER kstats support multiple data records. KSTAT_TYPE_INTR and KSTAT_TYPE_IO kstats support only one data record. ks_data_size is the total size of the data section, in bytes.

ks_snapt ime: The timestamp for the last data snapshot. This allows you to compute activity rates:

\[
\text{rate} = \frac{\text{new\_count} - \text{old\_count}}{\text{new\_snaptime} - \text{old\_snaptime}};
\]

Kstat data types: The following types of kstats are currently available:

```
#define KSTAT_TYPE_RAW 0 /* can be anything */
#define KSTAT_TYPE_NAMED 1 /* name/value pairs */
#define KSTAT_TYPE_INTR 2 /* interrupt statistics */
#define KSTAT_TYPE_IO 3 /* I/O statistics */
#define KSTAT_TYPE_TIMER 4 /* event timers */
```
To get a list of all kstat types currently supported in the system, tools can read out the standard system kstat `kstat_types` (full name spec is `<unix', 0, 'kstat_types'>`). This is a `KSTAT_TYPE_NAMED` kstat in which the name field describes the type of kstat, and the value field is the kstat type number (for example, `KSTAT_TYPE_IO` is type 3 -- see above).

**Raw kstat**

`KSTAT_TYPE_RAW` raw data

The "raw" kstat type is just treated as an array of bytes. This is generally used to export well-known structures, like `sysinfo`.

**Name=value kstat**

`KSTAT_TYPE_NAMED` A list of arbitrary `name=value` statistics.

define kstat_named {
    char name[KSTAT_STRLEN]; /* name of counter */
    uchar_t data_type; /* data type */
    union {
        char c[16]; /* enough for 128-bit ints */
        int32_t t i32;
        uint32_t ui32;
        int64_t t i64;
        uint64_t ui64;
    } value; /* value of counter */
} kstat_named_t;

/* These structure members are obsolete */

int32_t l;
uint32_t ul;
int64_t ll;
uint64_t ull;

#define KSTAT_DATA_CHAR 0
#define KSTAT_DATA_INT32 1
#define KSTAT_DATA_UINT32 2
#define KSTAT_DATA_INT64 3
#define KSTAT_DATA_UINT64 4

/* These types are obsolete */

#define KSTAT_DATA_LONG 1
#define KSTAT_DATA_ULONG 2
#define KSTAT_DATAONGLONG 3
#define KSTAT_DATA_ULONGLONG 4
#define KSTAT_DATA_FLOAT 5
#define KSTAT_DATA_DOUBLE 6

**Interrupt kstat**

`KSTAT_TYPE_INTR` Interrupt statistics.

An interrupt is a hard interrupt (sourced from the hardware device itself), a soft interrupt (induced by the system via the use of some system interrupt source), a watchdog interrupt (induced by a periodic timer call), spurious (an interrupt entry point was entered but there was no interrupt to service), or multiple service (an interrupt was detected and serviced just prior to returning from any of the other types).
#define KSTAT_INTR_HARD 0
#define KSTAT_INTR_SOFT 1
#define KSTAT_INTR_WATCHDOG 2
#define KSTAT_INTR_SPURIOUS 3
#define KSTAT_INTR_MULTSVC 4
#define KSTAT_NUM_INTRS 5

typedef struct kstat_intr {
    uint_t intrs[KSTAT_NUM_INTRS]; /* interrupt counters */
} kstat_intr_t;

KSTAT_TYPE_TIMER

Event timer kstat

These provide basic counting and timing information for any type of event.

typedef struct kstat_timer {
    char name[KSTAT_STRLEN]; /* event name */
    uchar_t resv; /* reserved */
    u_longlong_t num_events; /* number of events */
    hrt ime_t elapsed_time; /* cumulative elapsed time */
    hrt ime_t min_time; /* shortest event duration */
    hrt ime_t max_time; /* longest event duration */
    hrt ime_t start_time; /* previous event start time */
    hrt ime_t stop_time; /* previous event stop time */
} kstat_timer_t;

KSTAT_TYPE_IO

I/O kstat

I/O statistics.

typedef struct kstat_io {
    /*
    * Basic counters.
    */
    u_longlong_t nread; /* number of bytes read */
    u_longlong_t nwritten; /* number of bytes written */
    uint_t reads; /* number of read operations */
    uint_t writes; /* number of write operations */
    /*
    * Accumulated time and queue length statistics.
    */
    /*
    * Time statistics are kept as a running sum of "active" time.
    * Queue length statistics are kept as a running sum of the
    * product of queue length and elapsed time at that length --
    * that is, a Riemann sum for queue length integrated against time.
    * ^
    *   |     
    * 8 | i4   |
    *   |     |
    * Queue 6  
    * Length  |
    * 4 | i2   |
    */
} kstat_io_t;
At each change of state (entry or exit from the queue),
we add the elapsed time (since the previous state change)
to the active time if the queue length was non-zero during
that interval; and we add the product of the elapsed time
times the queue length to the running length*time sum.

This method is generalizable to measuring residency
in any defined system: instead of queue lengths, think
of "outstanding RPC calls to server X".

A large number of I/O subsystems have at least two basic
"lists" of transactions they manage: one for transactions
that have been accepted for processing but for which processing
has yet to begin, and one for transactions which are actively
being processed (but not done). For this reason, two cumulative
time statistics are defined here: pre-service (wait) time,
and service (run) time.

The units of cumulative busy time are accumulated nanoseconds.
The units of cumulative length*time products are elapsed time
times queue length.

hrtime_t wtime; /* cumulative wait (pre-service) time */
hrtime_t wlentime; /* cumulative wait length*time product*/
hrtime_t wlastupdate; /* last time wait queue changed */
hrtime_t rtime; /* cumulative run (service) time */
hrtime_t rlentime; /* cumulative run length*time product */
hrtime_t rlastupdate; /* last time run queue changed */
uint_t wcnt; /* count of elements in wait state */
uint_t rcnt; /* count of elements in run state */

The kstat library, libkstat, defines the user interface (API) to the system’s kstat facility.

You begin by opening libkstat with kstat_open(3KSTAT), which returns a pointer to
a fully initialized kstat control structure. This is your ticket to subsequent libkstat
operations:

typedef struct kstat_ctl {
    kid_t kc_chain_id; /* current kstat chain ID */
    kstat_t *kc_chain; /* pointer to kstat chain */
} kstat_io_t;
Only the first two fields, `kc_chain_id` and `kc_chain`, are of interest to `libkstat` clients. (`kc_kd` is the descriptor for `/dev/kstat`, the kernel statistics driver. `libkstat` functions are built on top of `/dev/kstat ioctl(2)` primitives. Direct interaction with `/dev/kstat` is strongly discouraged, since it is not a public interface.)

`kc_chain` points to your copy of the kstat chain. You typically walk the chain to find and process a certain kind of kstat. For example, to display all I/O kstats:

```c
kstat_ctl_t *kc;
kstat_t *ksp;
kstat_io_t kio;

kc = kstat_open();
for (ksp = kc->kc_chain; ksp != NULL; ksp = ksp->ks_next) {
    if (ksp->ks_type == KSTAT_TYPE_IO) {
        kstat_read(kc, ksp, &kio);
        my_io_display(kio);
    }
}
```

`kc_chain_id` is the kstat chain ID, or KCID, of your copy of the kstat chain. See `kstat_chain_update(3KSTAT)` for an explanation of KCIDs.

### FILES

- `/dev/kstat` kernel statistics driver
- `/usr/include/kstat.h`
- `/usr/include/sys/kstat.h`

### SEE ALSO

`ioctl(2)`, `gethrtime(3C)`, `getloadavg(3C)`, `kstat_chain_update(3KSTAT)`, `kstat_close(3KSTAT)`, `kstat_data_lookup(3KSTAT)`, `kstat_lookup(3KSTAT)`, `kstat_open(3KSTAT)`, `kstat_read(3KSTAT)`, `kstat_write(3KSTAT)`
The kstat_chain_update() function brings the user’s kstat header chain in sync with that of the kernel. The kstat chain is a linked list of kstat headers (kstat_t’s) pointed to by kc->kc_chain, which is initialized by kstat_open(3KSTAT). This chain constitutes a list of all kstats currently in the system.

During normal operation, the kernel creates new kstats and delete old ones as various device instances are added and removed, thereby causing the user’s copy of the kstat chain to become out of date. The kstat_chain_update() function detects this condition by comparing the kernel’s current kstat chain ID(KCID), which is incremented every time the kstat chain changes, to the user’s KCID, kc->kc_chain_id. If the KCIDs match, kstat_chain_update() does nothing. Otherwise, it deletes any invalid kstat headers from the user’s kstat chain, adds any new ones, and sets kc->kc_chain_id to the new KCID. All other kstat headers in the user’s kstat chain are unmodified.

The kstat_chain_update() function returns the new KCID if the kstat chain has changed, 0 if it hasn’t, or −1 on failure.

FILES
/dev/kstat kernel statistics driver

SEE ALSO
kstat(3KSTAT), kstat_close(3KSTAT), kstat_data_lookup(3KSTAT), kstat_lookup(3KSTAT), kstat_open(3KSTAT), kstat_read(3KSTAT), kstat_write(3KSTAT)
The `kstat_lookup()` function traverses the kstat chain, `kc->kc_chain`, searching for a kstat with the same `ks_module`, `ks_instance`, and `ks_name` fields; this triplet uniquely identifies a kstat. If `ks_module` is `NULL`, `ks_instance` is `-1`, or `ks_name` is `NULL`, then those fields will be ignored in the search. For example, `kstat_lookup(kc, NULL, -1, "foo")` will simply find the first kstat with name "foo".

The `kstat_data_lookup()` function searches the kstat’s data section for the record with the specified `name`. This operation is valid only for kstat types which have named data records. Currently, only the KSTAT_TYPE_NAMED and KSTAT_TYPE_TIMER kstats have named data records.

The `kstat_lookup()` function returns a pointer to the requested kstat if it is found, or `NULL` if it is not.

The `kstat_data_lookup()` function returns a pointer to the requested data record if it is found. If the requested record is not found, or if the kstat type is invalid, `kstat_data_lookup()` returns `NULL`.

```
#include <kstat.h>

kstat_t *kstat_lookup(kstat_ctl_t *kc, char *ks_module, int ks_instance, char *ks_name);

void *kstat_data_lookup(kstat_t *ksp, char *name);
```

/dev/kstat

kstat(3KSTAT), kstat_chain_update(3KSTAT), kstat_close(3KSTAT), kstat_open(3KSTAT), kstat_read(3KSTAT), kstat_write(3KSTAT)
kstat_open(3KSTAT)

NAME | kstat_open, kstat_close – initialize kernel statistics facility

SYNOPSIS | cc [ flag ... ] file ... -lkstat [ library ...]
#include <kstat.h>

kstat_ctl_t *kstat_open(void);
int kstat_close(kstat_ctl_t *kc);

DESCRIPTION | kstat_open() initializes a kstat control structure, which provides access to the kernel statistics library. It returns a pointer to this structure, which must be supplied as the kc argument in subsequent libkstat function calls.

kstat_close() frees all resources that were associated with kc. This is done automatically on exit(2) and execve() (see exec(2)).

RETURN VALUES | kstat_open() returns a pointer to a kstat control structure. On failure, it returns NULL and no resources are allocated.

kstat_close() returns 0 on success, −1 on failure.

FILES | /dev/kstat kernel statistics driver

SEE ALSO | kstat(3KSTAT), kstat_chain_update(3KSTAT), kstat_data_lookup(3KSTAT), kstat_lookup(3KSTAT), kstat_read(3KSTAT), kstat_write(3KSTAT)
kstat_read(3KSTAT)

NAME  kstat_read, kstat_write – read or write kstat data

SYNOPSIS cc [ flag ... ] file ... -lkstat [ library ... ]
#include <kstat.h>

```c
kid_t kstat_read(kstat_ctl_t *kc, kstat_t *ksp, void *buf);
kid_t kstat_write(kstat_ctl_t *kc, kstat_t *ksp, void *buf);
```

DESCRIPTION kstat_read() gets data from the kernel for the kstat pointed to by ksp. ksp->ks_data is automatically allocated (or reallocated) to be large enough to hold all of the data. ksp->ks_ndata is set to the number of data fields, ksp->ks_data_size is set to the total size of the data, and ksp->ks_snaptime is set to the high-resolution time at which the data snapshot was taken. If buf is non-NULL, the data is copied from ksp->ks_data into buf.

kstat_write() writes data from buf, or from ksp->ks_data if buf is NULL, to the corresponding kstat in the kernel. Only the superuser can use kstat_write().

RETURN VALUES On success, kstat_read() and kstat_write() return the current kstat chain ID (KCID). On failure, they return -1.

FILES /dev/kstat kernel statistics driver

SEE ALSO kstat(3KSTAT), kstat_chain_update(3KSTAT), kstat_close(3KSTAT), kstat_data_lookup(3KSTAT), kstat_lookup(3KSTAT), kstat_open(3KSTAT)
kva_match – look up a key in a key-value array

**SYNOPSIS**

```c
#include <secdb.h>
char *kva_match(kva_t *kva, char *, key);
```

**DESCRIPTION**

The `kva_match()` function searches a `kva_t` structure, which is part of the `authattr_t`, `execattr_t`, `profattr_t`, or `userattr_t` structures. The function takes two arguments: a pointer to a key value array, and a key. If the key is in the array, the function returns a pointer to the first corresponding value that matches that key. Otherwise, the function returns `NULL`.

**RETURN VALUES**

Upon success, the function returns a pointer to the value sought. Otherwise, it returns `NULL`.

**ATTRIBUTES**

See `attributes` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`getauthattr(3SECDB)`, `getexecattr(3SECDB)`, `getprofattr(3SECDB)`, `getuserattr(3SECDB)`

**NOTES**

The `kva_match()` function returns a pointer to data that already exists in the key-value array. It does not allocate its own memory for this pointer but obtains it from the key-value array that is passed as its first argument.
The `kvm_getu()` function reads the u-area of the process specified by `proc` to an area of static storage associated with `kd` and returns a pointer to it. Subsequent calls to `kvm_getu()` will overwrite this static area.

The `kd` argument is a pointer to a kernel descriptor returned by `kvm_open(3KVM)`. The `proc` argument is a pointer to a copy in the current process' address space of a `proc` structure, obtained, for instance, by a prior `kvm_nextproc(3KVM)` call.

The `kvm_getcmd()` function constructs a list of string pointers that represent the command arguments and environment that were used to initiate the process specified by `proc`.

The `kd` argument is a pointer to a kernel descriptor returned by `kvm_open(3KVM)`. The `u` argument is a pointer to a copy in the current process' address space of a `user` structure, obtained, for instance, by a prior `kvm_getu()` call. If `arg` is not `NULL`, the command line arguments are formed into a null-terminated array of string pointers. The address of the first such pointer is returned in `arg`. If `env` is not `NULL`, then the environment is formed into a null-terminated array of string pointers. The address of the first of these is returned in `env`.

The pointers returned in `arg` and `env` refer to data allocated by `malloc(3C)` and should be freed by a call to `free()` when no longer needed. See `malloc(3C)` Both the string pointers and the strings themselves are deallocated when freed.

Since the environment and command line arguments may have been modified by the user process, there is no guarantee that it will be possible to reconstruct the original command at all. Thus, `kvm_getcmd()` will make the best attempt possible, returning −1 if the user process data is unrecognizable.

On success, `kvm_getu()` returns a pointer to a copy of the u-area of the process specified by `proc`. On failure, it returns `NULL`.

The `kvm_getcmd()` function returns 0 on success and −1 on failure.
kvm_getu(3KVM)

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO

kvm_nextproc(3KVM), kvm_open(3KVM), kvm_read(3KVM), malloc(3C), libkvm(3LIB), attributes(5)

NOTES

If kvm_getcmd() returns −1, the caller still has the option of using the command line fragment that is stored in the u-area.

On systems that support both 32-bit and 64-bit processes, the 64-bit implementation of libkvm ensures that the arg and env pointer arrays for kvm_getcmd() are translated to the same form as if they were 64-bit processes. Applications that wish to access the raw 32-bit stack directly can use kvm_uread(). See kvm_read(3KVM).
NAME | kvm_nextproc, kvm_getproc, kvm_setproc – read system process structures
SYNOPSIS #include <kvm.h>
#include <sys/param.h>
#include <sys/time.h>
#include <sys/proc.h>

struct proc *kvm_nextproc(kvm_t *kd);
int kvm_setproc(kvm_t *kd);
struct proc *kvm_getproc(kvm_t *kd, pid_t pid);

DESCRIPTION
kvm_nextproc() The kvm_nextproc() function may be used to sequentially read all of the system process structures from the kernel identified by kd (see kvm_open(3KVM)). Each call to kvm_nextproc() returns a pointer to the static memory area that contains a copy of the next valid process table entry. There is no guarantee that the data will remain valid across calls to kvm_nextproc(), kvm_setproc(), or kvm_getproc(). Therefore, if the process structure must be saved, it should be copied to non-volatile storage.

For performance reasons, many implementations will cache a set of system process structures. Since the system state is liable to change between calls to kvm_nextproc(), and since the cache may contain obsolete information, there is no guarantee that every process structure returned refers to an active process, nor is it certain that all processes will be reported.

kvm_setproc() The kvm_setproc() function rewinds the process list, enabling kvm_nextproc() to rescan from the beginning of the system process table. This function will always flush the process structure cache, allowing an application to re-scan the process table of a running system.

kvm_getproc() The kvm_getproc() function locates the proc structure of the process specified by pid and returns a pointer to it. This function does not interact with the process table pointer manipulated by kvm_nextproc(); however, the restrictions regarding the validity of the data still apply.

RETURN VALUES
On success, kvm_nextproc() returns a pointer to a copy of the next valid process table entry. On failure, it returns NULL.

On success, kvm_getproc() returns a pointer to the proc structure of the process specified by pid. On failure, it returns NULL.

The kvm_setproc() function returns 0 on success -1 on failure.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:
### kvm_nextproc(3KVM)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

kvm_getu(3KVM), kvm_open(3KVM), kvm_read(3KVM), attributes(5)
NAME  |  kvm_nlist – get entries from kernel symbol table
SYNOPSIS  |  #include <kvm.h>
        #include <nlist.h>

        int kvm_nlist(kvm_t *kd, struct nlist *nl);

DESCRIPTION  |  

kvm_nlist() examines the symbol table from the kernel image identified by kd (see
kvm_open(3KVM)) and selectively extracts a list of values and puts them in the array
of nlist structures pointed to by nl. The name list pointed to by nl consists of an
array of structures containing names, types and values. The n_name field of each such
structure is taken to be a pointer to a character string representing a symbol name. The
list is terminated by an entry with a NULL pointer (or a pointer to a null string) in the
n_name field. For each entry in nl, if the named symbol is present in the kernel symbol
table, its value and type are placed in the n_value and n_type fields. If a symbol cannot
be located, the corresponding n_type field of nl is set to zero.

RETURN VALUES  |  kvm_nlist() returns the value of nlist(3UCB) or nlist(3ELF), depending on the

library used.

ATTRIBUTES  |  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
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<tbody>
<tr>
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</tr>
</tbody>
</table>

SEE ALSO  |  nlist(3UCB), nlist(3ELF), kvm_open(3KVM), kvm_read(3KVM), attributes(5)
The `kvm_open()` function initializes a set of file descriptors to be used in subsequent calls to kernel virtual memory (VM) routines. It returns a pointer to a kernel identifier that must be used as the `kd` argument in subsequent kernel VM function calls.

The `namelist` argument specifies an unstripped executable file whose symbol table will be used to locate various offsets in `corefile`. If `namelist` is NULL, the symbol table of the currently running kernel is used to determine offsets in the core image. In this case, it is up to the implementation to select an appropriate way to resolve symbolic references, for instance, using `/dev/ksyms` as a default `namelist` file.

The `corefile` argument specifies a file that contains an image of physical memory, for instance, a kernel crash dump file (see `savecore(1M)`) or the special device `/dev/mem`. If `corefile` is NULL, the currently running kernel is accessed, using `/dev/mem` and `/dev/kmem`.

The `swapfile` argument specifies a file that represents the swap device. If both `corefile` and `swapfile` are NULL, the swap device of the currently running kernel is accessed. Otherwise, if `swapfile` is NULL, `kvm_open()` may succeed but subsequent `kvm_getu(3KVM)` function calls may fail if the desired information is swapped out.

The `flag` function is used to specify read or write access for `corefile` and may have one of the following values:

- O_RDONLY  open for reading
- O_RDWR    open for reading and writing

The `errstr` argument is used to control error reporting. If it is a null pointer, no error messages will be printed. If it is non-null, it is assumed to be the address of a string that will be used to prefix error messages generated by `kvm_open`. Errors are printed to `stderr`. A useful value to supply for `errstr` would be `argv[0]`. This has the effect of printing the process name in front of any error messages.

Applications using `libkvm` are dependent on the underlying data model of the kernel image, that is, whether it is a 32-bit or 64-bit kernel.
The data model of these applications must match the data model of the kernel in order to correctly interpret the size and offsets of kernel data structures. For example, a 32-bit application that uses the 32-bit version of the libkvm interfaces will fail to open a 64-bit kernel image. Similarly, a 64-bit application that uses the 64-bit version of the libkvm interfaces will fail to open a 32-bit kernel image.

**kvm_close()**

The `kvm_close()` function closes all file descriptors that were associated with `kd`. These files are also closed on `exit(2)` and `execve()` (see `exec(2)`). `kvm_close()` also resets the proc pointer associated with `kvm_nextproc(3KVM)` and flushes any cached kernel data.

**RETURN VALUES**

The `kvm_open()` function returns a non-null value suitable for use with subsequent kernel VM function calls. On failure, it returns NULL and no files are opened.

The `kvm_close()` function returns 0 on success; −1 on failure.

**FILES**

```
/dev/kmem
/dev/ksyms
/dev/mem
```

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

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<tr>
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<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

```
savecore(1M), exec(2), exit(2), pathconf(2), getloadavg(3C), kstat(3KSTAT),
kvm_getu(3KVM), kvm_nextproc(3KVM), kvm_nlist(3KVM), kvm_read(3KVM),
sysconf(3C), libkvm(3LIB), proc(4), attributes(5)
```

**NOTES**

Kernel core dumps should be examined on the platform on which they were created. While a 32-bit application running on a 64-bit kernel can examine a 32-bit core dump, a 64-bit application running on a 64-bit kernel cannot examine a kernel core dump from the 32-bit system.

Applications using `libkvm` are likely to be platform- and release-dependent.

On 32-bit systems, applications that use `libkvm` to access the running kernel must be 32-bit applications. On systems that support both 32-bit and 64-bit applications, applications that use the `libkvm` interfaces to access the running kernel must themselves be 64-bit applications.

Most of the traditional uses of `libkvm` have been superseded by more stable interfaces that allow the same information to be extracted more efficiently, yet independent of the kernel data model. For examples, see `sysconf(3C), proc(4), kstat(3KSTAT), getloadavg(3C), and pathconf(2).`
NAME
kvm_read, kvm_write, kvm_uread, kvm_uwrite, kvm_kread, kvm_kwrite – copy data
to or from a kernel image or running system

SYNOPSIS
#include <kvm.h>

ssize_t kvm_read(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);
ssize_t kvm_write(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);
ssize_t kvm_kread(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);
ssize_t kvm_kwrite(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);
ssize_t kvm_uread(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);
ssize_t kvm_uwrite(kvm_t *kd, uintptr_t addr, void *buf, size_t nbytes);

DESCRIPTION

kvm_kread() The kvm_kread() function transfers data from the kernel address space to the
address space of the process. nbytes bytes of data are copied from the kernel virtual
address given by addr to the buffer pointed to by buf.

kvm_kwrite() The kvm_kwrite() function is like kvm_kread(), except that the direction of the
transfer is reversed. To use this function, the kvm_open(3KVM) call that returned kd
must have specified write access.

kvm_uread() The kvm_uread() function transfers data from the address space of the processes
specified in the most recent kvm_getu(3KVM) call. nbytes bytes of data are copied
from the user virtual address given by addr to the buffer pointed to by buf.

kvm_uwrite() The kvm_uwrite() function is like kvm_uread(), except that the direction of the
transfer is reversed. To use this function, the kvm_open(3KVM) call that returned kd
must have specified write access. The address is resolved in the address space of the
process specified in the most recent kvm_getu(3KVM) call.

kvm_read() The kvm_read() function transfers data from the kernel image specified by kd (see
kvm_open(3KVM)) to the address space of the process. nbytes bytes of data are copied
from the kernel virtual address given by addr to the buffer pointed to by buf.

kvm_write() The kvm_write() function is like kvm_read(), except that the direction of data
transfer is reversed. To use this function, the kvm_open(3KVM) call that returned kd
must have specified write access. If a user virtual address is given, it is resolved in the
address space of the process specified in the most recent kvm_getu(3KVM) call.
kvm_read(3KVM)

**USAGE**  The use of `kvm_read()` and `kvm_write()` is strongly discouraged. On some platforms, there is considerable ambiguity over which address space is to be accessed by these functions, possibly leading to unexpected results. The `kvm_kread()`, `kvm_kwrite()`, `kvm_uread()`, and `kvm_uwrite()` functions are much more clearly defined in this respect.

**RETURN VALUES**  On success, these functions return the number of bytes actually transferred. On failure, they return -1.

**ATTRIBUTES**  See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**  `kvm_getu(3KVM)`, `kvm_nlist(3KVM)`, `kvm_open(3KVM)`, `attributes(5)`
NAME
lgamma, lgamma_r, gamma, gamma_r – log gamma function

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>
extern int signgam;

double lgamma(double x);
double lgamma_r(double x, int *signgamp);

DESCRIPTION
Both lgamma() and lgamma_r() return

\[ \ln |\Gamma(x)| \]

where

\[ \Gamma(x) = \int_0^\infty t^{x-1}e^{-t}dt \]

for \( x > 0 \) and

\[ \Gamma(x) = \pi/(\Gamma(1-x)\sin(\pi x)) \]

for \( x < 1. \)

lgamma() uses the external integer signgam to return the sign of \( |\Gamma(x)| \) while lgamma_r() uses the user-allocated space addressed by signgamp.

IDIOSYNCRASIES
In the case of lgamma(), do not use the expression signgam*exp(lgamma(x)) to compute

\[ g := \Gamma(x) \]

Instead compute lgamma() first:

\[ lg = \text{lgamma}(x); g = \text{signgam}\cdot\exp(lg); \]
only after \texttt{lgamma()} has returned can \texttt{signgam} be correct. Note that \(|-(x)| \) must
overflow when \( x \) is large enough, underflow when \(-x\) is large enough, and generate a
division by 0 exception at the singularities \( x \) a nonpositive integer.

\textbf{RETURN VALUES} 
For exceptional cases, \texttt{matherr(3M)} tabulates the values to be returned as dictated by
various Standards.

\textbf{ATTRIBUTES} 
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>See \texttt{NOTES} below.</td>
</tr>
</tbody>
</table>

\textbf{SEE ALSO} \texttt{matherr(3M)}, attributes(5)

\textbf{NOTES} 
Although \texttt{lgamma_r()} is not mentioned by POSIX.4a Draft 6, it was added to
complete the functionality provided by similar thread-safe functions. This interface is
subject to change to be compatible with the "spirit" of POSIX.4a when it is approved as
a standard.

When compiling multi-thread applications, the \_REENTRANT flag must be defined on
the compile line. This flag should only be used in multi-thread applications.

\texttt{lgamma()} is unsafe in multithreaded applications. \texttt{lgamma_r()} should be used
instead.
libdevinfo is a set of interfaces used to access device configuration data.

Device configuration data is organized as a tree of device nodes, defined as `di_node_t` in the `libdevinfo` interfaces. Each `di_node_t` represents a physical or logical (pseudo) device. Three types of data are associated with device nodes:

- data defined for all device nodes (attributes)
- properties specific to each device
- minor node data

All device nodes have a set of common attributes, such as a node name, an instance number, and a driver binding name. Common device node attributes are accessed by calling interfaces listed on the `di_binding_name(3DEVINFO)` man page. Each device node also has a physical path, which is accessed by calling `di_devfs_path(3DEVINFO)`.

Properties provide device specific information for device configuration and usage. Properties may be defined by software (`di_prop_t`) or by firmware (`di_prom_prop_t`). One way to access each `di_prop_t` is to make successive calls to `di_prop_next(3DEVINFO)` until `DI_PROP_NIL` is returned. For each `di_prop_t`, use interfaces on the `di_prop_bytes(3DEVINFO)` man page to obtain property names and values. Another way to access these properties is to call `di_prop_lookup_bytes(3DEVINFO)` to find the value of a property with a given name. Accessing a `di_prom_prop_t` is similar to accessing a `di_prop_t`, except that the interface names start with `di_prom_prop` and additional calls to `di_prom_init(3DEVINFO)` and `di_prom_fini(3DEVINFO)` are required.

Minor nodes contain information exported by the device for creating special files for the device. Each device node has 0 or more minor nodes associated with it. A list minor nodes (`di_minor_t`) may be obtained by making successive calls to `di_minor_next(3DEVINFO)` until `DI_MINOR_NIL` is returned. For each minor node, `di_minor_devt(3DEVINFO)` and related interfaces are called to get minor node data.

Using `libdevinfo` involves three steps:

- Creating a snapshot of the device tree
- Traversing the device tree to get information of interest
- Destroying the snapshot of the device tree

A snapshot of the device tree is created by calling `di_init(3DEVINFO)` and destroyed by calling `di_fini(3DEVINFO)`. An application may specify the data to be included in the snapshot (full or partial tree, include or exclude properties and minor nodes) and get a handle to the root of the device tree. See `di_init(3DEVINFO)` for details. The application then traverses the device tree in the snapshot to obtain device configuration data.
The device tree is normally traversed through parent-child-sibling linkage. Each device node contains references to its parent, its next sibling, and the first of its children. Given the di_node_t returned from di_init(3DEVINFO), one can find all children by first calling di_child_node(3DEVINFO), followed by successive calls to di_sibling_node(3DEVINFO), until DI_NODE_NIL is returned. By following this procedure recursively, an application can visit all device nodes contained in the snapshot. Two interfaces, di_walk_node(3DEVINFO) and di_walk_minor(3DEVINFO), are provided to facilitate device tree traversal. The di_walk_node(3DEVINFO) interface visits all device nodes and executes a user-supplied callback function for each node visited. The di_walk_minor(3DEVINFO) does the same for each minor node in the device tree.

An alternative way to traverse the device tree is through the per-driver device node linkage. Device nodes contain a reference to the next device node bound to the same driver. Given the di_node_t returned from di_init(3DEVINFO), an application can find all device nodes bound to a driver by first calling di_drv_first_node(3DEVINFO), followed by successive calls to di_drv_next_node(3DEVINFO) until DI_NODE_NIL is returned. Note that traversing the per-driver device node list works only when the snapshot includes all device nodes.

See libdevinfo(3LIB) for a complete list of libdevinfo interfaces. See di_init(3DEVINFO) for examples of libdevinfo usage. See Writing Device Drivers for details of Solaris device configuration.

EXAMPLES

EXAMPLE 1 Information Accessible Through libdevinfo Interfaces

The following example illustrates the kind of information accessible through libdevinfo interfaces for a device node representing a hard disk (sd2):

Attributes
  node name: sd
  instance: 2
  physical path: /sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@2,0

Properties
  target=2
  lun=0

Minor nodes
  (disk partition /dev/dsk/c0t2d0s0)
    name: a
    dev_t: 0x0080010 (32/16)
    spectype: IF_BLK (block special)
  (disk partition /dev/rdsk/c0t2d0s2)
    name: c.raw
    dev_t: 0x0080012 (32/18)
    spectype: IF_CHR (character special)
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO

devlinks(1M), prtconf(1M),
di_binding_name(3DEVINFO), di_child_node(3DEVINFO),
di_devfs_path(3DEVINFO), di_drv_first_node(3DEVINFO),
di_drv_next_node(3DEVINFO), di_fini(3DEVINFO), di_init(3DEVINFO), di_minor_devt(3DEVINFO),
di_minor_next(3DEVINFO), di_prom_fini(3DEVINFO), di_prom_init(3DEVINFO),
di_prop_lookup_bytes(3DEVINFO), di_prop_next(3DEVINFO),
di_sibling_node(3DEVINFO), di_walk_minor(3DEVINFO),
di_walk_node(3DEVINFO), libdevinfo(3LIB), attributes(5)

Writing Device Drivers
NAME | libnvpair – library of name-value pair functions  
SYNOPSIS | cc [flag ...] file ...-lnvpair [library ...]  
include <libnvpair.h>  
DESCRIPTION | The libnvpair library exports a set of functions for managing name-value pairs.  
The library defines two opaque handles:  
nvpair_t handle to a name-value pair  
nvlist_t handle to a list of name-value pairs  
The library supports the following operations:  
- Allocate and free an nvlist_t.  
- Add and remove an nvpair_t from a list.  
- Search nvlist_t for a specified name pair.  
- Pack an nvlist_t into a contiguous buffer.  
- Expand a packed nvlist into a searchable nvlist_t.  
See libnvpair(3LIB) for a complete list of libnvpair functions.  
ATTRIBUTES | See attributes(5) for descriptions of the following attributes:  
| ATTRIBUTE TYPE | ATTRIBUTE VALUE  
| Interface Stability | Evolving  
| MT-Level | MT-Safe  
SEE ALSO | libnvpair(3LIB), attributes(5)
The PICL interface is the platform-independent interface for clients to access the platform information. The set of functions and data structures of this interface are defined in the `<picl.h>` header.

The information published through PICL is organized in a tree, where each node is an instance of a well-defined PICL class. The functions in the PICL interface allow the clients to access the properties of the nodes.

The name of the base PICL class is `picl`, which defines a basic set of properties that all nodes in the tree must possess. The following table shows the property set of a `picl` class node.

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Property Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>The name of the node</td>
</tr>
<tr>
<td>_class</td>
<td>The PICL class name of the node</td>
</tr>
<tr>
<td>_parent</td>
<td>Node handle of the parent node</td>
</tr>
<tr>
<td>_child</td>
<td>Node handle of the first child node</td>
</tr>
<tr>
<td>_peer</td>
<td>Node handle of the next peer node</td>
</tr>
</tbody>
</table>

Property names with a leading underscore (`_`) are reserved for use by the PICL framework. The property names _class, _parent, _child, and _peer are reserved names of the PICL framework, and are used to refer to a node's parent, child, and peer nodes, respectively. A client shall access a reserved property by their names only as they do not have an associated handle. The property name is not a reserved property, but a mandatory property for all nodes.

Properties are classified into different types. Properties of type integer, unsigned-integer, and float have integer, unsigned integer, and floating-point values, respectively. A table property type has the handle to a table as its value. A table is a matrix of properties. A reference property type has a handle to a node in the tree as its value. A reference property may be used to establish an association between any two nodes in the tree. A timestamp property type has the value of time in seconds since Epoch. A bytearray property type has an array of bytes as its value. A charstring property type has a null (`\0`) terminated sequence of ASCII characters. The size of a property specifies the size of its value in bytes. A void property type denotes a property that exists but has no value.

The following table lists the different PICL property types enumerated in `picl_prop_type_t`. 

---

**NAME**
libpicl – PICL interface library

**SYNOPSIS**
```
cc [ flag . . . ] file . . . -lpicl [ library . . . ]
#include <picl.h>
```
<table>
<thead>
<tr>
<th>Property Type</th>
<th>Property Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICL_PTYPE_VOID</td>
<td>None</td>
</tr>
<tr>
<td>PICL_PTYPE_INT</td>
<td>Is an integer</td>
</tr>
<tr>
<td>PICL_PTYPE_UNSIGNED_INT</td>
<td>Is an unsigned integer</td>
</tr>
<tr>
<td>PICL_PTYPE_FLOAT</td>
<td>Is a floating-point number</td>
</tr>
<tr>
<td>PICL_PTYPE_REFERENCE</td>
<td>Is a PICL node handle</td>
</tr>
</tbody>
</table>

Reference properties may be used by plug-ins to publish properties in nodes of different classes. To make these property names unique, their names must be prefixed by `_picl_class_name_`, where `picl_class_name` is the class name of the node referenced by the property. Valid PICL class names are combinations of uppercase and lowercase letters ‘a’ through ‘z’, digits ‘0’ through ‘9’, and ‘-’ (minus) characters. The string that follows the `_picl_class_name_` portion of a reference property name may be used to indicate a specific property in the referenced class, when applicable.

The information about a node’s property that can be accessed by PICL clients is defined by the `picl_propinfo_t` structure.

```c
typedef struct {
    picl_prop_type_t type; /* property type */
    unsigned int accessmode; /* read, write */
    size_t size; /* item size or string size */
    char name[PICL_PROPNAMELEN_MAX];
} picl_propinfo_t;
```

The `type` member specifies the property value type and the `accessmode` specifies the allowable access to the property. The plug-in module that adds the property to the PICL tree also sets the access mode of that property. The volatile nature of a property created by the plug-in is not visible to the PICL clients. The `size` member specifies the number of bytes occupied by the property’s value. The maximum allowable size of property value is `PICL_PROPSIZE_MAX`, which is set to 512KB.

The plug-in module may publish a property granting a combination of the following access modes to the clients:

```c
#define PICL_READ 0x1 /* read permission */
#define PICL_WRITE 0x2 /* write permission */
```

The maximum length of the name of any property is specified by `PICL_PROPNAMELEN_MAX`.

The maximum length of a PICL class name is specified by `PICL_CLASSNAMELEN_MAX`. 

---

libpicl(3PICL)

258 man pages section 3: Extended Library Functions • Last Revised 28 Mar 2000
libpicl(3PICL)

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

libpicl(3LIB), attributes(5)
libpicltree(3PICLTREE)

NAME
libpicltree – PTree and Plug-in Registration interface library

SYNOPSIS
cc [flag ...] file ... -lpicltree [library ...]
#include <picltree.h>

DESCRIPTION
The PTree interface is the set of functions and data structures to access and manipulate
the PICL tree. The daemon and the plug-in modules use the PTree interface.

The Plug-in Registration interface is used by the plug-in modules to register
themselves with the daemon.

The plug-in modules create the nodes and properties of the tree. At the time of
creating a property, the plug-ins specify the property information in the
ptree_propinfo_t structure defined as:

```c
typedef struct {
    int version; /* version */
    picl_propinfo_t piclinfo; /* info to clients */
    int (*read)(ptree_rarg_t *arg, void *buf);
        /* read access function for */
        /* volatile prop */
    int (*write)(ptree_warg_t *arg, const void *buf);
        /* write access function for */
        /* volatile prop */
} ptree_propinfo_t;
```

See libpicl(3PICL) for more information on PICL tree nodes and properties.

The maximum size of a property value cannot exceed PICL_PROPSIZE_MAX. It is
currently set to 512KB.

Volatile Properties
In addition to PICL_READ and PICL_WRITE property access modes, the plug-in
modules specify whether a property is volatile or not by setting the bit
PICL_VOLATILE.

```c
#define PICL_VOLATILE 0x4
```

For a volatile property, the plug-in module provides the access functions to read
and/or write the property in the ptree_propinfo_t argument passed when
creating the property.

The daemon invokes the access functions of volatile properties when clients access
their values. Two arguments are passed to the read access functions. The first
argument is a pointer to ptree_rarg_t, which contains the handle of the node, the
handle of the accessed property and the credentials of the caller. The second argument
is a pointer to the buffer where the value is to be copied.

```c
typedef struct {
    picl_nodehdl_t nodeh;
    picl_prophdl_t proph;
    door_cred_t cred;
} ptree_rarg_t;
```

The prototype of the read access function for volatile property is:
int read(ptree_rarg_t *rarg, void *buf);

The read function returns PICL_SUCCESS to indicate successful completion.

Similarly, when a write access is performed on a volatile property, the daemon invokes the write access function provided by the plug-in for that property and passes it two arguments. The first argument is a pointer to ptree_warg_t, which contains the handle to the node, the handle of the accessed property and the credentials of the caller. The second argument is a pointer to the buffer containing the value to be written.

typedef struct {
    picl_nodehdl_t nodeh;
    picl_prophdl_t proph;
    door_cred_t cred;
} ptree_warg_t;

The prototype of the write access function for volatile property is:

int write(ptree_warg_t *warg, const void *buf);

The write function returns PICL_SUCCESS to indicate successful completion.

For all volatile properties, the ‘size’ of the property must be specified to be the maximum possible size of the value. The maximum size of the value cannot exceed PICL_PROPSIZE_MAX. This allows a client to allocate a sufficiently large buffer before retrieving a volatile property’s value.

Plug-in Modules

Plug-in modules are shared objects that are located in well-known directories for the daemon to locate and load them. Plug-in module’s are located in the one of the following plug-in directories depending on the platform-specific nature of the data they collect and publish.

/usr/platform/picl/plugins/`uname -i`
/usr/platform/picl/plugins/`uname -m`
/usr/lib/picl/plugins/

A plug-in module may specify its dependency on another plug-in module using the -l linker option. The plug-ins are loaded by the PICL daemon using dlopen(3DL) according to the specified dependencies. Each plug-in module must define a .init section, which is executed when the plug-in module is loaded, to register themselves with the daemon. See picld_plugin_register(3PICLTREE) for more information on plug-in registration.

The plug-in modules may use the picld_log(3PICLTREE) function to log their messages to the system log file.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:
libpicltree(3PICLTREE)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO libpicl(3PICL), libpicltree(3LIB), picld_log(3PICLTREE), picld_plugin_register(3PICLTREE), attributes(5)
The libtnfctl library provides an API to control TNF ("Trace Normal Form") probes within a process or the kernel. See tracing(3TNF) for an overview of the Solaris tracing architecture. The client of libtnfctl controls probes in one of four modes:

- **Internal mode**: The target is the controlling process itself; that is, the client controls its own probes.
- **Direct mode**: The target is a separate process; a client can either exec(2) a program or attach to a running process for probe control. The libtnfctl library uses proc(4) on the target process for probe and process control in this mode, and additionally provides basic process control features.
- **Indirect mode**: The target is a separate process, but the controlling process is already using proc(4) to control the target, and hence libtnfctl cannot use those interfaces directly. Use this mode to control probes from within a debugger. In this mode, the client must provide a set of functions that libtnfctl can use to query and update the target process.
- **Kernel mode**: The target is the Solaris kernel.

A process is controlled "externally" if it is being controlled in either direct mode or indirect mode. Alternatively, a process is controlled "internally" when it uses internal mode to control its own probes.

There can be only one client at a time doing probe control on a given process. Therefore, it is not possible for a process to be controlled internally while it is being controlled externally. It is also not possible to have a process controlled by multiple external processes. Similarly, there can be only one process at a time doing kernel probe control. Note, however, that while a given target may only be controlled by one libtnfctl client, a single client may control an arbitrary number of targets. That is, it is possible for a process to simultaneously control its own probes, probes in other processes, and probes in the kernel.

The following tables denote the modes applicable to all libtnfctl interfaces (INT = internal mode; D = direct mode; IND = indirect mode; K = kernel mode).

These interfaces create handles in the specified modes:

<table>
<thead>
<tr>
<th>Function</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnfctl_internal_open()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_exec_open()</td>
<td>D</td>
</tr>
<tr>
<td>tnfctl_pid_open()</td>
<td>D</td>
</tr>
</tbody>
</table>
libtnfctl(3TNF)

<table>
<thead>
<tr>
<th>Function</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnfctl_indirect_open()</td>
<td>IND</td>
</tr>
<tr>
<td>tnfctl_kernel_open()</td>
<td>K</td>
</tr>
</tbody>
</table>

These interfaces are used with the specified modes:

<table>
<thead>
<tr>
<th>Function</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnfctl_continue()</td>
<td>D</td>
</tr>
<tr>
<td>tnfctl_probe_connect()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_probe_disconnect_all()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_trace_attr_get()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_buffer_alloc()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_register_funcs()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_probe_apply()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_probe_apply_ids()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_probe_state_get()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctlProbe_enable()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctlProbe_disable()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_trace()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_check_libs()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_close()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_strerror()</td>
<td>INT</td>
</tr>
<tr>
<td>tnfctl_buffer_dealloc()</td>
<td>K</td>
</tr>
<tr>
<td>tnfctl_trace_state_set()</td>
<td>K</td>
</tr>
<tr>
<td>tnfctl_filter_state_set()</td>
<td>K</td>
</tr>
<tr>
<td>tnfctl_filter_list_get()</td>
<td>K</td>
</tr>
<tr>
<td>tnfctl_filter_list_add()</td>
<td>K</td>
</tr>
<tr>
<td>tnfctl_filter_list_delete()</td>
<td>K</td>
</tr>
</tbody>
</table>

When using libtnfctl, the first task is to create a handle for controlling probes. The tnfctl_internal_open() function creates an internal mode handle for controlling probes in the same process, as described above. The tnfctl_pid_open() and tnfctl_exec_open() functions create handles in direct mode. The tnfctl_indirect_open() function creates an indirect mode handle, and the
libtnfctl(3TNF)

The `tnfctl_kernel_open()` function creates a kernel mode handle. A handle is required for use in nearly all other `libtnfctl` functions. The `tnfctl_close()` function releases the resources associated with a handle.

The `tnfctl_continue()` function is used in direct mode to resume execution of the target process.

The `tnfctl_buffer_alloc()` function allocates a trace file or, in kernel mode, a trace buffer.

The `tnfctl_probe_apply()` and `tnfctl_probe_apply_ids()` functions call a specified function for each probe or for a designated set of probes.

The `tnfctl_register_funcs()` function registers functions to be called whenever new probes are seen or probes have disappeared, providing an opportunity to do one-time processing for each probe.

The `tnfctl_check_libs()` function is used primarily in indirect mode to check whether any new probes have appeared, that is, they have been made available by `dlopen(3DL)`, or have disappeared, that is, they have disassociated from the process by `dlclose(3DL)`.

The `tnfctl_probe_enable()` and `tnfctl_probe_disable()` functions control whether the probe, when hit, will be ignored.

The `tnfctl_probe_trace()` and `tnfctl_probe_untrace()` functions control whether an enabled probe, when hit, will cause an entry to be made in the trace file.

The `tnfctl_probe_connect()` and `tnfctl_probe_disconnect_all()` functions control which functions, if any, are called when an enabled probe is hit.

The `tnfctl_probe_state_get()` function returns information about the status of a probe, such as whether it is currently enabled.

The `tnfctl_trace_attrs_get()` function returns information about the tracing session, such as the size of the trace buffer or trace file.

The `tnfctl_strerror()` function maps a `tnfctl` error code to a string, for reporting purposes.

The remaining functions apply only to kernel mode.

The `tnfctl_trace_state_set()` function controls the master switch for kernel tracing. See `prex(1)` for more details.

The `tnfctl_filter_state_set()`, `tnfctl_filter_list_get()`, `tnfctl_filter_list_add()`, and `tnfctl_filter_list_delete()` functions allow a set of processes to be specified for which probes will not be ignored when hit. This prevents kernel activity caused by uninteresting processes from cluttering up the kernel’s trace buffer.
libtnfctl(3TNF)

The `tnfctl_buffer_dealloc()` function deallocates the kernel’s internal trace buffer.

**RETURN VALUES**

Upon successful completion, these functions return `TNFCTL_ERR_NONE`.

**ERRORS**

The error codes for libtnfctl are:

- `TNFCTL_ERR_ACCES`: Permission denied.
- `TNFCTL_ERR_NOTARGET`: The target process completed.
- `TNFCTL_ERR_ALLOCFAIL`: A memory allocation failure occurred.
- `TNFCTL_ERR_INTERNAL`: An internal error occurred.
- `TNFCTL_ERR_SIZEETOOSMALL`: The requested trace size is too small.
- `TNFCTL_ERR_SIZEETOOBIG`: The requested trace size is too big.
- `TNFCTL_ERR_BADARG`: Bad input argument.
- `TNFCTL_ERR_NOTDYNAMIC`: The target is not a dynamic executable.
- `TNFCTL_ERR_NOLIBTNFPROBE`: `libtnfprobe.so` not linked in target.
- `TNFCTL_ERR_BUF BROKEN`: Tracing is broken in the target.
- `TNFCTL_ERR_BUF EXISTS`: A buffer already exists.
- `TNFCTL_ERR_NOBUF`: No buffer exists.
- `TNFCTL_ERR_BADDEALLOC`: Cannot deallocate buffer.
- `TNFCTL_ERR_NOPROCESS`: No such target process exists.
- `TNFCTL_ERR_F ILENO TFOUND`: File not found.
- `TNFCTL_ERR_BUSY`: Cannot attach to process or kernel because it is already tracing.
- `TNFCTL_ERR INVALIDPROBE`: Probe no longer valid.
- `TNFCTL_ERR_USR1`: Error code reserved for user.
- `TNFCTL_ERR_USR2`: Error code reserved for user.
- `TNFCTL_ERR_USR3`: Error code reserved for user.
- `TNFCTL_ERR_USR4`: Error code reserved for user.
- `TNFCTL_ERR_USR5`: Error code reserved for user.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>SUNWtnfc</td>
</tr>
</tbody>
</table>
libtnfctl(3TNF)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO
prex(1), exec(2), dlclose(3DL), dlopen(3DL), TNF_PROBE(3TNF),
tnfctl_buffer_alloc(3TNF), tnfctl_buffer_dealloc(3TNF),
tnfctl_check_libs(3TNF), tnfctl_close(3TNF), tnfctl_continue(3TNF),
tnfctl_internal_open(3TNF), tnfctl_exec_open(3TNF),
tnfctl_filter_list_add(3TNF), tnfctl_filter_list_delete(3TNF),
tnfctl_filter_list_get(3TNF), tnfctl_filter_state_set(3TNF),
tnfctl_kernel_open(3TNF), tnfctl_pid_open(3TNF),
tnfctl_probe_apply(3TNF), tnfctl_probe_apply_ids(3TNF),
tnfctl_probe_connect(3TNF), tnfctl_probe_disable(3TNF),
tnfctl_probe_enable(3TNF), tnfctl_probe_state_get(3TNF),
tnfctl_probe_trace(3TNF), tnfctl_probe_untrace(3TNF),
tnfctl_indirect_open(3TNF), tnfctl_register_funcs(3TNF),
tnfctl_strerror(3TNF), tnfctl_trace_attrs_get(3TNF),
tnfctl_trace_state_set(3TNF), libtnfctl(3LIB), proc(4), attributes(5)

Linker and Libraries Guide

NOTES
This API is MT-Safe. Multiple threads may concurrently operate on independent tnfctl handles, which is the typical behavior expected. The libtnfctl library does not support multiple threads operating on the same tnfctl handle. If this is desired, it is the client's responsibility to implement locking to ensure that two threads that use the same tnfctl handle are not simultaneously in a libtnfctl interface.
NAME
log10 – base 10 logarithm function

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double log10(double x);

DESCRIPTION
The log10() function computes the base 10 logarithm of x, log10(x). The value of x
must be positive.

RETURN VALUES
Upon successful completion, log10() returns the base 10 logarithm of x.

If x is NaN, NaN is returned. If x is less than 0, -HUGE_VAL or NaN is returned, and
errno is set to EDOM. If x is 0, -HUGE_VAL is returned and errno may be set to
ERANGE.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by
Standards other than XPG4.

ERRORS
The log10() function will fail if:

EDOM The value of x is negative.

The log10() function may fail if:

ERANGE The value of x is 0.

No other errors will occur.

USAGE
An application wishing to check for error situations should set errno to 0 before
calling log10(). If errno is non-zero on return, or the return value is NaN, an error
has occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
isnan(3M), log(3M), matherr(3M), pow(3M), attributes(5), standards(5)
The `log1p()` function computes \( \log_e(1.0 + x) \). The value of \( x \) must be greater than \(-1.0\).

Upon successful completion, `log1p()` returns the natural logarithm of \( 1.0 + x \).

If \( x \) is NaN, `log1p()` returns NaN.

If \( x \) is less than \(-1.0\), `log1p()` returns `-HUGE_VAL` or NaN and sets `errno` to EDOM.

If \( x \) is \(-1.0\), `log1p()` returns `-HUGE_VAL` and may set `errno` to ERANGE.

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by Standards other than XPG4.

The `log1p()` function will fail if:

- **EDOM** The value of \( x \) is less than \(-1.0\).

The `log1p()` function may fail and set `errno` to:

- **ERANGE** The value of \( x \) is \(-1.0\).

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
log(3M)

NAME log – natural logarithm function

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double log(double x);

DESCRIPTION The log() function computes the natural logarithm of x, log_e(x). The value of x must be positive.

RETURN VALUES Upon successful completion, log() returns the natural logarithm of x.

If x is NaN, NaN is returned.

If x is less than 0, -HUGE_VAL or NaN is returned and errno is set to EDOM.

If x is 0, -HUGE_VAL is returned and errno may be set to ERANGE.

In IEEE 754 mode (the -xlibmieee cc compilation option), if x is Inf or a quiet NaN, x is returned; if x is a signaling NaN, a quiet NaN is returned and the invalid operation exception is raised; if x is 1, 0 is returned; for all other positive x, a normalized number is returned and the inexact exception is raised.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS The log() function will fail if:

EDOM The value of x is negative.

The log() function may fail if:

ERANGE The value of x is 0.

No other errors will occur.

USAGE An application wishing to check for error situations should set errno to 0 before calling log(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO exp(3M), isnan(3M), log10(3M), log1p(3M), matherr(3M), attributes(5), standards(5)
logb – radix-independent exponent

cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double logb(double x);

The logb() function computes the exponent of x, which is the integral part of \( \log_r |x| \), as a signed floating point value, for non-zero x, where r is the radix of the machine’s floating-point arithmetic.

Upon successful completion, logb() returns the exponent of x.

If x is 0.0, logb() returns -HUGE_VAL and sets errno to EDOM.

If x is ±Inf, logb() returns +Inf.

If x is NaN, logb() returns NaN.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by various Standards.

The logb() function will fail if:

EDOM The x argument is 0.0.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO ilogb(3M), matherr(3M), attributes(5)
maillock(3MAIL)

NAME
maillock, mailunlock, touchlock – functions to manage lockfile(s) for user’s mailbox

SYNOPSIS
cc [ flag ... ] file ... -lmail [ library ... ]
#include <maillock.h>

int maillock(const char *user, int retrycnt);
void mailunlock(void);
void touchlock(void);

DESCRIPTION
The maillock() function attempts to create a lockfile for the user’s mail file. If a
lockfile already exists, and it has not been modified in the last 5 minutes, maillock() will remove the lockfile and set its own lockfile.

It is crucial that programs locking mail files refresh their locks at least every three
minutes to maintain the lock. Refresh the lockfile by calling the touchlock() function with no arguments.

The algorithm used to determine the age of the lockfile takes into account clock drift
between machines using a network file system. A zero is written into the lockfile so
that the lock will be respected by systems running the standard version of System V.

If the lockfile has been modified in the last 5 minutes the process will sleep until the
lock is available. The sleep algorithm is to sleep for 5 seconds times the attempt
number. That is, the first sleep will be for 5 seconds, the next sleep will be for 10
seconds, etc. until the number of attempts reaches retrycnt.

When the lockfile is no longer needed, it should be removed by calling
mailunlock().

The user argument is the login name of the user for whose mailbox the lockfile will be
created. maillock() assumes that user’s mail files are in the “standard” place as
defined in <maillock.h>.

RETURN VALUES
Upon successful completion, maillock() returns 0. Otherwise it returns −1.

FILES
/var/mail/* user mailbox files
/var/mail/* .lock user mailbox lock files

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO
libmail(3LIB), attributes(5)
The `mailunlock()` function will only remove the lockfile created from the most previous call to `maillock()`. Calling `maillock()` for different users without intervening calls to `mailunlock()` will cause the initially created lockfile(s) to remain, potentially blocking subsequent message delivery until the current process finally terminates.
The System V Interface Definition, Third Edition (SVID3) specifies that certain libm functions call matherr() when exceptions are detected. Users may define their own mechanisms for handling exceptions, by including a function named matherr() in their programs. The matherr() function is of the form described above. When an exception occurs, a pointer to the exception structure exc will be passed to the user-supplied matherr() function. This structure, which is defined in the <math.h> header file, is as follows:

```
struct exception {
    int type;
    char *name;
    double arg1, arg2, retval;
};
```

The type member is an integer describing the type of exception that has occurred, from the following list of constants (defined in the header file):

- **DOMAIN**: argument domain exception
- **SING**: argument singularity
- **OVERFLOW**: overflow range exception
- **UNDERFLOW**: underflow range exception
- **TLOSS**: total loss of significance
- **PLOSS**: partial loss of significance

Note that both TLOSS and PLOSS reflect limitations of particular algorithms for trigonometric functions that suffer abrupt declines in accuracy at definite boundaries. Since the implementation does not suffer such abrupt declines, PLOSS is never signaled. TLOSS is signaled for Bessel functions only to satisfy SVID3 requirements.

The name member points to a string containing the name of the function that incurred the exception. The arg1 and arg2 members are the arguments with which the function was invoked. retval is set to the default value that will be returned by the function unless the user’s matherr() sets it to a different value.

If the user’s matherr() function returns non-zero, no exception message will be printed, and errno will not be set.

When an application is built as a SVID3 conforming application (see standards(5)), if matherr() is not supplied by the user, the default matherr exception-handling mechanisms, summarized in the table below, will be invoked upon exception:
In general, **errno** is not a reliable error indicator in that it may be unexpectedly set by a function in a handler for an asynchronous signal.

<table>
<thead>
<tr>
<th>&lt;math.h&gt; type</th>
<th>DOMAIN</th>
<th>SING</th>
<th>OVERFLOW</th>
<th>UNDERFLOW</th>
<th>TLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>errno</td>
<td>EDOM</td>
<td>EDOM</td>
<td>ERANGE</td>
<td>ERANGE</td>
<td>ERANGE</td>
</tr>
<tr>
<td>IEEE Exception</td>
<td>Invalid Operation</td>
<td>Division by Zero</td>
<td>Overflow</td>
<td>Underflow</td>
<td>–</td>
</tr>
<tr>
<td>fp_exception_type</td>
<td>fp_invalid</td>
<td>fp_division</td>
<td>fp_overflow</td>
<td>fp_underflow</td>
<td>–</td>
</tr>
<tr>
<td>ACOS, ASIN (</td>
<td>x</td>
<td>&gt; 1):</td>
<td>Md, 0.0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>ACOSH (x &lt; 1), ATANH (</td>
<td>x</td>
<td>&gt; 1):</td>
<td>NaN</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>ATAN2 (0,0):</td>
<td>Md, 0.0</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>COSH, SINH:</td>
<td>–</td>
<td>–</td>
<td>±HUGE</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>EXP:</td>
<td>–</td>
<td>–</td>
<td>+HUGE</td>
<td>0.0</td>
<td>–</td>
</tr>
<tr>
<td>FMOD (x,0):</td>
<td>x</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>HYPOT:</td>
<td>–</td>
<td>–</td>
<td>+HUGE</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>J0, J1, JN (</td>
<td>x</td>
<td>&gt; X_TLOSS):</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>LGAMMA:</td>
<td>–</td>
<td>–</td>
<td>+HUGE</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>usual cases</td>
<td>–</td>
<td>–</td>
<td>+HUGE</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>(x = 0 or –integer)</td>
<td>–</td>
<td>Ms, +HUGE</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>LOG, LOG10:</td>
<td>Md, –HUGE</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>(x &lt; 0)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
Matherr(3M)

<table>
<thead>
<tr>
<th>&lt;math.h&gt; type</th>
<th>DOMAIN</th>
<th>SING</th>
<th>OVERFLOW</th>
<th>UNDERFLOW</th>
<th>TLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x = 0)</td>
<td>−</td>
<td>Ms, −HUGE</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>POW:</td>
<td>−</td>
<td>−</td>
<td>±HUGE</td>
<td>±0.0</td>
<td>−</td>
</tr>
<tr>
<td>usual cases</td>
<td>−</td>
<td>−</td>
<td>±HUGE</td>
<td>±0.0</td>
<td>−</td>
</tr>
<tr>
<td>(x &lt; 0) ** (y not an integer)</td>
<td>Md, 0.0</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>0 ** 0</td>
<td>Md, 0.0</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>0 ** (y &lt; 0)</td>
<td>Md, 0.0</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>REMAINDER (x,0):</td>
<td>NaN</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>SCALB:</td>
<td>−</td>
<td>−</td>
<td>±HUGE_VAL</td>
<td>±0.0</td>
<td>−</td>
</tr>
<tr>
<td>SQRT (x &lt; 0):</td>
<td>Md, 0.0</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Y0, Y1, YN:</td>
<td>−</td>
<td></td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>(x &lt; 0)</td>
<td>Md, −HUGE</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>(x = 0)</td>
<td>−</td>
<td>Md, −HUGE</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>(x &gt; X_TLOSS)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>Mt, 0.0</td>
</tr>
</tbody>
</table>

**Abbreviations**

- Md: Message is printed (DOMAIN error).
- Ms: Message is printed (SING error).
- Mt: Message is printed (TLOSS error).
- NaN: IEEE NaN result and invalid operation exception.
- HUGE: Maximum finite single-precision floating-point number.
- HUGE_VAL: IEEE ∞ result and division-by-zero exception.
- X_TLOSS: The value X_TLOSS is defined in <values.h>.

The interaction of IEEE arithmetic and matherr() is not defined when executing under IEEE rounding modes other than the default round to nearest: matherr() is not always called on overflow or underflow, and the matherr() may return results that differ from those in this table.

The X/Open System Interfaces and Headers (XSH) Issue 3 and later revisions of that specification no longer sanctions the use of the matherr() interface. The following table summarizes the values returned in the exceptional cases. In general, XSH dictates that as long as one of the input argument(s) is a NaN, NaN shall be returned. In particular, pow(NaN, 0) = NaN.

---

276 man pages section 3: Extended Library Functions • Last Revised 23 Sep 1997
## CAE SPECIFICATION ERROR HANDLING PROCEDURES

(compile with cc -Xa)

<table>
<thead>
<tr>
<th><code>&lt;math.h&gt;</code> type</th>
<th>DOMAIN</th>
<th>SING</th>
<th>OVERFLOW</th>
<th>UNDERFLOW</th>
<th>TLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>errno</code></td>
<td>EDOM</td>
<td>EDOM</td>
<td>ERANGE</td>
<td>ERANGE</td>
<td>ERANGE</td>
</tr>
<tr>
<td>ACOS, ASIN (</td>
<td>x</td>
<td>&gt; 1):</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ATAN2 (0,0):</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>COSH, SINH:</td>
<td>-</td>
<td>-</td>
<td>{±HUGE_VAL}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EXP:</td>
<td>-</td>
<td>-</td>
<td>[+HUGE_VAL]</td>
<td>[0.0]</td>
<td>-</td>
</tr>
<tr>
<td>FMOD (x,0):</td>
<td>[NaN]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HYPT:</td>
<td>-</td>
<td>-</td>
<td>[+HUGE_VAL]</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>J0, J1, JN (</td>
<td>x</td>
<td>&gt; X_TLOSS):</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LGAMMA:</td>
<td>-</td>
<td>-</td>
<td>{+HUGE_VAL}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LOG, LOG10:</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(x &lt; 0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(x = 0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>POW:</td>
<td>-</td>
<td>-</td>
<td>±HUGE_VAL</td>
<td>±0.0</td>
<td>-</td>
</tr>
<tr>
<td>usual cases</td>
<td>-</td>
<td>-</td>
<td>±HUGE_VAL</td>
<td>±0.0</td>
<td>-</td>
</tr>
<tr>
<td>(x &lt; 0) ** (y not an integer)</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0 ** 0</td>
<td>[1.0]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0 ** (y &lt; 0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SQRT (x &lt; 0):</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Y0, Y1, YN:</td>
<td>-</td>
<td>-</td>
<td>{±HUGE_VAL}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(x &lt; 0)</td>
<td>-</td>
<td>-</td>
<td>{±HUGE_VAL}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(x = 0)</td>
<td>-</td>
<td>-</td>
<td>{±HUGE_VAL}</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Abbreviations

- **errno** is not to be relied upon in all braced cases.
- **NaN**: IEEE NaN result and invalid operation exception.
- **HUGE_VAL**: IEEE $\infty$ result and division-by-zero exception.
- **X_TLOSS**: The value X_TLOSS is defined in `<values.h>`.

The ANSI/ISO-C standard covers a small subset of the CAE specification.

The following table summarizes the values returned in the exceptional cases.

<table>
<thead>
<tr>
<th><strong>&lt;math.h&gt; type</strong></th>
<th><strong>DOMAIN</strong></th>
<th><strong>SING</strong></th>
<th><strong>OVERFLOW</strong></th>
<th><strong>UNDERFLOW</strong></th>
<th><strong>TLOSS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$(x &gt; X_TLOSS)$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### ANSI/ISO-C Error Handling Procedures

(compile with `cc -Xc`)

<table>
<thead>
<tr>
<th><strong>&lt;math.h&gt; type</strong></th>
<th><strong>DOMAIN</strong></th>
<th><strong>SING</strong></th>
<th><strong>OVERFLOW</strong></th>
<th><strong>UNDERFLOW</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>errno</strong></td>
<td>EDOM</td>
<td>EDOM</td>
<td>ERANGE</td>
<td>ERANGE</td>
</tr>
<tr>
<td><strong>ACOS</strong>, <strong>ASIN</strong></td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>ATAN2 (0,0)</strong></td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>EXP</strong></td>
<td>-</td>
<td>-</td>
<td>+HUGE_VAL</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>FMOD (x,0)</strong></td>
<td>NaN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>LOG, LOG10</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(x &lt; 0)$</td>
<td>-HUGE_VAL</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$(x = 0)$</td>
<td>-</td>
<td>-HUGE_VAL</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>POW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>usual cases</td>
<td>-</td>
<td>-</td>
<td>$\pm$HUGE_VAL</td>
<td>$\pm$0.0</td>
</tr>
<tr>
<td>$(x &lt; 0)$ <strong>(y not an integer)</strong></td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0 <strong>(y &lt; 0)</strong></td>
<td>-HUGE_VAL</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>SQRT (x &lt; 0)</strong></td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Abbreviations

- **NaN**: IEEE NaN result and invalid operation exception.
- **HUGE_VAL**: IEEE $\infty$ result and division-by-zero exception.
EXAMPLES

**EXAMPLE 1** Example of `matherr()` function

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int
matherr(struct exception *x) {  
    switch (x->type) {  
        case DOMAIN:  
            /* change sqrt to return sqrt(-arg1), not NaN */  
            if (!strcmp(x->name, "sqrt")) {  
                x->retval = sqrt(-x->arg1);  
                return (0); /* print message and set errno */  
            } /* FALLTHRU */  
        case SING:  
            /* all other domain or sing exceptions, print message and */  
            /* abort */  
            fprintf(stderr, "domain exception in %s\n", x->name);  
            abort( );  
            break;  
    }  
    return (0); /* all other exceptions, execute default procedure */  
}
```

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>Attribute Type</th>
<th>Attribute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

attributes(5), standards(5)
### m_create_layout(3LAYOUT)

#### NAME
m_create_layout – initialize a layout object

#### SYNOPSIS
c
cc [ flag... ] file... -llayout [ library... ]
#include <sys/layout.h>

```
LayoutObject m_create_layout(const AttrObject attrobj, const char* modifier);
```

#### DESCRIPTION
The `m_create_layout()` function creates a `LayoutObject` associated with the locale identified by `attrobj`.

The `LayoutObject` is an opaque object containing all the data and methods necessary to perform the layout operations on context-dependent or directional characters of the locale identified by the `attrobj`. The memory for the `LayoutObject` is allocated by `m_create_layout()`. The `LayoutObject` created has default layout values. If the `modifier` argument is not `NULL`, the layout values specified by the `modifier` overwrite the default layout values associated with the locale. Internal states maintained by the layout transformation function across transformations are set to their initial values.

The `attrobj` argument is or may be an amalgam of many opaque objects. A locale object is just one example of the type of object that can be attached to an attribute object. The `attrobj` argument specifies a name that is usually associated with a locale category. If `attrobj` is `NULL`, the created `LayoutObject` is associated with the current locale as set by the `setlocale(3C)` function.

The `modifier` argument announces a set of layout values when the `LayoutObject` is created.

#### RETURN VALUES
Upon successful completion, the `m_create_layout()` function returns a `LayoutObject` for use in subsequent calls to `m_*_layout()` functions. Otherwise the `m_create_layout()` function returns `(LayoutObject) 0` and sets `errno` to indicate the error.

#### ERRORS
The `m_create_layout()` function may fail if:

- **EBADF** The attribute object is invalid or the locale associated with the attribute object is not available.
- **EINVAL** The `modifier` string has a syntax error or it contains unknown layout values.
- **EMFILE** There are `{OPEN_MAX}` file descriptors currently open in the calling process.
- **ENOMEM** Insufficient storage space is available.
ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO setlocale(3C), attributes(5)
md5(3EXT)

NAME
md5, MD5Init, MD5Update, MD5Final, md5_calc - MD5 hashing functions

SYNOPSIS
ec [ flag ... ] file ... -lmd5 [ library ... ]
#include <md5.h>

void MD5Init(MD5_CTX *context);
void MD5Update(MD5_CTX *context, unsigned char *input, unsigned int inlen);
void MD5Final(unsigned char *output, MD5_CTX *context);
void md5_calc(unsigned char *output, unsigned char *input, unsigned int inlen);

DESCRIPTION
The MD5Init() initializes an MD5 context structure that is used as an input argument to the MD5Update() and MD5Final() functions. This function must be called every time a new hash needs to be computed.

The MD5Update() function updates the MD5 context buffer that will be used in the final hash output.

The MD5Final() function generates the final MD5 hash, using the md5 context that was updated in the calls to MD5Update().

These function should be called if scatter/gather buffer support is required. For applications that need to hash a single contiguous buffer, md5_calc() provides a single call to generate the MD5 hash.

RETURN VALUES
These functions do not return a value.

EXAMPLES

EXAMPLE 1 Authenticate a message found in multiple buffers

The following is a sample function that must authenticate a message that is found in multiple buffers. The calling function provides an authentication buffer that will contain the result of the MD5 hash.

```
int AuthenticateMsg(unsigned char *auth_buffer, struct iovec *messageIov, unsigned int num_buffers)
{
    MD5_CTX md5_context;
    unsigned int i;
    MD5Init(&md5_context);
    for(i=0, i<num_buffers; i++)
    {
        MD5Update(&md5_context, messageIov->iov_base, messageIov->iov_len);
        messageIov += sizeof(struct iovec);
    }
    MD5Final(auth_buffer, &md5_context);
}```
EXAMPLE 1 Authenticate a message found in multiple buffers

    return 0;

EXAMPLE 2 Use md5_calc() to generate the MD5 hash

Since the buffer to be computed is contiguous, the md5_calc() function can be used
to generate the MD5 hash.

    int AuthenticateMsg(unsigned char *auth_buffer, unsigned char *buffer, unsigned int length)
    {
        md5_calc(buffer, auth_buffer, length);
        return (0);
    }

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
m_destroy_layout(3LAYOUT)

NAME  m_destroy_layout – destroy a layout object

SYNOPSIS  cc [ flag... ] file... -llayout [ library... ]
#include <sys/layout.h>

int m_destroy_layout(const LayoutObject layoutobject);

DESCRIPTION  The m_destroy_layout() function destroys a LayoutObject by deallocating the
layout object and all the associated resources previously allocated by the
m_create_layout(3LAYOUT) function.

RETURN VALUES  Upon successful completion, 0 is returned. Otherwise -1 is returned and errno is set
to indicate the error.

ERRORS  The m_destroy_layout() function may fail if:
EBADF  The attribute object is erroneous.
EFAULT  Errors occurred while processing the request.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  m_create_layout(3LAYOUT), attributes(5)
**NAME**
media_findname – convert a supplied name into an absolute pathname that can be used to access removable media

**SYNOPSIS**
```
#include <volmgt.h>

char *media_findname(char *start);
```

**DESCRIPTION**
media_findname() converts the supplied start string into an absolute pathname that can then be used to access a particular piece of media.

The start parameter can be one of the following types of specifications:

- **/dev/** ...
  An absolute pathname in /dev, such as /dev/rdiskette0, in which case a copy of that string is returned (see NOTES on this page).

- **/vol/** ...
  An absolute Volume Management pathname, such as /vol/dev/aliases/floppy0 or /vol/dsk/fred. If this supplied pathname is not a symbolic link, then a copy of that pathname is returned. If the supplied pathname is a symbolic link then it is dereferenced and a copy of that dereferenced pathname is returned.

- **volume_name**
  The Volume Management volume name for a particular volume, such as fred (see fdformat(1) for a description of how to label floppies). In this case a pathname in the Volume Management namespace is returned.

- **volmgt_symname**
  The Volume Management symbolic name for a device, such as floppy0 or cdrom2 (see volfs(7FS) for more information on Volume Management symbolic names), in which case a pathname in the Volume Management namespace is returned.

- **media_type**
  The Volume Management generic media type name. For example, floppy or cdrom. In this case media_findname() looks for the first piece of media that matches that media type, starting at 0 (zero) and continuing on until a match is found (or some fairly large maximum number is reached). In this case, if a match is found, a copy of the pathname to the volume found is returned.

**RETURN VALUES**
Upon successful completion media_findname() returns a pointer to the pathname found. In the case of an error a null pointer is returned.
For cases where the supplied start parameter is an absolute pathname, media_findname() can fail, returning a null string pointer, if an lstat(2) of that supplied pathname fails. Also, if the supplied absolute pathname is a symbolic link, media_findname() can fail if a readlink(2) of that symbolic link fails, or if a stat(2) of the pathname pointed to by that symbolic link fails, or if any of the following is true:

ENXIO The specified absolute pathname was not a character special device, and it was not a directory with a character special device in it.

**EXAMPLES**

**EXAMPLE 1** Sample programs of the media_findname() function.

The following example attempts to find what the Volume Management pathname is to a piece of media called fred. Notice that a volmgt_check() is done first (see the NOTES section on this page).

```c
(void) volmgt_check(NULL);
if ((nm = media_findname("fred")) != NULL) {
    (void) printf("media named \"fred\" is at \"%s\"\n", nm);
} else {
    (void) printf("media named \"fred\" not found\n");
}
```

This example looks for whatever volume is in the first floppy drive, letting media_findname() call volmgt_check() if and only if no floppy is currently known to be the first floppy drive.

```c
if ((nm = media_findname("floppy0")) != NULL) {
    (void) printf("path to floppy0 is \"%s\"\n", nm);
} else {
    (void) printf("nothing in floppy0\n");
}
```

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

cc(1B), fdformat(1), void(1M), lstat(2), readlink(2), stat(2), free(3C), malloc(3C), volmgt_check(3VOLMGT), volmgt_inuse(3VOLMGT), volmgt_root(3VOLMGT), volmgt_running(3VOLMGT), volmgt_symname(3VOLMGT), attributes(5), volfs(7FS)

**NOTES**

If media_findname() cannot find a match for the supplied name, it performs a volmgt_check(3VOLMGT) and tries again, so it can be more efficient to perform volmgt_check() before calling media_findname().
Upon success media_findname() returns a pointer to string which has been allocated; this should be freed when no longer in use (see free(3C)).
media_getattr(3VOLMGT)

NAME  
media_getattr, media_setattr – get and set media attributes

SYNOPSIS  
cc [ flag ... ] file ... -lvolmgt [ library ... ]  
#include <volmgt.h>

char *media_getattr(char *vol_path, char *attr);

int media_setattr(char *vol_path, char *attr, char *value);

DESCRIPTION  
media_setattr() and media_getattr() respectively set and get attribute-value pairs (called properties) on a per-volume basis.

Volume Management supports system properties and user properties. System properties are ones that Volume Management predefines. Some of these system properties are writable, but only by the user that owns the volume being specified, and some system properties are read only:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Writable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>s-access</td>
<td>RO</td>
<td>&quot;seq&quot;, &quot;rand&quot;</td>
<td>sequential or random access</td>
</tr>
<tr>
<td>s-density</td>
<td>RO</td>
<td>&quot;low&quot;, &quot;medium&quot;, &quot;high&quot;</td>
<td>media density</td>
</tr>
<tr>
<td>s-parts</td>
<td>RO</td>
<td>comma separated list of slice numbers</td>
<td>list of partitions on this volume</td>
</tr>
<tr>
<td>s-location</td>
<td>RO</td>
<td>pathname</td>
<td>Volume Management pathname to media</td>
</tr>
<tr>
<td>s-mejectable</td>
<td>RO</td>
<td>&quot;true&quot;, &quot;false&quot;</td>
<td>whether or not media is manually ejectable</td>
</tr>
<tr>
<td>s-rmoneject</td>
<td>R/W</td>
<td>&quot;true&quot;, &quot;false&quot;</td>
<td>should media access points be removed from database upon ejection</td>
</tr>
<tr>
<td>s-enxio</td>
<td>R/W</td>
<td>&quot;true&quot;, &quot;false&quot;</td>
<td>if set return ENXIO when media access attempted</td>
</tr>
</tbody>
</table>

Properties can also be defined by the user. In this case the value can be any string the user wishes.

RETURN VALUES  
Upon successful completion media_getattr() returns a pointer to the value corresponding to the specified attribute. A null pointer is returned if the specified volume doesn’t exist, if the specified attribute for that volume doesn’t exist, if the specified attribute is boolean and its value is false, or if malloc(3C) fails to allocate space for the return value.

media_setattr() returns 1 upon success, and 0 upon failure.
Both media_getattr() and media_setattr() can fail returning a null pointer if an open(2) of the specified vol_path fails, if an fstat(2) of that pathname fails, or if that pathname is not a block or character special device.

media_getattr() can also fail if the specified attribute was not found, and media_setattr() can also fail if the caller doesn’t have permission to set the attribute, either because it’s a system attribute, or because the caller doesn’t own the specified volume.

Additionally, either routine can fail returning the following error values:

- **ENXIO** The Volume Management daemon, vold, is not running
- **EINTR** The routine was interrupted by the user before finishing

### EXAMPLE 1 Using media_getattr()

The following example checks to see if the volume called fred that Volume Management is managing can be ejected by means of software, or if it can only be manually ejected:

```c
if (media_getattr("/vol/rdsk/fred", "s-mejectable") != NULL) {
    (void) printf(""fred"") must be manually ejected\n"
} else {
    (void) printf("software can eject "fred"");
}
```

This example shows setting the s-enxio property for the floppy volume currently in the first floppy drive:

```c
int res;
if ((res = media_setattr("/vol/dev/aliases/floppy0", "s-enxio", "true") == 0) {
    (void) printf("can't set s-enxio flag for floppy0\n");
}
```

### ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

### SEE ALSO

cc(1B), vold(1M), lstat(2), open(2), readlink(2), stat(2), free(3C), malloc(3C), media_findname(3VOLMGT), volmgt_check(3VOLMGT), volmgt_inuse(3VOLMGT), volmgt_root(3VOLMGT), volmgt_running(3VOLMGT), volmgt_symname(3VOLMGT), attributes(5)

### NOTES

Upon success media_getattr() returns a pointer to a string which has been allocated, and should be freed when no longer in use (see free(3C)).
media_getid(3VOLMGT)

NAME
media_getid – return the id of a piece of media

SYNOPSIS
cc [flag ...] file ...-lvolgmt [library ...]

#include <volmgt.h>
unsigned long media_getid(char *vol_path);

DESCRIPTION
media_getid() returns the id of a piece of media. Volume Management must be
running. See volmgt_running(3VOLMGT).

PARAMETERS
vol_path Path to the block or character special device.

RETURN VALUES
media_getid() returns the id of the volume. This value is unique for each volume. If
media_getid() returns 0, the path provided is not valid, for example, it is a block
or char device.

EXAMPLES
EXAMPLE 1 Using media_getid()

The following example first checks if Volume Management is running, then checks the
volume management name space for path, and then returns the id for the piece of
media.

char *path;
...

if (volmgt_running()) {
    if (volmgt_ownsname(path)) {
        (void) printf("id of %s is %lld\n",
            path, media_getid(path));
    }
}

If a program using media_getid() does not check whether or not Volume
Management is running, then any NULL return value will be ambiguous, as it could
mean that either Volume Management does not have path in its name space, or Volume
Management is not running.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>Safe</td>
</tr>
<tr>
<td>Commitment Level</td>
<td>Public</td>
</tr>
</tbody>
</table>

SEE ALSO
volmgt_ownsname(3VOLMGT), volmgt_running(3VOLMGT), attributes(5)
m_getvalues_layout(3LAYOUT)

NAME    m_getvalues_layout – query layout values of a LayoutObject

SYNOPSIS
#include <sys/layout.h>

int m_getvalues_layout(const LayoutObject layout_object, LayoutValues values, int *index_returned);

DESCRIPTION
The m_getvalues_layout() function queries the current setting of layout values within a LayoutObject.

The layout_object argument specifies a LayoutObject returned by the m_create_layout(3LAYOUT) function.

The values argument specifies the list of layout values that are to be queried. Each value element of a LayoutValueRec must point to a location where the layout value is stored. That is, if the layout value is of type T, the argument must be of type T*. The values are queried from the LayoutObject and represent its current state.

It is the user’s responsibility to manage the space allocation for the layout values queried. If the layout value name has QueryValueSize OR-ed to it, instead of the value of the layout value, only its size is returned. The caller can use this option to determine the amount of memory needed to be allocated for the layout values queried.

RETURN VALUES
Upon successful completion, the m_getvalues_layout() function returns 0. If any value cannot be queried, the index of the value causing the error is returned in index_returned, −1 is returned and errno is set to indicate the error.

ERRORS
The m_getvalues_layout() function may fail if:

EINVAL    The layout value specified by index_returned is unknown, its value is invalid, or the layout_object argument is invalid. In the case of an invalid layout_object argument, the value returned in index_returned is −1.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
m_create_layout(3LAYOUT), attributes(5)
NAME
mkdirp, rmdirp – create or remove directories in a path

SYNOPSIS
cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

int mkdirp(const char *path, mode_t mode);
int rmdirp(char *dir, char *dir1);

DESCRIPTION
The mkdirp() function creates all the missing directories in path with mode. See chmod(2) for the values of mode.

The rmdirp() function removes directories in path dir. This removal begins at the end of the path and moves backward toward the root as far as possible. If an error occurs, the remaining path is stored in dir1.

RETURN VALUES
If path already exists or if a needed directory cannot be created, mkdirp() returns −1 and sets errno to one of the error values listed for mkdir(2). It returns zero if all the directories are created.

The rmdirp() function returns 0 if it is able to remove every directory in the path. It returns −2 if a ‘.’ or ‘..’ is in the path and −3 if an attempt is made to remove the current directory. Otherwise it returns−1.

EXAMPLES
EXAMPLE 1 Example of creating scratch directories.
The following example creates scratch directories.

/* create scratch directories */
if(mkdirp("/tmp/sub1/sub2/sub3", 0755) == −1) {
   fprintf(stderr, "cannot create directory");
   exit(1);
}
chdir("/tmp/sub1/sub2/sub3");
.
.
/* cleanup */
chdir("/tmp");
rmdir("sub1/sub2/sub3");

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
chmod(2), mkdir(2), rmdir(2), malloc(3C), attributes(5)

NOTES
mkdirp() uses malloc(3C) to allocate temporary space for the string.
When compiling multithreaded applications, the _REENTRANT flag must be defined on the compile line. This flag should only be used in multithreaded applications.
These routines perform arithmetic on integers of arbitrary length. The integers are stored using the defined type MINT. Pointers to a MINT should be initialized using the function mp_itom(n), which sets the initial value to n. Alternatively, mp_xtom(a) may be used to initialize a MINT from a string of hexadecimal digits. mp_mfree(a) may be used to release the storage allocated by the mp_itom(a) and mp_xtom(a) routines.

The mp_madd(a,b,c), mp_msub(a,b,c) and mp_mult(a,b,c) functions assign to their third arguments the sum, difference, and product, respectively, of their first two arguments. The mp_mdiv(a,b,q,r) function assigns the quotient and remainder, respectively, to its third and fourth arguments. The mp_sdiv(a,n,q,r) function is similar to mp_mdiv(a,b,q,r) except that the divisor is an ordinary integer. The mp_msqrt(a,b,r) function produces the square root and remainder of its first argument. The mp_mcmp(a,b) function compares the values of its arguments and returns 0 if the two values are equal, a value greater than 0 if the first argument is greater than the second, and a value less than 0 if the second argument is greater than the first. The mp_rpow(a,n,b) function raises a to the nth power and assigns this value to b.
mp pow(a,b,c,d) function raises a to the bth power, reduces the result modulo c and assigns this value to d. The mp_min(a) and mp_mout(a) functions perform decimal input and output. The mp_gcd(a,b,c) function finds the greatest common divisor of the first two arguments, returning it in the third argument. The mp_mtox(a) function provides the inverse of mp_xtom(a). To release the storage allocated by mp_mtox(a) use free() (see malloc(3C)).

Use the -lmp loader option to obtain access to these functions.

FILES
/usr/lib/libmp.a
/usr/lib/libmp.so

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO
exp(3M), malloc(3C), libmp(3LIB), attributes(5)

DIAGNOSTICS
Illegal operations and running out of memory produce messages and core images.

WARNINGS
The function pow() exists in both libmp and libm with widely differing semantics. This is why libmp.so.2 exists. libmp.so.1 exists solely for reasons of backward compatibility, and should not be used otherwise. Use the mp_*( ) functions instead. See libmp(3LIB).
The `m_setvalues_layout()` function changes the layout values of a `LayoutObject`. The `layout_object` argument specifies a `LayoutObject` returned by the `m_create_layout(3LAYOUT)` function. The `values` argument specifies the list of layout values that are to be changed. The values are written into the `LayoutObject` and may affect the behavior of subsequent layout functions. Some layout values do alter internal states maintained by a `LayoutObject`.

The `m_setvalues_layout()` function can be implemented as a macro that evaluates the first argument twice. Upon successful completion, the requested layout values are set and 0 is returned. Otherwise -1 is returned and `errno` is set to indicate the error. If any value cannot be set, none of the layout values are changed and the (zero-based) index of the first value causing the error is returned in `index_returned`.

The `m_setvalues_layout()` function may fail if:

- **EINVAL** The layout value specified by `index_returned` is unknown, its value is invalid, or the `layout_object` argument is invalid.
- **EMFILE** There are `{OPEN_MAX}` file descriptors currently open in the calling process.

Do not use expressions with side effects such as auto-increment or auto-decrement within the first argument to the `m_setvalues_layout()` function.

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also `m_create_layout(3LAYOUT), attributes(5)`
### SYNOPSIS

```c
#include <sys/layout.h>

int m_transform_layout(LayoutObject layout_object, const char *InpBuf,
                       const size_t ImpSize, const void *OutBuf, size_t *Outsize, size_t *ImpToOut,
                       size_t *OutToInp, unsigned char *Property, size_t *InpBufIndex);
```

### DESCRIPTION

The `m_transform_layout()` function performs layout transformations (reordering, shaping, cell determination) or provides additional information needed for layout transformation (such as the expected size of the transformed layout, the nesting level of different segments in the text and cross-references between the locations of the corresponding elements before and after the layout transformation). Both the input text and output text are character strings.

The `m_transform_layout()` function transforms the input text in `InpBuf` according to the current layout values in `layout_object`. Any layout value whose value type is `LayoutTextDescriptor` describes the attributes of the `InpBuf` and `OutBuf` arguments. If the attributes are the same for both `InpBuf` and `OutBuf`, a null transformation is performed with respect to that specific layout value.

The `InpBuf` argument specifies the source text to be processed. The `InpBuf` may not be `NULL`, unless there is a need to reset the internal state.

The `ImpSize` argument is the number of bytes within `InpBuf` to be processed by the transformation. Its value will not change after return from the transformation. `ImpSize` set to `-1` indicates that the text in `InpBuf` is delimited by a null code element. If `ImpSize` is not set to `-1`, it is possible to have some null elements in the input buffer. This might be used, for example, for a "one shot" transformation of several strings, separated by nulls.

Output of this function may be one or more of the following depending on the setting of the arguments:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>OutBuf</code></td>
<td>Any transformed data is stored in <code>OutBuf</code>, converted to <code>ShapeCharset</code>.</td>
</tr>
<tr>
<td><code>Outsize</code></td>
<td>The number of bytes in <code>OutBuf</code>.</td>
</tr>
<tr>
<td><code>ImpToOut</code></td>
<td>A cross-reference from each <code>InpBuf</code> code element to the transformed data. The cross-reference relates to the data in <code>InpBuf</code> starting with the first element that <code>InpBufIndex</code> points to (and not necessarily starting from the beginning of the <code>InpBuf</code>).</td>
</tr>
<tr>
<td><code>OutToInp</code></td>
<td>A cross-reference to each <code>InpBuf</code> code element from the transformed data. The cross-reference relates to the data in <code>InpBuf</code> starting with the first element that <code>InpBufIndex</code> points to (and not necessarily starting from the beginning of the <code>InpBuf</code>).</td>
</tr>
</tbody>
</table>
m_transform_layout(3LAYOUT)

**Property**

A weighted value that represents peculiar input string transformation properties with different connotations as explained below. If this argument is not a null pointer, it represents an array of values with the same number of elements as the source substring text before the transformation. Each byte will contain relevant “property” information of the corresponding element in `InpBuf` starting from the element pointed by `InpBufIndex`. The four rightmost bits of each “property” byte will contain information for bidirectional environments (when `ActiveDirectional` is True) and they will mean “NestingLevels.” The possible value from 0 to 15 represents the nesting level of the corresponding element in the `InpBuf` starting from the element pointed by `InpBufIndex`. If `ActiveDirectional` is false the content of NestingLevel bits will be ignored. The leftmost bit of each “property” byte will contain a “new cell indicator” for composed character environments, and will have a value of either 1 (for an element in `InpBuf` that is transformed to the beginning of a new cell) or 0 (for the “zero-length” composing character elements, when these are grouped into the same presentation cell with a non-composing character). Here again, each element of “property” pertains to the elements in the `InpBuf` starting from the element pointed by `InpBufIndex`. (Remember that this is not necessarily the beginning of `InpBuf`). If none of the transformation properties is required, the argument `Property` can be NULL. The use of “property” can be enhanced in the future to pertain to other possible usage in other environments.

The `InpBufIndex` argument is an offset value to the location of the transformed text. When `m_transform_layout()` is called, `InpBufIndex` contains the offset to the element in `InpBuf` that will be transformed first. (Note that this is not necessarily the first element in `InpBuf`). At the return from the transformation, `InpBufIndex` contains the offset to the first element in the `InpBuf` that has not been transformed. If the entire substring has been transformed successfully, `InpBufIndex` will be incremented by the amount defined by `InpSize`.

Each of these output arguments may be NULL to specify that no output is desired for the specific argument, but at least one of them should be set to a non-null value to perform any significant work.

The layout object maintains a directional state that keeps track of directional changes, based on the last segment transformed. The directional state is maintained across calls to the layout transformation functions and allows stream data to be processed with the layout functions. The directional state is reset to its initial state whenever any of the layout values `TypeOfText`, `Orientation`, or `ImplicitAlg` is modified by means of a call to `m_setvalues_layout()`.

The `layout_object` argument specifies a `LayoutObject` returned by the `m_create_layout()` function.
The `OutBuf` argument contains the transformed data. This argument can be specified as a null pointer to indicate that no transformed data is required.

The encoding of the `OutBuf` argument depends on the `ShapeCharset` layout value defined in `layout_object`. If the `ActiveShapeEditing` layout value is not set (False), the encoding of `OutBuf` is guaranteed to be the same as the codeset of the locale associated with the `LayoutObject` defined by `layout_object`.

On input, the `OutSize` argument specifies the size of the output buffer in number of bytes. The output buffer should be large enough to contain the transformed result; otherwise, only a partial transformation is performed. If the `ActiveShapeEditing` layout value is set (True) the `OutBuf` should be allocated to contain at least the `InpSize` multiplied by `ShapeCharsetSize`.

On return, the `OutSize` argument is modified to the actual number of bytes placed in `OutBuf`.

When the `OutSize` argument is specified as zero, the function calculates the size of an output buffer large enough to contain the transformed text, and the result is returned in this field. The contents of the buffers specified by `InpBuf` and `OutBuf`, and the value of `InpBufIndex`, remain unchanged. If `OutSize = NULL`, the `EINVAL` error condition should be returned.

If the `InpToOut` argument is not a null pointer, it points to an array of values with the same number of bytes in `InpBuf` starting with the one pointed by `InpBufIndex` and up to the end of the substring in the buffer. On output, the nth value in `InpToOut` corresponds to the nth byte in `InpBuf`. This value is the index (in units of bytes) in `OutBuf` that identifies the transformed `ShapeCharset` element of the nth byte in `InpBuf`. In the case of multibyte encoding, the index points (for each of the bytes of a code element in the `InpBuf`) to the first byte of the transformed code element in the `OutBuf`.

`InpToOut` may be specified as `NULL` if no index array from `InpBuf` to `OutBuf` is desired.

If the `OutToInp` argument is not a null pointer, it points to an array of values with the same number of bytes as contained in `OutBuf`. On output, the nth value in `OutToInp` corresponds to the nth byte in `OutBuf`. This value is the index in `InpBuf`, starting with the byte pointed to by `InpBufIndex`, that identifies the logical code element of the nth byte in `OutBuf`. In the case of multibyte encoding, the index will point for each of the bytes of a transformed code element in the `OutBuf` to the first byte of the code element in the `InpBuf`.

`OutToInp` may be specified as `NULL` if no index array from `OutBuf` to `InpBuf` is desired.

To perform shaping of a text string without reordering of code elements, the `layout_object` should be set with input and output layout value `TypeOfText` set to `TEXT_VISUAL` and both in and out of `Orientation` set to the same value.
**m_transform_layout(3LAYOUT)**

**RETURN VALUES**
If successful, the `m_transform_layout()` function returns 0. If unsuccessful, the returned value is −1 and the `errno` is set to indicate the source of error. When the size of `OutBuf` is not large enough to contain the entire transformed text, the input text state at the end of the uncompleted transformation is saved internally and the error condition `E2BIG` is returned in `errno`.

**ERRORS**
The `m_transform_layout()` function may fail if:

- **E2BIG** The output buffer is full and the source text is not entirely processed.
- **EBADF** The layout values are set to a meaningless combination or the layout object is not valid.
- **EILSEQ** Transformation stopped due to an input code element that cannot be shaped or is invalid. The `InpBufIndex` argument is set to indicate the code element causing the error. The suspect code element is either a valid code element but cannot be shaped into the `ShapeCharset` layout value, or is an invalid code element not defined by the codeset of the locale of `layout_object`. The `mbtowc()` and `wctomb()` functions, when used in the same locale as the `LayoutObject`, can be used to determine if the code element is valid.
- **EINVAL** Transformation stopped due to an incomplete composite sequence at the end of the input buffer, or `OutSize` contains `NULL`.
- **ERANGE** More than 15 embedding levels are in source text or `InpBuf` contain unbalanced directional layout information (push/pop) or an incomplete composite sequence has been detected in the input buffer at the beginning of the string pointed to by `InpBufIndex`.

An incomplete composite sequence at the end of the input buffer is not always detectable. Sometimes, the fact that the sequence is incomplete will only be detected when additional character elements belonging to the composite sequence are found at the beginning of the next input buffer.

**USAGE**
A `LayoutObject` will have a meaningful combination of default layout values. Whoever chooses to change the default layout values is responsible for making sure that the combination of layout values is meaningful. Otherwise, the result of `m_transform_layout()` might be unpredictable or implementation-specific with `errno` set to `EBADF`.

**ATTRIBUTES**
See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

300 man pages section 3: Extended Library Functions • Last Revised 8 Jun 1999
SEE ALSO attributes(5)

m_transform_layout(3LAYOUT)
m_wtransform_layout(3LAYOUT)

NAME  m_wtransform_layout – layout transformation for wide character strings

SYNOPSIS

```
#include <sys/layout.h>

int m_wtransform_layout(LayoutObject layout_object, const wchar_t *InpBuf, const size_t ImpSize, const void *OutBuf, size_t *Outsize, size_t *InpToOut, size_t *OutToInp, unsigned char *Property, size_t *InpBufIndex);
```

DESCRIPTION

The `m_wtransform_layout()` function performs layout transformations (reordering, shaping, cell determination) or provides additional information needed for layout transformation (such as the expected size of the transformed layout, the nesting level of different segments in the text and cross-references between the locations of the corresponding elements before and after the layout transformation). Both the input text and output text are wide character strings.

The `m_wtransform_layout()` function transforms the input text in `InpBuf` according to the current layout values in `layout_object`. Any layout value whose value type is `LayoutTextDescriptor` describes the attributes of the `InpBuf` and `OutBuf` arguments. If the attributes are the same for both `InpBuf` and `OutBuf`, a null transformation is performed with respect to that specific layout value.

The `InpBuf` argument specifies the source text to be processed. The `InpBuf` may not be NULL, unless there is a need to reset the internal state.

The `InpSize` argument is the number of bytes within `InpBuf` to be processed by the transformation. Its value will not change after return from the transformation. `InpSize` set to −1 indicates that the text in `InpBuf` is delimited by a null code element. If `InpSize` is not set to −1, it is possible to have some null elements in the input buffer. This might be used, for example, for a "one shot" transformation of several strings, separated by nulls.

Output of this function may be one or more of the following depending on the setting of the arguments:

- `OutBuf` Any transformed data is stored in `OutBuf`, converted to `ShapeCharset`.
- `Outsize` The number of wide characters in `OutBuf`.
- `InpToOut` A cross-reference from each `InpBuf` code element to the transformed data. The cross-reference relates to the data in `InpBuf` starting with the first element that `InpBufIndex` points to (and not necessarily starting from the beginning of the `InpBuf`).
- `OutToInp` A cross-reference to each `InpBuf` code element from the transformed data. The cross-reference relates to the data in `InpBuf` starting with the first element that `InpBufIndex` points to (and not necessarily starting from the beginning of the `InpBuf`).
m_wtransform_layout(3LAYOUT)

**Property**

A weighted value that represents peculiar input string transformation properties with different connotations as explained below. If this argument is not a null pointer, it represents an array of values with the same number of elements as the source substring text before the transformation. Each byte will contain relevant “property” information of the corresponding element in InpBuf starting from the element pointed by InpBufIndex. The four rightmost bits of each “property” byte will contain information for bidirectional environments (when ActiveDirectional is True) and they will mean “NestingLevels.” The possible value from 0 to 15 represents the nesting level of the corresponding element in the InpBuf starting from the element pointed by InpBufIndex. If ActiveDirectional is false the content of NestingLevel bits will be ignored. The leftmost bit of each “property” byte will contain a “new cell indicator” for composed character environments, and will have a value of either 1 (for an element in InpBuf that is transformed to the beginning of a new cell) or 0 (for the “zero-length” composing character elements, when these are grouped into the same presentation cell with a non-composing character). Here again, each element of “property” pertains to the elements in the InpBuf starting from the element pointed by InpBufIndex. (Remember that this is not necessarily the beginning of InpBuf). If none of the transformation properties is required, the argument Property can be NULL. The use of “property” can be enhanced in the future to pertain to other possible usage in other environments.

The InpBufIndex argument is an offset value to the location of the transformed text. When m_wtransform_layout() is called, InpBufIndex contains the offset to the element in InpBuf that will be transformed first. (Note that this is not necessarily the first element in InpBuf). At the return from the transformation, InpBufIndex contains the offset to the first element in the InpBuf that has not been transformed. If the entire substring has been transformed successfully, InpBufIndex will be incremented by the amount defined by InpSize.

Each of these output arguments may be null to specify that no output is desired for the specific argument, but at least one of them should be set to a non-null value to perform any significant work.

In addition to the possible outputs above, layout_object maintains a directional state across calls to the transform functions. The directional state is reset to its initial state whenever any of the layout values TypeOfText, Orientation, or ImplicitAlg is modified by means of a call to m_setvalues_layout().

The layout_object argument specifies a LayoutObject returned by the m_create_layout() function.
m_wtransform_layout(3LAYOUT)

The `OutBuf` argument contains the transformed data. This argument can be specified as a null pointer to indicate that no transformed data is required.

The encoding of the `OutBuf` argument depends on the `ShapeCharset` layout value defined in `layout_object`. If the `ActiveShapeEditing` layout value is not set (False), the encoding of `OutBuf` is guaranteed to be the same as the codeset of the locale associated with the `LayoutObject` defined by `layout_object`.

On input, the `OutSize` argument specifies the size of the output buffer in number of wide characters. The output buffer should be large enough to contain the transformed result; otherwise, only a partial transformation is performed. If the `ActiveShapeEditing` layout value is set (True) the `OutBuf` should be allocated to contain at least the `InpSize` multiplied by `ShapeCharsetSize`.

On return, the `OutSize` argument is modified to the actual number of code elements in `OutBuf`.

When the `OutSize` argument is specified as zero, the function calculates the size of an output buffer large enough to contain the transformed text, and the result is returned in this field. The content of the buffers specified by `InpBuf` and `OutBuf`, and the value of `InpBufIndex`, remain unchanged. If `OutSize = NULL`, the `EINVAL` error condition should be returned.

If the `InpToOut` argument is not a null pointer, it points to an array of values with the same number of wide characters in `InpBuf` starting with the one pointed by `InpBufIndex` and up to the end of the substring in the buffer. On output, the nth value in `InpToOut` corresponds to the nth byte in `InpBuf`. This value is the index (in units of wide characters) in `OutBuf` that identifies the transformed `ShapeCharset` element of the nth byte in `InpBuf`.

`InpToOut` may be specified as `NULL` if no index array from `InpBuf` to `OutBuf` is desired.

If the `OutToInp` argument is not a null pointer, it points to an array of values with the same number of wide characters as contained in `OutBuf`. On output, the nth value in `OutToInp` corresponds to the nth byte in `OutBuf`. This value is the index in `InpBuf`, starting with wide character byte pointed to by `InpBufIndex`, that identifies the logical code element of the nth wide character in `OutBuf`.

`OutToInp` may be specified as `NULL` if no index array from `OutBuf` to `InpBuf` is desired.

To perform shaping of a text string without reordering of code elements, the `layout_object` should be set with input and output layout value `TypeOfText` set to `TEXT_VISUAL` and both in and out of `Orientation` set to the same value.

**RETURN VALUES**

If successful, the `m_wtransform_layout()` function returns 0. If unsuccessful, the returned value is −1 and the `errno` is set to indicate the source of error. When the size of `OutBuf` is not large enough to contain the entire transformed text, the input text state at the end of the uncompleted transformation is saved internally and the error condition `E2BIG` is returned in `errno`.

304  man pages section 3: Extended Library Functions  •  Last Revised 8 Jun 1999
m_wtransform_layout() function may fail if:

- **E2BIG**: The output buffer is full and the source text is not entirely processed.
- **EBADF**: The layout values are set to a meaningless combination or the layout object is not valid.
- **EILSEQ**: Transformation stopped due to an input code element that cannot be shaped or is invalid. The `InpBufIndex` argument is set to indicate the code element causing the error. The suspect code element is either a valid code element but cannot be shaped into the `ShapeCharset` layout value, or is an invalid code element not defined by the codeset of the locale of `layout_object`. The `mbtowc()` and `wctomb()` functions, when used in the same locale as the `LayoutObject`, can be used to determine if the code element is valid.
- **EINVAL**: Transformation stopped due to an incomplete composite sequence at the end of the input buffer, or `OutSize` contains `NULL`.
- **ERANGE**: More than 15 embedding levels are in source text or `InpBuf` contain unbalanced directional layout information (push/pop) or an incomplete composite sequence has been detected in the input buffer at the beginning of the string pointed to by `InpBufIndex`.

An incomplete composite sequence at the end of the input buffer is not always detectable. Sometimes the fact that the sequence is incomplete will only be detected when additional character elements belonging to the composite sequence are found at the beginning of the next input buffer.

**USAGE**

A `LayoutObject` will have a meaningful combination of default layout values. Whoever chooses to change the default layout values is responsible for making sure that the combination of layout values is meaningful. Otherwise, the result of `m_wtransform_layout()` might be unpredictable or implementation-specific with `errno` set to `EBADF`.

**EXAMPLES**

**EXAMPLE 1** Shaping and reordering input string into output buffer

The following example illustrated what the different arguments of `m_wtransform_layout()` look like when a string in `InpBuf` is shaped and reordered into `OutBuf`. Upper-case letters in the example represent left-to-right letters while lower-case letters represent right-to-left letters. `xyz` represents the shapes of `cde`.

<table>
<thead>
<tr>
<th>Position: 0123456789</th>
<th>InpBuf: AB cde 12z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position: 012456789</td>
<td>OutBuf: AB 12 zyxZ</td>
</tr>
<tr>
<td>Position: 0123456789</td>
<td></td>
</tr>
</tbody>
</table>

Extended Library Functions  305
EXAMPLE 1 Shaping and reordering input string into output buffer  (Continued)

OutToInp: 0127865439
Position: 0123456789
Property.NestLevel: 0001111220
Property.CellBdry: 1111111111

The values (encoded in binary) returned in the Property argument define the
directionality of each code element in the source text as defined by the type of
algorithm used within the layout_object. While the algorithm may be implementation
dependent, the resulting values and levels are defined such as to allow a single
method to be used in determining the directionality of the source text. The base rules
are:

- Odd levels are always RTL.
- Even levels are always LTR.
- The Orientation layout value setting determines the initial level (0 or 1) used.

Within a Property array each increment in the level indicates the corresponding code
elements should be presented in the opposite direction. Callers of this function should
realize that the Property values for certain code elements is dependent on the context
of the given character and the layout values: Orientation and ImplicitAlg.
Callers should not assume that a given code element always has the same Property
value in all cases.

EXAMPLE 2 Algorithm to handle nesting

The following is an example of a standard presentation algorithm that handles nesting
correctly. The goal of this algorithm is ultimately to return to a zero nest level. Note
that more efficient algorithms do exist; the following is provided for clarity rather than
for efficiency.

1. Search for the highest next level in the string.
2. Reverse all surrounding code elements of the same level. Reduce the nest level of
these code elements by 1.
3. Repeat 1 and 2 until all code elements are of level 0.

The following shows the progression of the example from above:

Position: 0123456789 0123456789 0123456789
InpBuf: AB cde 12Z AB cde 21Z AB 12 edcZ
Property.NestLevel: 0001111220 0001111110 0000000000
Property.CellBdry: 1111111111 1111111111 1111111111

ATTRIBUTES See attributes(5) for descriptions of the following attributes:
m_wtransform_layout(3LAYOUT)

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO attributes(5)
newDmiOctetString(3DMI)

NAME    newDmiOctetString – create DmiOctetString in dynamic memory

SYNOPSIS cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/util.hh>

DmiOctetString_t *newDmiOctetString(DmiOctetString_t *str);

DESCRIPTION The newDmiOctetString() function creates a DmiOctetString in dynamic memory and returns a pointer to the newly created DmiOctetString. The function returns NULL if no memory is available.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO   libdmi(3LIB), attributes(5)
newDmiString(3DMI)

NAME
newDmiString – create DmiString in dynamic memory

SYNOPSIS
cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/util.hh>

DmiString_t *newDmiString(char *str);

DESCRIPTION
The newDmiString() function creates a DmiString in dynamic memory and
returns a pointer to the newly created DmiString. The function returns NULL if no
memory is available.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
freeDmiString(3DMI), libdmi(3LIB), attributes(5)
nextafter() function computes the next representable double-precision floating-point value following \( x \) in the direction of \( y \). Thus, if \( y \) is less than \( x \), \texttt{nextafter()} returns the largest representable floating-point number less than \( x \).

If \( x \) or \( y \) is NaN, then \texttt{nextafter()} returns NaN.

If \( x \) is finite and the correct function value would overflow, \texttt{nextafter()} returns \( \pm\text{HUGE\_VAL} \) (according to the sign of \( x \)) and sets \texttt{errno} to \texttt{ERANGE}.

The \texttt{nextafter()} function will fail if:

- \texttt{ERANGE} The correct value would overflow.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also attributes(5),
nlist(3ELF)

NAME
nlist – get entries from name list

SYNOPSIS
cc [ flag... ] file ... -lelf [ library ... ]
#include <nlist.h>

int nlist(const char *filename, struct nlist *nl);

DESCRIPTION
nlist() examines the name list in the executable file whose name is pointed to by
filename, and selectively extracts a list of values and puts them in the array of nlist() structures pointed to by nl. The name list nl consists of an array of structures
containing names of variables, types, and values. The list is terminated with a null
name, that is, a null string is in the name position of the structure. Each variable name
is looked up in the name list of the file. If the name is found, the type, value, storage
class, and section number of the name are inserted in the other fields. The type field
may be set to 0 if the file was not compiled with the -g option to cc(1B).

nlist() will always return the information for an external symbol of a given name if
the name exists in the file. If an external symbol does not exist, and there is more than
one symbol with the specified name in the file (such as static symbols defined in
separate files), the values returned will be for the last occurrence of that name in the
file. If the name is not found, all fields in the structure except n_name are set to 0.

This function is useful for examining the system name list kept in the file
/dev/ksyms. In this way programs can obtain system addresses that are up to date.

RETURN VALUES
All value entries are set to 0 if the file cannot be read or if it does not contain a valid
name list.

nlist() returns 0 on success, −1 on error.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
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</tr>
</thead>
<tbody>
<tr>
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<td>Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
cc(1B), elf(3ELF), kvm_nlist(3KVM), kvm_open(3KVM), a.out(4),
attributes(5), ksym(3D), mem(3D)
NOTE(3EXT)

NAME
NOTE, _NOTE – annotate source code with info for tools

SYNOPSIS
#include <note.h>

NOTE(NoteInfo);

or
#include<sys/note.h>

 NOTE(NoteInfo);

DESCRIPTION
These macros are used to embed information for tools in program source. A use of one
of these macros is called an “annotation”. A tool may define a set of such annotations
which can then be used to provide the tool with information that would otherwise be
unavailable from the source code.

Annotations should, in general, provide documentation useful to the human reader. If
information is of no use to a human trying to understand the code but is necessary for
proper operation of a tool, use another mechanism for conveying that information to
the tool (one which does not involve adding to the source code), so as not to detract
from the readability of the source. The following is an example of an annotation which
provides information of use to a tool and to the human reader (in this case, which data
are protected by a particular lock, an annotation defined by the static lock analysis tool
lock_lint).

NOTE(MUTEX_PROTECTS_DATA(foo_lock, foo_list Foo))

Such annotations do not represent executable code; they are neither statements nor
declarations. They should not be followed by a semicolon. If a compiler or tool that
analyzes C source does not understand this annotation scheme, then the tool will
ignore the annotations. (For such tools, NOTE(x) expands to nothing.)

Annotations may only be placed at particular places in the source. These places are
where the following C constructs would be allowed:

- a top-level declaration (that is, a declaration not within a function or other
  construct)
- a declaration or statement within a block (including the block which defines a
  function)
- a member of a struct or union.

Annotations are not allowed in any other place. For example, the following are illegal:

x = y * NOTE(...) z ;
typedef NOTE(...) unsigned int uint ;

While NOTE and _NOTE may be used in the places described above, a particular type
of annotation may only be allowed in a subset of those places. For example, a
particular annotation may not be allowed inside a struct or union definition.
Ordinarily, `NOTE` should be used rather than `_NOTE`, since use of `_NOTE` technically makes a program non-portable. However, it may be inconvenient to use `NOTE` for this purpose in existing code if `NOTE` is already heavily used for another purpose. In this case one should use a different macro and write a header file similar to `/usr/include/note.h` which maps that macro to `_NOTE` in the same manner. For example, the following makes `FOO` such a macro:

```
#ifndef _FOO_H
#define _FOO_H
#define FOO _NOTE
#include <sys/note.h>
#endif
```

Public header files which span projects should use `_NOTE` rather than `NOTE`, since `NOTE` may already be used by a program which needs to include such a header file.

**NoteInfo Argument**

The actual `NoteInfo` used in an annotation should be specified by a tool that deals with program source (see the documentation for the tool to determine which annotations, if any, it understands).

`NoteInfo` must have one of the following forms:

- `NoteName`
- `NoteName (Args)`

where `NoteName` is simply an identifier which indicates the type of annotation, and `Args` is something defined by the tool that specifies the particular `NoteName`. The general restrictions on `Args` are that it be compatible with an ANSI C tokenizer and that unquoted parentheses be balanced (so that the end of the annotation can be determined without intimate knowledge of any particular annotation).

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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</thead>
<tbody>
<tr>
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<td>Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`note(4)`, `attributes(5)`
nvlist_add_boolean

NAME nvlist_add_boolean, nvlist_add_byte, nvlist_add_int16, nvlist_add_uint16, nvlist_add_int32, nvlist_add_uint32, nvlist_add_int64, nvlist_add_uint64, nvlist_add_string, nvlist_add_byte_array, nvlist_add_int16_array, nvlist_add_uint16_array, nvlist_add_int32_array, nvlist_add_uint32_array, nvlist_add_int64_array, nvlist_add_uint64_array, nvlist_add_string_array – add new name-value pair to nvlist_t

SYNOPSIS

```c
#include <libnvpair.h>

int nvlist_add_boolean(nvlist_t *nvl, char *name);
int nvlist_add_byte(nvlist_t *nvl, char *name, uchar_t val);
int nvlist_add_int16(nvlist_t *nvl, char *name, int16_t val);
int nvlist_add_uint16(nvlist_t *nvl, char *name, uint16_t val);
int nvlist_add_int32(nvlist_t *nvl, char *name, int32_t val);
int nvlist_add_uint32(nvlist_t *nvl, char *name, uint32_t val);
int nvlist_add_int64(nvlist_t *nvl, char *name, int64_t val);
int nvlist_add_uint64(nvlist_t *nvl, char *name, uint64_t val);
int nvlist_add_string(nvlist_t *nvl, char *name, char *val);
int nvlist_add_byte_array(nvlist_t *nvl, char *name, uchar_t *val, uint_t nelem);
int nvlist_add_int16_array(nvlist_t *nvl, char *name, int16_t *val, uint_t nelem);
int nvlist_add_uint16_array(nvlist_t *nvl, char *name, uint16_t *val, uint_t nelem);
int nvlist_add_int32_array(nvlist_t *nvl, char *name, int32_t *val, uint_t nelem);
int nvlist_add_uint32_array(nvlist_t *nvl, char *name, uint32_t *val, uint_t nelem);
int nvlist_add_int64_array(nvlist_t *nvl, char *name, int64_t *val, uint_t nelem);
int nvlist_add_uint64_array(nvlist_t *nvl, char *name, uint64_t *val, uint_t nelem);
int nvlist_add_string_array(nvlist_t *nvl, char *name, char **val, uint_t nelem);
```

PARAMETERS

nvl The nvlist_t (name-value pair list) to be processed.
name Name of the nvpair (name-value pair).
nelem Number of elements in value (that is, array size).
These functions add a new name-value pair to an `nvlist_t`. The uniqueness of `nvpair` name and data types follows the `nvflag` argument specified for `nvlist_alloc()`. See `nvlist_alloc(3NVPAIR).

If `NV_UNIQUE_NAME` was specified for `nvflag`, existing `nvpairs` with matching names are removed before the new `nvpair` is added.

If `NV_UNIQUE_NAME_TYPE` was specified for `nvflag`, existing `nvpairs` with matching names and data types are removed before the new `nvpair` is added.

If neither was specified for `nvflag`, the new `nvpair` is unconditionally added at the end of the list. The library preserves the order of the name-value pairs across packing, unpacking, and duplication.

Upon successful completion, 0 is returned. Otherwise, −1 is returned and `errno` is set to indicate the error.

These functions will fail if:

- `EINVAL` There is an invalid argument.
- `ENOMEM` There is insufficient memory.

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>Attribute Type</th>
<th>Attribute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

Extended Library Functions 315
nvlist_alloc(3NVPAIR)

NAME
nvlist_alloc, nvlist_free, nvlist_size, nvlist_pack, nvlist_unpack, nvlist_dup – manage a
name-value pair list

SYNOPSIS
#include <libnvpair.h>

int nvlist_alloc(nvlist_t **nvlp, uint_t nvflag, int flag);
void nvlist_free(nvlist_t *nvl);
int nvlist_size(nvlist_t *nvl, size_t *size, int encoding);
int nvlist_pack(nvlist_t *nvl, char **bufp, size_t *buflen, int
encoding, int flag);
int nvlist_unpack(char *buf, nvlist_t **nvlp, int flag);
int nvlist_dup(nvlist_t *nvl, nvlist_t **nvlp, int flag);

DESCRIPTION
The nvlist_alloc() function allocates a new name-value pair list and updates nvlp
to point to the handle. The argument nvflag specifies nvlist properties to remain
persistent across packing, unpacking, and duplication.

The nvlist_free() function frees a name-value pair list.

The nvlist_size() function returns the minimum size of a contiguous buffer large
enough to pack nvl. The encoding parameter specifies the method of encoding when
packing nvl. The supported encoding methods is:

NV_ENCODE_NATIVE Straight bcopy() as described in bcopy(3C).

The nvlist_pack() function packs nvl into contiguous memory starting at *bufp.
The encoding parameter specifies the method of encoding (see above).

- If *bufp is not NULL, *bufp is expected to be a caller-allocated buffer of size *buflen.
- If *bufp is NULL, the library will allocate memory and update *bufp to point to the
memory and update *buflen to contain the size of the allocated memory.

The nvlist_unpack() function takes a buffer with a packed nvlist_t and
unpacks it into a searchable nvlist_t. The library allocates memory for nvlist_t.
The caller is responsible for freeing the memory by calling nvlist_free().

The nvlist_dup() function makes a copy of nvl and updates nvlp to point to the
copy.

PARAMETERS
nvlp Address of a pointer to nvlist_t.
nvflag Specify bit fields defining nvlist properties:
  NV_UNIQUE_NAME The nvpair names are unique.
  NV_UNIQUE_NAME_TYPE Name-data type combination is
unique
flag Specify 0. Reserved for future use.
**nvlist_alloc(3NVPAIR)**

<table>
<thead>
<tr>
<th>nvlist_t to be processed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointer to buffer to contain the encoded size.</td>
</tr>
<tr>
<td>Address of buffer to pack <code>nvlist</code> into. Must be 8-byte aligned. If NULL, library will allocate memory.</td>
</tr>
<tr>
<td>Size of buffer <code>bufp</code> points to.</td>
</tr>
<tr>
<td>Buffer containing packed <code>nvlist</code>.</td>
</tr>
<tr>
<td>Encoding method for packing.</td>
</tr>
</tbody>
</table>

**RETURN VALUES**

Upon successful completion, 0 is returned. Otherwise, -1 is returned and `errno` is set to indicate the error.

**ERRORS**

All five functions will fail if:

- **EINVAL** There is an invalid argument.

The `nvlist_alloc()`, `nvlist_dup()`, `nvlist_pack()`, and `nvlist_unpack()` functions will fail if:

- **ENOMEM** There is insufficient memory.

The `nvlist_pack()` and `nvlist_unpack()` functions will fail if:

- **EFAULT** An encode/decode error occurs.
- **ENOTSUP** An encode/decode method is not supported.

**EXAMPLES**

```c
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <string.h>
#include <unistd.h>
#include <libnvpair.h>

/* generate a packed nvlist */
static int
create_packed_nvlist(char **buf, uint_t *buflen, int encode)
{
    uchar_t bytes[] = {0xaa, 0xbb, 0xcc, 0xdd};
    int16_t int16[] = {0, 1, 2};
    int32_t int32[] = {3, 4, 5};
    uint64_t uint64[] = {0x100000007, 0x100000008, 0x100000009};
    char *strs[] = {"child0", "child1", "child2"};
    int err;
    nvlist_t *nvl;

    err = nvlist_alloc(&nvl, NV_UNIQUE_NAME, 0); /* allocate list */
    if (err) {
        (void) printf("nvlist_alloc() failed\n");
        return -1;
    }
    ```
/* add a value of each type */
if ((nvlist_add_boolean(nvl, "bool") != 0) ||
    (nvlist_add_byte(nvl, "byte", bytes[0]) != 0) ||
    (nvlist_add_int16(nvl, "int16", int16[0]) != 0) ||
    (nvlist_add_int32(nvl, "int32", int32[0]) != 0) ||
    (nvlist_add_uint64(nvl, "uint64", uint64[0]) != 0) ||
    (nvlist_add_string(nvl, "string", strs[0]) != 0) ||
    (nvlist_add_byte_array(nvl, "byte_array", bytes, 4) != 0) ||
    (nvlist_add_int16_array(nvl, "int16_array", int16, 3) != 0) ||
    (nvlist_add_int32_array(nvl, "int32_array", int32, 3) != 0) ||
    (nvlist_add_uint64_array(nvl, "uint64_array", uint64, 3) != 0) ||
    (nvlist_add_string_array(nvl, "string_array", strs, 3) != 0)) {
    nvlist_free(nvl);
    return (-1);
}

err = nvlist_size(nvl, buflen, encode);
if (err) {
    (void) printf("nvlist_size: %s\n", strerror(err));
    return (err);
}

/* pack into contig. memory */
err = nvlist_pack(nvl, buf, buflen, encode, 0);
if (err) {
    (void) printf("nvlist_pack: %s\n", strerror(err));
    /* free the original list */
    nvlist_free(nvl);
    return (err);
}

/* read a packed nvlist from file or create a packed nvlist */
static int
get_nvlist_buf(char *file, char **buf, size_t *buflen) {
    int fd, rv;
    struct stat sbuf;
    if (file == NULL)
        return (create_packed_nvlist(buf, buflen, NV_ENCODE_NATIVE));

    /* read from file */
    fd = open(file, O_RDONLY);
    if (fd == -1) {
        (void) printf("cannot open file %s\n", file);
        return (-1);
    }
    (void) fstat(fd, &sbuf);
    *buflen = sbuf.st_size;
*buf = malloc(*buflen);
if (*buf == NULL) {
    (void) printf("out of memory\n")
    return (-1);
}
rv = read(fd, *buf, *buflen);
(void) close(fd);
return (rv);

/* selectively print nvpairs */
static void
nvlist_lookup_and_print(nvlist_t *nvl)
{
    char **str_val;
    int i, int_val;
    uint_t nval;

    if (nvlist_lookup_int32(nvl, "int32", &int_val) == 0)
        (void) printf("int32 = %d\n", int_val);
    if (nvlist_lookup_string_array(nvl, "string_array", &str_val, &nval)
        == 0) {
        (void) printf("string_array =");
        for (i = 0; i < nval; i++)
            (void) printf(" %s", str_val[i]);
        (void) printf("\n");
    }
}
void
main(int argc, char *argv[])
{
    int c, err;
    char *file = NULL, *buf = NULL;
    size_t buflen;
    nvlist_t *nvl = NULL;

    while ((c = getopt(argc, argv, "r:")) != EOF)
        switch (c) {
            case 'r':
                file = optarg;
                break;
            default:
                (void) printf("Usage: %s [ -r file ]", argv[0]);
                return;
        }
    if (get_nvlist_buf(file, &buf, &buflen) != 0) {
        (void) printf("cannot get packed nvlist buffer\n");
        return;
    }
    /* unpack into an nvlist_t */
err = nvlist_unpack(buf, buflen, &nvl, 0);
if (err) {
    (void) printf("nvlist_unpack(): %s", strerror(err));
    return;
}
/* selectively print out attributes */
nvlist_lookup_and_print(nvl);
return;

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
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</tr>
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</tr>
</tbody>
</table>

SEE ALSO  bcopy(3C), libnvpair(3NVPAIR), attributes(5)
nvlist_lookup_boolean(3NVPAIR)

NAME
nvlist_lookup_boolean, nvlist_lookup_byte, nvlist_lookup_int16,
nvlist_lookup_uint16, nvlist_lookup_int32, nvlist_lookup_uint32, nvlist_lookup_int64,
nvlist_lookup_uint64, nvlist_lookup_string, nvlist_lookup_byte_array,
nvlist_lookup_int16_array, nvlist_lookup_uint16_array, nvlist_lookup_int32_array,
nvlist_lookup_uint32_array, nvlist_lookup_int64_array, nvlist_lookup_uint64_array,
nvlist_lookup_string_array – match name and type indicated by the interface name
and retrieve data value

SYNOPSIS
cc [flag ...] file ...-lnvpair [library ...]
#include <libnvpair.h>

int nvlist_lookup_boolean(nvlist_t *nvl, char *name);
int nvlist_lookup_byte(nvlist_t *nvl, char *name, uchar_t *val);
int nvlist_lookup_int16(nvlist_t *nvl, char *name, int16_t *val);
int nvlist_lookup_uint16(nvlist_t *nvl, char *name, uint16_t *val);
int nvlist_lookup_int32(nvlist_t *nvl, char *name, int32_t *val);
int nvlist_lookup_uint32(nvlist_t *nvl, char *name, uint32_t *val);
int nvlist_lookup_int32(nvlist_t *nvl, char *name, int64_t *val);
int nvlist_lookup_uint32(nvlist_t *nvl, char *name, uint64_t *val);
int nvlist_lookup_string(nvlist_t *nvl, char *name, char **val);
int nvlist_lookup_byte_array(nvlist_t *nvl, char *name, uchar_t **val, uint_t *nelem);
int nvlist_lookup_int16_array(nvlist_t *nvl, char *name, int16_t **val, uint_t *nelem);
int nvlist_lookup_uint16_array(nvlist_t *nvl, char *name, uint16_t **val, uint_t *nelem);
int nvlist_lookup_int32_array(nvlist_t *nvl, char *name, int32_t **val, uint_t *nelem);
int nvlist_lookup_uint32_array(nvlist_t *nvl, char *name, uint32_t **val, uint_t *nelem);
int nvlist_lookup_int64_array(nvlist_t *nvl, char *name, int64_t **val, uint_t *nelem);
int nvlist_lookup_uint64_array(nvlist_t *nvl, char *name, uint64_t **val, uint_t *nelem);
int nvlist_lookup_string_array(nvlist_t *nvl, char *name, char **val, uint_t *nelem);

PARAMETERS
nvl The nvlist_t to be processed.
name Name of the name-value pair to search.
nelem Address to store the number of elements in value.
nvlist_lookup_boolean(3NVPAIR)

val Address to store the starting address of the value.

DESCRIPTION These functions find the nvpair (name-value pair) that matches the name and type as indicated by the interface name. If one is found, nelem and val are modified to contain the number of elements in value and the starting address of data, respectively.

These functions work for nvlists (lists of name-value pairs) allocated with NV_UNIQUE_NAME or NV_UNIQUE_NAME_TYPE specified in nvlist_alloc(). (See nv_list_alloc(3NVPAIR).) If this is not the case, the function returns ENOTSUP because the list potentially contains multiple nvpairs with the same name and type.

All memory required for storing the array elements, including string value, are managed by the library. References to such data remain valid until nvlist_free() is called on nvl.

RETURN VALUES Upon successful completion, 0 is returned. Otherwise, –1 is returned and errno is set to indicate the error.

ERRORS These functions will fail if:

EINVAL There is an invalid argument.
ENOENT No matching name-value pair is found
ENOTSUP An encode/decode method is not supported.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO libnvpair(3NVPAIR), attributes(5)
nvlist_next_nvpair, nvpair_name, nvpair_type – return data regarding name-value pairs

The `nvlist_next_nvpair()` function returns a handle to the next `nvpair` in the list following `nvpair`. If `nvpair` is NULL, the first pair is returned. If `nvpair` is the last pair in the `nvlist`, NULL is returned.

The `nvpair_name()` function returns a string containing the name of `nvpair`.

The `nvpair_type()` function retrieves the value of the `nvpair` in the form of enumerated type `data_type_t`. This is used to determine the appropriate `nvpair_*()` function to call for retrieving the value.

Upon successful completion, `nvpair_name()` returns a string containing the name of the name-value pair.

Upon successful completion, `nvpair_type()` returns an enumerated data type.

Upon reaching the end of a list, `nvlist_next_pair()` returns NULL. Otherwise, the function returns a handle to next `nvpair` in the list.

No errors are defined.

See `attributes(5)` for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO `libnvpair(3NVPAIR), attributes(5)`
nvlist_remove(3NVPAIR)

NAME
nvlist_remove, nvlist_remove_all – remove name-value pairs

SYNOPSIS
cce [flag ...] file ...-lnvpair [library ...]
#include <libnvpair.h>

void nvlist_remove(nvlist_t *nvl, char *name, data_type_t type);
void nvlist_remove_all(nvlist_t *nvl, char *name);

PARAMETERS
nvl The nvlist_t to be processed.
name Name of the name-value pair to be removed.
type Data type of the nvpair to be removed.

DESCRIPTION
The nvlist_remove() function removes the first occurrence of nvpair that
matches the name and the type.

The nvlist_remove_all() function removes all occurrences of nvpair that match
the name, regardless of type.

RETURN VALUES
No return values are defined.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
libnvpair(3NVPAIR), attributes(5)
### NAME

nvpair_value_byte, nvpair_value_int16, nvpair_value_uint16, nvpair_value_int32,
nvpair_value_uint32, nvpair_value_int64, nvpair_value_uint64, nvpair_value_string,
nvpair_value_byte_array, nvpair_value_int16_array, nvpair_value_uint16_array,
nvpair_value_int32_array, nvpair_value_uint32_array, nvpair_value_int64_array,
nvpair_value_uint64_array, nvpair_value_string_array – retrieve value from a
name-value pair

### SYNOPSIS

```c
#include <libnvpair.h>

int nvpair_value_byte(nvpair_t *nvpair, uchar_t *val);
int nvpair_value_int16(nvpair_t *nvpair, int16_t *val);
int nvpair_value_uint16(nvpair_t *nvpair, uint16_t *val);
int nvpair_value_int32(nvpair_t *nvpair, int32_t *val);
int nvpair_value_uint32(nvpair_t *nvpair, uint32_t *val);
int nvpair_value_int64(nvpair_t *nvpair, int64_t *val);
int nvpair_value_uint64(nvpair_t *nvpair, uint64_t *val);
int nvpair_value_string(nvpair_t *nvpair, char **val);
int nvpair_value_byte_array(nvpair_t *nvpair, uchar_t **val, uint_t *nelem);
int nvpair_value_int16_array(nvpair_t *nvpair, int16_t **val, uint_t *nelem);
int nvpair_value_uint16_array(nvpair_t *nvpair, uint16_t **val, uint_t *nelem);
int nvpair_value_int32_array(nvpair_t *nvpair, int32_t **val, uint_t *nelem);
int nvpair_value_uint32_array(nvpair_t *nvpair, uint32_t **val, uint_t *nelem);
int nvpair_value_int64_array(nvpair_t *nvpair, int64_t **val, uint_t *nelem);
int nvpair_value_uint64_array(nvpair_t *nvpair, uint64_t **val, uint_t *nelem);
int nvpair_value_string_array(nvpair_t *nvpair, char ***val, uint_t *nelem);
```

### PARAMETERS

- **nvpair**: Name-value pair to be processed.
- **nelem**: Address to store the number of elements in value.
- **val**: Address to store the value or the starting address of the array value.
These functions retrieve the value of `nvpair`. The data type of `nvpair` must match the interface name for the call to be successful.

There is no `nvpair_value_boolean();` the existence of the name implies the value is true.

For array data types, including string, the memory containing the data is managed by the library and references to the value remains valid until `nvlist_free()` is called on the `nvlist_t` from which `nvpair` is obtained. See `nvlist_free(3NVPAIR)`.

Upon successful completion, 0 is returned. Otherwise, –1 is returned and `errno` is set to indicate the error.

These functions will fail if:

- `EINVAL` Either one of the arguments is NULL or the type of `nvpair` does not match the function name.

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also `libnvpair(3LIB), attributes(5)`.
p2open, p2close – open, close pipes to and from a command

SYNOPSIS

cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

int p2open(const char *cmd, FILE *fp[2]);
int p2close(FILE *fp[2]);

DESCRIPTION

p2open() forks and execs a shell running the command line pointed to by cmd. On
return, fp[0] points to a FILE pointer to write the command’s standard input and
fp[1] points to a FILE pointer to read from the command’s standard output. In this
way the program has control over the input and output of the command.

The function returns 0 if successful; otherwise, it returns −1.

p2close() is used to close the file pointers that p2open() opened. It waits for the
process to terminate and returns the process status. It returns 0 if successful;
otherwise, it returns −1.

RETURN VALUES

A common problem is having too few file descriptors. p2close() returns −1 if the
two file pointers are not from the same p2open().

EXAMPLES

EXAMPLE 1 Example of file descriptors.

#include <stdio.h>
#include <libgen.h>

main(argc,argv)
int argc;
char **argv;
{
    FILE *fp[2];
    pid_t pid;
    char buf[16];
    pid=p2open("/usr/bin/cat", fp);
    if ( pid == −1 ) {
        fprintf(stderr, "p2open failed\n");
        exit(1);
    }
    write(fileno(fp[0]),"This is a test\n", 16);
    if(read(fileno(fp[1]), buf, 16) <=0)
        fprintf(stderr, "p2open failed\n");
    else
        write(1, buf, 16);
    (void)p2close(fp);  
}

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:
SEE ALSO

fclose(3C), popen(3C), setbuf(3C), attributes(5)

NOTES

Buffered writes on fp[0] can make it appear that the command is not listening.
Judiciously placed fflush() calls or unbuffering fp[0] can be a big help; see
fclose(3C).

Many commands use buffered output when connected to a pipe. That, too, can make it
appear as if things are not working.

Usage is not the same as for popen(), although it is closely related.
NAME  pam – PAM (Pluggable Authentication Module)

SYNOPSIS  
#include <security/pam_appl.h>
cc [ flag... ] file ... -lpam [ library ... ]

DESCRIPTION  
The PAM framework, libpam, consists of an interface library and multiple authentication service modules. The PAM interface library is the layer implementing the Application Programming Interface (API). The authentication service modules are a set of dynamically loadable objects invoked by the PAM API to provide a particular type of user authentication. PAM gives system administrators the flexibility of choosing any authentication service available on the system to perform authentication. This framework also allows new authentication service modules to be plugged in and made available without modifying the applications.

The PAM library interface consists of six categories of functions, the names for which all start with the prefix pam_.

The first category contains functions for establishing and terminating an authentication activity, which are pam_start(3PAM) and pam_end(3PAM). The functions pam_set_data(3PAM) and pam_get_data(3PAM) maintain module specific data. The functions pam_set_item(3PAM) and pam_get_item(3PAM) maintain state information. pam_strerror(3PAM) is the function that returns error status information.

The second category contains the functions that authenticate an individual user and set the credentials of the user, pam_authenticate(3PAM) and pam_setcred(3PAM).

The third category of PAM interfaces is account management. The function pam_acct_mgmt(3PAM) checks for password aging and access-hour restrictions.

Category four contains the functions that perform session management after access to the system has been granted. See pam_open_session(3PAM) and pam_close_session(3PAM)

The fifth category consists of the function that changes authentication tokens, pam_chauthtok(3PAM). An authentication token is the object used to verify the identity of the user. In UNIX, an authentication token is a user’s password.

The sixth category of functions can be used to set values for PAM environment variables. See pam_putenv(3PAM), pam_getenv(3PAM), and pam_getenvlist(3PAM).

The pam_*() interfaces are implemented through the library libpam. For each of the categories listed above, excluding categories one and six, dynamically loadable shared modules exist that provides the appropriate service layer functionality upon demand. The functional entry points in the service layer start with the pam_sm_ prefix. The only difference between the pam_sm_*() interfaces and their
corresponding pam_interpose() interfaces is that all the pam_sm_*() interfaces require extra parameters to pass service-specific options to the shared modules. Refer to pam_sm(3PAM) for an overview of the PAM service module APIs.

A sequence of calls sharing a common set of state information is referred to as an authentication transaction. An authentication transaction begins with a call to pam_start(). pam_start() allocates space, performs various initialization activities, and assigns a PAM authentication handle to be used for subsequent calls to the library.

After initiating an authentication transaction, applications can invoke pam_authenticate() to authenticate a particular user, and pam_acct_mgmt() to perform system entry management. For example, the application may want to determine if the user’s password has expired.

If the user has been successfully authenticated, the application calls pam_setcred() to set any user credentials associated with the authentication service. Within one authentication transaction (between pam_start() and pam_end()), all calls to the PAM interface should be made with the same authentication handle returned by pam_start(). This is necessary because certain service modules may store module-specific data in a handle that is intended for use by other modules. For example, during the call to pam_authenticate(), service modules may store data in the handle that is intended for use by pam_setcred().

To perform session management, applications call pam_open_session(). Specifically, the system may want to store the total time for the session. The function pam_close_session() closes the current session.

When necessary, applications can call pam_get_item() and pam_set_item() to access and to update specific authentication information. Such information may include the current username.

To terminate an authentication transaction, the application simply calls pam_end(), which frees previously allocated space used to store authentication information.

The PAM architecture enables authentication by multiple authentication services through stacking. System entry applications, such as login(1), stack multiple service modules to authenticate users with multiple authentication services. The order in which authentication service modules are stacked is specified in the configuration file, pam.conf(4). A system administrator determines this ordering, and also determines whether the same password can be used for all authentication services.
The authentication library, /usr/lib/libpam.so.1, implements the framework interface. Various authentication services are implemented by their own loadable modules whose paths are specified through the pam.conf(4) file.

The PAM functions may return one of the following generic values, or one of the values defined in the specific man pages:

- **PAM_SUCCESS**: The function returned successfully.
- **PAM_OPEN_ERR**: dlopen() failed when dynamically loading a service module.
- **PAM_SYMBOL_ERR**: Symbol not found.
- **PAM_SERVICE_ERR**: Error in service module.
- **PAM_SYSTEM_ERR**: System error.
- **PAM_BUF_ERR**: Memory buffer error.
- **PAM_CONV_ERR**: Conversation failure.
- **PAM_PERM_DENIED**: Permission denied.

See attributes(5) for description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO

login(1), pam_authenticate(3PAM), pam_chauthtok(3PAM),
pam_open_session(3PAM), pam_set_item(3PAM), pam_setcred(3PAM),
pam_sm(3PAM), pam_start(3PAM), pam_strerror(3PAM), pam.conf(4),
attributes(5)

NOTES

The interfaces in libpam() are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_acct_mgmt(3PAM)

NAME pam_acct_mgmt – perform PAM account validation procedures

SYNOPSIS ee [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>

int pam_acct_mgmt(pam_handle_t *pamh, int flags);

DESCRIPTION The pam_acct_mgmt() function is called to determine if the current user’s account is valid. It checks for password and account expiration, and verifies access hour restrictions. This function is typically called after the user has been authenticated with pam_authenticate(3PAM).

The pamh argument is an authentication handle obtained by a prior call to pam_start(). The following flags may be set in the flags field:

- PAM_SILENT The account management service should not generate any messages.
- PAM_DISALLOW_NULL_AUTHTOK The account management service should return PAM_NEW_AUTHTOK_REQD if the user has a null authentication token.

RETURN VALUES Upon successful completion, PAM_SUCCESS is returned. In addition to the error return values described in pam(3PAM), the following values may be returned:

- PAM_USER_UNKNOWN User not known to underlying account management module.
- PAM_AUTH_ERR Authentication failure.
- PAM_NEW_AUTHTOK_REQD New authentication token required. This is normally returned if the machine security policies require that the password should be changed because the password is NULL or has aged.
- PAM_ACCT_EXPIRED User account has expired.

ATTRIBUTES See attributes(5) for description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO pam(3PAM), pam_authenticate(3PAM), pam_start(3PAM), libpam(3LIB), attributes(5)

NOTES The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_authenticate

pam_authenticate – perform authentication within the PAM framework

SYNOPSIS

```
include <security/pam_appl.h>

int pam_authenticate(pam_handle_t *pamh, int flags);
```

DESCRIPTION

The `pam_authenticate()` function is called to authenticate the current user. The user is usually required to enter a password or similar authentication token depending upon the authentication service configured within the system. The user in question should have been specified by a prior call to `pam_start()` or `pam_set_item()`.

The following flags may be set in the `flags` field:

- **PAM_SILENT**: Authentication service should not generate any messages.
- **PAM_DISALLOW_NULL_AUTHTOK**: The authentication service should return `PAM_AUTH_ERROR` if the user has a null authentication token.

RETURN VALUES

Upon successful completion, `PAM_SUCCESS` is returned. In addition to the error return values described in `pam(3PAM)`, the following values may be returned:

- **PAM_AUTH_ERR**: Authentication failure.
- **PAM_CRED_INSUFFICIENT**: Cannot access authentication data due to insufficient credentials.
- **PAM_AUTHINFO_UNAVAIL**: Underlying authentication service cannot retrieve authentication information.
- **PAM_USER_UNKNOWN**: User not known to the underlying authentication module.
- **PAM_MAXTRIES**: An authentication service has maintained a retry count which has been reached. No further retries should be attempted.

ATTRIBUTES

See `attributes(5)` for description of the following attributes:

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<thead>
<tr>
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</tr>
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</tr>
</tbody>
</table>

SEE ALSO

`pam(3PAM)`, `pam_open_session(3PAM)`, `pam_set_item(3PAM)`, `pam_setcred(3PAM)`, `pam_start(3PAM)`, `libpam(3LIB)`, `attributes(5)`
In the case of authentication failures due to an incorrect username or password, it is the responsibility of the application to retry `pam_authenticate()` and to maintain the retry count. An authentication service module may implement an internal retry count and return an error `PAM_MAXTRIES` if the module does not want the application to retry.

If the PAM framework cannot load the authentication module, then it will return `PAM_ABORT`. This indicates a serious failure, and the application should not attempt to retry the authentication.

For security reasons, the location of authentication failures is hidden from the user. Thus, if several authentication services are stacked and a single service fails, `pam_authenticate()` requires that the user re-authenticate each of the services.

A null authentication token in the authentication database will result in successful authentication unless `PAM_DISALLOW_NULL_AUTHTOK` was specified. In such cases, there will be no prompt to the user to enter an authentication token.

The interfaces in `libpam` are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
NAME
pam_chauthtok – perform password related functions within the PAM framework

SYNOPSIS
cc [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>

int pam_chauthtok(pam_handle_t *pamh, const int flags);

DESCRIPTION
The pam_chauthtok() function is called to change the authentication token associated with a particular user referenced by the authentication handle pamh.

The following flag may be passed in to pam_chauthtok():

PAM_SILENT       The password service should not generate any messages.
PAM_CHANGE_EXPIRED_AUTHTOK The password service should only update those passwords that have aged. If this flag is not passed, all password services should update their passwords.

Upon successful completion of the call, the authentication token of the user will be changed in accordance with the password service configured in the system through pam.conf(4).

RETURN VALUES
Upon successful completion, PAM_SUCCESS is returned. In addition to the error return values described in pam(3PAM), the following values may be returned:

PAM_PERM_DENIED No permission.
PAM_AUTHTOK_ERR Authentication token manipulation error.
PAM_AUTHTOK_RECOVERY_ERR Authentication information cannot be recovered.
PAM_AUTHTOK_LOCK_BUSY Authentication token lock busy.
PAM_AUTHTOK_DISABLE_AGING Authentication token aging disabled.
PAM_USER_UNKNOWN User unknown to password service.
PAM_TRY_AGAIN Preliminary check by password service failed.

ATTRIBUTES
See attributes(5) for description of the following attributes:

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<tbody>
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<tr>
<td>MT-Level</td>
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</tr>
</tbody>
</table>

SEE ALSO
login(1), passwd(1), pam(3PAM), pam_authenticate(3PAM), pam_start(3PAM), attributes
pam_chauthtok(3PAM)

NOTES

The flag PAM_CHANGE_EXPIRED_AUTHTOK is typically used by a login application which has determined that the user's password has aged or expired. Before allowing the user to login, the login application may invoke pam_chauthtok() with this flag to allow the user to update the password. Typically, applications such as passwd(1) should not use this flag.

The pam_chauthtok() functions performs a preliminary check before attempting to update passwords. This check is performed for each password module in the stack as listed in pam.conf(4). The check may include pinging remote name services to determine if they are available. If pam_chauthtok() returns PAM_TRY_AGAIN, then the check has failed, and passwords are not updated.

The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
The `pam_getenv()` function searches the PAM handle `pamh` for a value associated with `name`. If a value is present, `pam_getenv()` makes a copy of the value and returns a pointer to the copy back to the calling application. If no such entry exists, `pam_getenv()` returns `NULL`. It is the responsibility of the calling application to free the memory returned by `pam_getenv()`.

If successful, `pam_getenv()` returns a copy of the value associated with `name` in the PAM handle; otherwise, it returns a `NULL` pointer.

See `attributes(5)` for descriptions of the following attributes:

```
<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
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</tr>
</tbody>
</table>
```

The interfaces in `libpam` are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_getenvlist(3PAM)

NAME pam_getenvlist – returns a list of all the PAM environment variables

SYNOPSIS
#include <security/pam_appl.h>

char **pam_getenvlist(pam_handle_t *pamh);

DESCRIPTION The pam_getenvlist() function returns a list of all the PAM environment variables stored in the PAM handle pamh. The list is returned as a null-terminated array of pointers to strings. Each string contains a single PAM environment variable of the form name=value. The list returned is a duplicate copy of all the environment variables stored in pamh. It is the responsibility of the calling application to free the memory returned by pam_getenvlist().

RETURN VALUES If successful, pam_getenvlist() returns in a null-terminated array a copy of all the PAM environment variables stored in pamh. Otherwise, pam_getenvlist() returns a null pointer.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO pam(3PAM), pam_getenv(3PAM), pam_putenv(3PAM), libpam(3LIB), attributes(5)

NOTES The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
### NAME
pam_get_user – PAM routine to retrieve user name

### SYNOPSIS
```c
#include <security/pam_appl.h>

int pam_get_user(pam_handle_t *pamh, char **user, const char *prompt);
```

### DESCRIPTION
The `pam_get_user()` function is used by PAM service modules to retrieve the current user name from the PAM handle. If the user name has not been set with `pam_start()` or `pam_set_item()`, the PAM conversation function will be used to prompt the user for the user name with the string "prompt". If `prompt` is `NULL`, then `pam_get_item()` is called and the value of `PAM_USER_PROMPT` is used for prompting. If the value of `PAM_USER_PROMPT` is `NULL`, the following default prompt is used:

```
Please enter user name:
```

After the user name is gathered by the conversation function, `pam_set_item()` is called to set the value of `PAM_USER`. By convention, applications that need to prompt for a user name should call `pam_set_item()` and set the value of `PAM_USER_PROMPT` before calling `pam_authenticate()`. The service module's `pam_sm_authenticate()` function will then call `pam_get_user()` to prompt for the user name.

Note that certain PAM service modules, such as a smart card module, may override the value of `PAM_USER_PROMPT` and pass in their own prompt. Applications that call `pam_authenticate()` multiple times should set the value of `PAM_USER` to `NULL` with `pam_set_item()` before calling `pam_authenticate()`, if they want the user to be prompted for a new user name each time. The value of `user` retrieved by `pam_get_user()` should not be modified or freed. The item will be released by `pam_end()`.

### RETURN VALUES
Upon success, `pam_get_user()` returns `PAM_SUCCESS`; otherwise it returns an error code. Refer to `pam(3PAM)` for information on error related return values.

### ATTRIBUTES
See `attributes(5)` for description of the following attributes:

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<thead>
<tr>
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</tr>
</tbody>
</table>

### SEE ALSO
`pam(3PAM), pam_authenticate(3PAM), pam_end(3PAM), pam_get_item(3PAM), pam_set_item(3PAM), pam_sm(3PAM), pam_sm_authenticate(3PAM), pam_start(3PAM), attributes(5)`
pam_get_user(3PAM)

NOTES  The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_open_session(3PAM)

NAME
pam_open_session, pam_close_session – perform PAM session creation and termination operations

SYNOPSIS
cc [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>

int pam_open_session(pam_handle_t *pamh, int flags);

int pam_close_session(pam_handle_t *pamh, int flags);

DESCRIPTION
The pam_open_session() function is called after a user has been successfully authenticated. See pam_authenticate(3PAM) and pam_acct_mgmt(3PAM). It is used to notify the session modules that a new session has been initiated. All programs that use the pam(3PAM) library should invoke pam_open_session() when beginning a new session. Upon termination of this activity, pam_close_session() should be invoked to inform pam(3PAM) that the session has terminated.

The pamh argument is an authentication handle obtained by a prior call to pam_start(). The following flag may be set in the flags field for pam_open_session() and pam_close_session():

PAM_SILENT The session service should not generate any messages.

RETURN VALUES
Upon successful completion, PAM_SUCCESS is returned. In addition to the return values defined in pam(3PAM), the following value may be returned on error:

PAM_SESSION_ERR Cannot make or remove an entry for the specified session.

ATTRIBUTES
See attributes(5) for description of the following attributes:

<table>
<thead>
<tr>
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<tr>
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</tbody>
</table>

SEE ALSO
getutxent(3C), pam(3PAM), pam_acct_mgmt(3PAM), pam_authenticate(3PAM), pam_start(3PAM), attributes(5)

NOTES
In many instances, the pam_open_session() and pam_close_session() calls may be made by different processes. For example, in UNIX the login process opens a session, while the init process closes the session. In this case, UTMP/WTMP entries may be used to link the call to pam_close_session() with an earlier call to pam_open_session(). This is possible because UTMP/WTMP entries are uniquely identified by a combination of attributes, including the user login name and device name, which are accessible through the PAM handle, pamh. The call to pam_open_session() should precede UTMP/WTMP entry management, and the call to pam_close_session() should follow UTMP/WTMP exit management.
pam_open_session(3PAM)

The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_putenv – change or add a value to the PAM environment

SYNOPSIS

cc [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>

int pam_putenv(pam_handle_t *pamh, const char *name_value);

DESCRIPTION

The pam_putenv() function sets the value of the PAM environment variable name equal to value either by altering an existing PAM variable or by creating a new one.

The name_value argument points to a string of the form name=value. A call to pam_putenv() does not immediately change the environment. All name_value pairs are stored in the PAM handle pamh. An application such as login(1) may make a call to pam_getenv(3PAM) or pam_getenvlist(3PAM) to retrieve the PAM environment variables saved in the PAM handle and set them in the environment if appropriate. login will not set PAM environment values which overwrite the values for SHELL, HOME, LOGNAME, MAIL, CDPATH, IPS, and PATH. Nor will login set PAM environment values which overwrite any value that begins with LD_.

If name_value equals NAME=, then the value associated with NAME in the PAM handle will be set to an empty value. If name_value equals NAME, then the environment variable NAME will be removed from the PAM handle.

RETURN VALUES

The pam_putenv() function may return one of the following values:

- PAM_SUCCESS: The function returned successfully.
- PAM_OPEN_ERR: dlopen() failed when dynamically loading a service module.
- PAM_SYMBOL_ERR: Symbol not found.
- PAM_SERVICE_ERR: Error in service module.
- PAM_SYSTEM_ERR: System error.
- PAM_BUF_ERR: Memory buffer error.
- PAM_CONV_ERR: Conversation failure.
- PAM_PERM_DENIED: Permission denied.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
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<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO
dlopen(3DL), pam(3PAM), pam_getenv(3PAM), pam_getenvlist(3PAM), libpam(3LIB), attributes(5)
The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
The `pam_setcred()` function is used to establish, modify, or delete user credentials. It is typically called after the user has been authenticated and after a session has been opened. See `pam_authenticate(3PAM)`, `pam_acct_mgmt(3PAM)`, and `pam_open_session(3PAM)`.

The user is specified by a prior call to `pam_start()` or `pam_set_item()`, and is referenced by the authentication handle, `pamh`. The following flags may be set in the `flags` field. Note that the first four flags are mutually exclusive:

- **PAM_ESTABLISH_CRED**: Set user credentials for an authentication service.
- **PAM_DELETE_CRED**: Delete user credentials associated with an authentication service.
- **PAM_REINITIALIZE_CRED**: Reinitialize user credentials.
- **PAM_REFRESH_CRED**: Extend lifetime of user credentials.
- **PAM_SILENT**: Authentication service should not generate any messages.

If no flag is set, **PAM_ESTABLISH_CRED** is used as the default.

Upon success, `pam_setcred()` returns **PAM_SUCCESS**. In addition to the error return values described in `pam(3PAM)` the following values may be returned upon error:

- **PAM_CRED_UNAVAIL**: Underlying authentication service can not retrieve user credentials unavailable.
- **PAM_CRED_EXPIRED**: User credentials expired.
- **PAM_USER_UNKNOWN**: User unknown to underlying authentication service.
- **PAM_CRED_ERR**: Failure setting user credentials.

See `attributes(5)` for description of the following attributes:

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</table>
The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
NAME | pam_set_data, pam_get_data – PAM routines to maintain module specific state
SYNOPSIS | 
include <security/pam_appl.h>

int pam_set_data(pam_handle_t *pamh, const char *module_data_name, void *data, void (*cleanup)(pam_handle_t *pamh, void *data, int pam_end_status));

int pam_get_data(const pam_handle_t *pamh, const char *module_data_name, const void **data);

DESCRIPTION | The pam_set_data() and pam_get_data() functions allow PAM service modules to access and update module specific information as needed. These functions should not be used by applications.

The pam_set_data() function stores module specific data within the PAM handle pamh. The module_data_name argument uniquely identifies the data, and the data argument represents the actual data. The module_data_name argument should be unique across all services.

The cleanup function frees up any memory used by the data after it is no longer needed, and is invoked by pam_end(). The cleanup function takes as its arguments a pointer to the PAM handle, pamh, a pointer to the actual data, data, and a status code, pam_end_status. The status code determines exactly what state information needs to be purged.

If pam_set_data() is called and module data already exists from a prior call to pam_set_data() under the same module_data_name, then the existing data is replaced by the new data, and the existing cleanup function is replaced by the new cleanup function.

The pam_get_data() function retrieves module-specific data stored in the PAM handle, pamh, identified by the unique name, module_data_name. The data argument is assigned the address of the requested data. The data retrieved by pam_get_data() should not be modified or freed. The data will be released by pam_end().

RETURN VALUES | In addition to the return values listed in pam(3PAM), the following value may also be returned:

PAM_NO_MODULE_DATA No module specific data is present.

ATTRIBUTES | See attributes(5) for description of the following attributes:

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</table>

SEE ALSO | pam(3PAM), pam_end(3PAM), libpam(3LIB), attributes(5)
The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
The pam_get_item() and pam_set_item() functions allow applications and PAM service modules to access and to update PAM information as needed. The information is specified by item_type, and can be one of the following:

- **PAM_SERVICE** The service name.
- **PAM_USER** The user name.
- **PAM_AUTHTOK** The user authentication token.
- **PAM_OLDAUTHTOK** The old user authentication token.
- **PAM_TTY** The tty name.
- **PAM_RHOST** The remote host name.
- **PAM_RUSER** The remote user name.
- **PAM_CONV** The pam_conv structure.
- **PAM_USER_PROMPT** The default prompt used by pam_get_user().

For security reasons, the item_type PAM_AUTHTOK and PAM_OLDAUTHTOK are available only to the module providers. The authentication module, account module, and session management module should treat PAM_AUTHTOK as the current authentication token and ignore PAM_OLDAUTHTOK. The password management module should treat PAM_OLDAUTHTOK as the current authentication token and PAM_AUTHTOK as the new authentication token.

The pam_set_item() function is passed the authentication handle, pamh, returned by pam_start(), a pointer to the object, item, and its type, item_type. If successful, pam_set_item() copies the item to an internal storage area allocated by the authentication module and returns PAM_SUCCESS. An item that had been previously set will be overwritten by the new value.

The pam_get_item() function is passed the authentication handle, pamh, returned by pam_start(), an item_type, and the address of the pointer, item, which is assigned the address of the requested object. The object data is valid until modified by a subsequent call to pam_set_item() for the same item_type, or unless it is modified by any of the underlying service modules. If the item has not been previously set, pam_get_item() returns a null pointer. An item retrieved by pam_get_item() should not be modified or freed. The item will be released by pam_end().
Upon success, `pam_get_item()` returns `PAM_SUCCESS`; otherwise it returns an error code. Refer to `pam(3PAM)` for information on error related return values.

**ATTRIBUTES**

See `attributes(5)` for description of the following attributes:

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</table>

**SEE ALSO**

`pam(3PAM), pam_acct_mgmt(3PAM), pam_authenticate(3PAM), pam_chauthtok(3PAM), pam_get_user(3PAM), pam_open_session(3PAM), pam_setcred(3PAM), pam_start(3PAM), attributes(5)`

**NOTES**

The interfaces in `libpam` are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
PAM gives system administrators the flexibility of choosing any authentication service available on the system to perform authentication. The framework also allows new authentication service modules to be plugged in and made available without modifying the applications.

The PAM framework, libpam, consists of an interface library and multiple authentication service modules. The PAM interface library is the layer implementing the Application Programming Interface (API). The authentication service modules are a set of dynamically loadable objects invoked by the PAM API to provide a particular type of user authentication.

This manual page gives an overview of the PAM APIs for the service modules.

### Interface Overview

The PAM service module interface consists of functions which can be grouped into four categories. The names for all the authentication library functions start with `pam_sm`. The only difference between the `pam_*()` interfaces and their corresponding `pam_sm_*()` interfaces is that all the `pam_sm_*()` interfaces require extra parameters to pass service-specific options to the shared modules. They are otherwise identical.

The first category contains functions to authenticate an individual user, `pam_sm_authenticate(3PAM)`, and to set the credentials of the user, `pam_sm_setcred(3PAM)`. These back-end functions implement the functionality of `pam_authenticate(3PAM)` and `pam_setcred(3PAM)` respectively.

The second category contains the function to do account management: `pam_sm_acct_mgmt(3PAM)`. This includes checking for password aging and access-hour restrictions. This back-end function implements the functionality of `pam_acct_mgmt(3PAM)`.

The third category contains the functions `pam_sm_open_session(3PAM)` and `pam_sm_close_session(3PAM)` to perform session management after access to the system has been granted. These back-end functions implement the functionality of `pam_open_session(3PAM)` and `pam_close_session(3PAM)`, respectively.

The fourth category consists a function to change authentication tokens `pam_sm_chauthtok(3PAM)`. This back-end function implements the functionality of `pam_chauthtok(3PAM)`.

### Stateful Interface

A sequence of calls sharing a common set of state information is referred to as an authentication transaction. An authentication transaction begins with a call to `pam_start()`. `pam_start()` allocates space, performs various initialization

```c
#include <security/pam_appl.h>
#include <security/pam_modules.h>
cc [ flag ...] file ... -lpam [ library ...]
```
activities, and assigns an authentication handle to be used for subsequent calls to the library. Note that the service modules do not get called or initialized when `pam_start()` is called. The modules are loaded and the symbols resolved upon first use of that function.

The PAM handle keeps certain information about the transaction that can be accessed through the `pam_get_item()` API. Though the modules can also use `pam_set_item()` to change any of the item information, it is recommended that nothing be changed except `PAM_AUTHTOK` and `PAM_OLCDM_AUTHTOK`.

If the modules want to store any module specific state information then they can use the `pam_set_data(3PAM)` function to store that information with the PAM handle. The data should be stored with a name which is unique across all modules and module types. For example, `SUNW_PAM_UNIX_AUTH_userid` can be used as a name by the UNIX module to store information about the state of user’s authentication. Some modules use this technique to share data across two different module types.

Also, during the call to `pam_authenticate()`, the UNIX module may store the authentication status (success or reason for failure) in the handle, using a unique name such as `SUNW_SECURE_RPC_DATA`. This information is intended for use by `pam_setcred()`.

During the call to `pam_acct_mgmt()`, the account modules may store data in the handle to indicate which passwords have aged. This information is intended for use by `pam_chauthtok()`.

The module can also store a cleanup function associated with the data. The PAM framework calls this cleanup function, when the application calls `pam_end()` to close the transaction.

**Interaction with the User**

The PAM service modules do not communicate directly with the user; instead they rely on the application to perform all such interactions. The application passes a pointer to the function, `conv()`, along with any associated application data pointers, through the `pam_conv` structure when it initiates an authentication transaction (via a call to `pam_start()`). The service module will then use the function, `conv()`, to prompt the user for data, output error messages, and display text information. Refer to `pam_start(3PAM)` for more information. The modules are responsible for the localization of all messages to the user.

**CONVENTIONS**

By convention, applications that need to prompt for a user name should call `pam_set_item()` and set the value of `PAM_USER_PROMPT` before calling `pam_authenticate()`. The service module’s `pam_sm_authenticate()` function will then call `pam_get_user()` to prompt for the user name. Note that certain PAM service modules (such as a smart card module) may override the value of `PAM_USER_PROMPT` and pass in their own prompt.

Though the PAM framework enforces no rules about the module’s names, location, options and such, there are certain conventions that all module providers are expected to follow.
By convention, the modules should be located in the `/usr/lib/security` directory. Additional modules may be located in `/opt/<pkg>/lib`.

By convention, the modules are named `pam_<service_name>_<module_type>.so.1`. If the given module implements more than one module type (for example, `pam_unix.so.1` module), then the `module_type` suffix should be dropped.

For every such module, there should be a corresponding manual page in section 5 which should describe the `module_type` it supports, the functionality of the module, along with the options it supports. The dependencies should be clearly identified to the system administrator. For example, it should be made clear whether this module is a stand-alone module or depends upon the presence of some other module. One should also specify whether this module should come before or after some other module in the stack.

By convention, the modules should support the following options:

- **debug**
  Syslog debugging information at `LOG_DEBUG` level. Be careful as to not log any sensitive information such as passwords.

- **nowarn**
  Turn off warning messages such as "password is about to expire."

In addition, it is recommended that the auth and the password module support the following options:

- **use_first_pass**
  Instead of prompting the user for the password, use the user's initial password (entered when the user was authenticated to the first authentication module in the stack) for authentication. If the passwords do not match, or if no password has been entered, return failure and do not prompt the user for a password. Support for this scheme allows the user to type only one password for multiple schemes.

- **try_first_pass**
  Instead of prompting the user for the password, use the user's initial password (entered when the user was authenticated to the first authentication module in the stack) for authentication. If the passwords do not match, or if no password has been entered, prompt the user for a password after identifying which type of password (i.e., UNIX, etc.) is being requested. Support for this scheme allows the user to try to use only one password for multiple schemes, and type multiple passwords only if necessary.

If an unsupported option is passed to the modules, it should syslog the error at `LOG_ERR` level.
The permission bits on the service module should be set such that it is not writable by either "group" or "other." The PAM framework will not load the module if the above permission rules are not followed.

If there are any errors, the modules should log them using syslog(3C) at the LOG_ERR level.

The PAM service module functions may return any of the PAM error numbers specified in the specific man pages. It can also return a PAM_IGNORE error number to mean that the PAM framework should ignore this module regardless of whether it is required, optional or sufficient. This error number is normally returned when the module does not want to deal with the given user at all.

See attributes(5) for description of the following attributes:

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</tbody>
</table>

The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_sm_acct_mgmt(3PAM)

NAME
pam_sm_acct_mgmt – service provider implementation for pam_acct_mgmt

SYNOPSIS
cc [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>
#include <security/pam_modules.h>

int pam_sm_acct_mgmt(pam_handle_t *pamh, int flags, int argc, const char **argv);

DESCRIPTION
In response to a call to pam_acct_mgmt(3PAM), the PAM framework calls pam_sm_acct_mgmt() from the modules listed in the pam.conf(4) file. The account management provider supplies the back-end functionality for this interface function. Applications should not call this API directly.

The pam_sm_acct_mgmt() function determines whether or not the current user’s account and password are valid. This includes checking for password and account expiration, and valid login times. The user in question is specified by a prior call to pam_start(), and is referenced by the authentication handle, pamh, which is passed as the first argument to pam_sm_acct_mgmt(). The following flags may be set in the flags field:

PAM_SILENT The account management service should not generate any messages.

PAM_DISALLOW_NULL_AUTHTOK The account management service should return PAM_NEW_AUTHTOK_REQD if the user has a null authentication token.

The argc argument represents the number of module options passed in from the configuration file pam.conf(4). argv specifies the module options, which are interpreted and processed by the account management service. Please refer to the specific module man pages for the various available options. If an unknown option is passed to the module, an error should be logged through syslog(3C) and the option ignored.

If an account management module determines that the user password has aged or expired, it should save this information as state in the authentication handle, pamh, using pam_set_data(). pam_chauthok() uses this information to determine which passwords have expired.

RETURN VALUES
If there are no restrictions to logging in, PAM_SUCCESS is returned. The following error values may also be returned upon error:

PAM_USER_UNKNOWN User not known to underlying authentication module.

PAM_NEW_AUTHTOK_REQD New authentication token required.

PAM_ACCT_EXPIRED User account has expired.

PAM_PERM_DENIED User denied access to account at this time.
pam_sm_acct_mgmt(3PAM)

**PAM_IGNORE**

Ignore underlying account module regardless of whether the control flag is required, optional or sufficient.

**ATTRIBUTES**
See attributes(5) for description of the following attributes:

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</table>

**SEE ALSO**
pam(3PAM), pam_acct_mgmt(3PAM), pam_set_data(3PAM), pam_start(3PAM), syslog(3C), libpam(3LIB), pam.conf(4), attributes(5)

**NOTES**
The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.

356  man pages section 3: Extended Library Functions  •  Last Revised 13 Oct 1998
pam_sm_authenticate(3PAM)

NAME
pam_sm_authenticate – service provider implementation for pam_authenticate

SYNOPSIS
cc [ flag ...] file ... -lpam [ library ...]
#include <security/pam_appl.h>
#include <security/pam_modules.h>

int pam_sm_authenticate(pam_handle_t *pamh, int flags, int argc, const char **argv);

DESCRIPTION
In response to a call to pam_authenticate(3PAM), the PAM framework calls pam_sm_authenticate() from the modules listed in the pam.conf(4) file. The authentication provider supplies the back-end functionality for this interface function.

The pam_sm_authenticate() function is called to verify the identity of the current user. The user is usually required to enter a password or similar authentication token depending upon the authentication scheme configured within the system. The user in question is specified by a prior call to pam_start(), and is referenced by the authentication handle pamh.

If the user is unknown to the authentication service, the service module should mask this error and continue to prompt the user for a password. It should then return the error, PAM_USER_UNKNOWN.

The following flag may be passed in to pam_sm_authenticate():

PAM_SILENT
The authentication service should not generate any messages.

PAM_DISALLOW_NULL_AUTHTOK
The authentication service should return PAM_AUTH_ERROR if the user has a null authentication token.

The argc argument represents the number of module options passed in from the configuration file pam.conf(4). argv specifies the module options, which are interpreted and processed by the authentication service. Please refer to the specific module man pages for the various available options. If any unknown option is passed in, the module should log the error and ignore the option.

Before returning, pam_sm_authenticate() should call pam_get_item() and retrieve PAM_AUTHTOK. If it has not been set before and the value is NULL, pam_sm_authenticate() should set it to the password entered by the user using pam_set_item().

An authentication module may save the authentication status (success or reason for failure) as state in the authentication handle using pam_set_data(3PAM). This information is intended for use by pam_setcred().

RETURN VALUES
Upon successful completion, PAM_SUCCESS must be returned. In addition, the following values may be returned:

PAM_MAXTRIES
Maximum number of authentication attempts exceeded.
pam_sm_authenticate(3PAM)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAM_AUTH_ERR</td>
<td>Authentication failure.</td>
</tr>
<tr>
<td>PAM_CRED_INSUFFICIENT</td>
<td>Cannot access authentication data due to insufficient credentials.</td>
</tr>
<tr>
<td>PAM_AUTHINFO_UNAVAIL</td>
<td>Underlying authentication service can not retrieve authentication information.</td>
</tr>
<tr>
<td>PAM_USER_UNKNOWN</td>
<td>User not known to underlying authentication module.</td>
</tr>
<tr>
<td>PAM_IGNORE</td>
<td>Ignore underlying authentication module regardless of whether the control flag is required, optional, or sufficient.</td>
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**ATTRIBUTES**

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**SEE ALSO**

pam(3PAM), pam_authenticate(3PAM), pam_get_item(3PAM), pam_set_data(3PAM), pam_set_item(3PAM), pam_setcred(3PAM), pam_start(3PAM), libpam(3LIB), pam.conf(4), attributes(5)

**NOTES**

Modules should not retry the authentication in the event of a failure. Applications handle authentication retries and maintain the retry count. To limit the number of retries, the module can return a PAM_MAXTRIES error.

The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
NAME
pam_sm_chauthtok – service provider implementation for pam_chauthtok

SYNOPSIS
cc [ flag ...] file ... -lpam [ library ... ]
#include <security/pam_appl.h>
#include <security/pam_modules.h>

int pam_sm_chauthtok(pam_handle_t *pamh, int flags, int argc, const char **argv);

DESCRIPTION
In response to a call to pam_chauthtok() the PAM framework calls
pam_sm_chauthtok(3PAM) from the modules listed in the pam.conf(4) file. The
password management provider supplies the back-end functionality for this interface
function.

The pam_sm_chauthtok() function changes the authentication token associated
with a particular user referenced by the authentication handle pamh.

The following flag may be passed to pam_chauthtok():

PAM_SILENT
The password service should not generate
any messages.

PAM_CHANGE_EXPIRED_AUTHTOK
The password service should only update
those passwords that have aged. If this flag
is not passed, the password service should
update all passwords.

PAM_PRELIM_CHECK
The password service should only perform
preliminary checks. No passwords should
be updated.

PAM_UPDATE_AUTHTOK
The password service should update
passwords.

Note that PAM_PRELIM_CHECK and PAM_UPDATE_AUTHTOK cannot be set at the same
time.

Upon successful completion of the call, the authentication token of the user will be
ready for change or will be changed, depending upon the flag, in accordance with the
authentication scheme configured within the system.

The argc argument represents the number of module options passed in from the
configuration file pam.conf(4). The argv argument specifies the module options,
which are interpreted and processed by the password management service. Please
refer to the specific module man pages for the various available options.

It is the responsibility of pam_sm_chauthtok() to determine if the new password
meets certain strength requirements. pam_sm_chauthtok() may continue to
re-prompt the user (for a limited number of times) for a new password until the
password entered meets the strength requirements.
Before returning, `pam_sm_chauthtok()` should call `pam_get_item()` and retrieve both `PAM_AUTHTOK` and `PAM_OLD_AUTHTOK`. If both are `NULL`, `pam_sm_chauthtok()` should set them to the new and old passwords as entered by the user.

**RETURN VALUES**

Upon successful completion, `PAM_SUCCESS` must be returned. The following values may also be returned:

- **PAM_PERM_DENIED**: No permission.
- **PAM_AUTHTOK_ERR**: Authentication token manipulation error.
- **PAM_AUTHTOK_RECOVERY_ERR**: Old authentication token cannot be recovered.
- **PAM_AUTHTOK_LOCK_BUSY**: Authentication token lock busy.
- **PAM_AUTHTOK_DISABLE_AGING**: Authentication token aging disabled.
- **PAM_USER_UNKNOWN**: User unknown to password service.
- **PAM_TRYAGAIN**: Preliminary check by password service failed.

**ATTRIBUTES**

See `attributes(5)` for description of the following attributes:

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**SEE ALSO**

`ping(1M), pam(3PAM), pam_chauthtok(3PAM), pam_get_data(3PAM), pam_get_item(3PAM), pam_set_data(3PAM), libpam(3LIB), pam.conf(4), attributes(5)`

**NOTES**

The PAM framework invokes the password services twice. The first time the modules are invoked with the flag, `PAM_PRELIM_CHECK`. During this stage, the password modules should only perform preliminary checks. For example, they may `ping` remote name services to see if they are ready for updates. If a password module detects a transient error such as a remote name service temporarily down, it should return `PAM_TRYAGAIN` to the PAM framework, which will immediately return the error back to the application. If all password modules pass the preliminary check, the PAM framework invokes the password services again with the flag, `PAM_UPDATE_AUTHTOK`. During this stage, each password module should proceed to update the appropriate password. Any error will again be reported back to application.
If a service module receives the flag PAM_CHANGE_EXPIRED_AUTHTOK, it should check whether the password has aged or expired. If the password has aged or expired, then the service module should proceed to update the password. If the status indicates that the password has not yet aged or expired, then the password module should return PAM_IGNORE.

If a user’s password has aged or expired, a PAM account module could save this information as state in the authentication handle, pamh, using pam_set_data(). The related password management module could retrieve this information using pam_get_data() to determine whether or not it should prompt the user to update the password for this particular module.

The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
NAME  pam_sm_open_session, pam_sm_close_session – service provider implementation for pam_open_session and pam_close_session

SYNOPSIS  

```c
#include <security/pam_appl.h>
#include <security/pam_modules.h>

int pam_sm_open_session(pamHandle_t *pamh, int flags, int argc,
                        const char **argv);

int pam_sm_close_session(pamHandle_t *pamh, int flags, int argc,
                         const char **argv);
```

DESCRIPTION  In response to a call to `pam_open_session(3PAM)` and `pam_close_session(3PAM)`, the PAM framework calls `pam_sm_open_session()` and `pam_sm_close_session()`, respectively from the modules listed in the `pam.conf(4)` file. The session management provider supplies the back-end functionality for this interface function.

The `pam_sm_open_session()` function is called to initiate session management. The `pam_sm_close_session()` function is invoked when a session has terminated.

The argument `pamh` is an authentication handle. The following flag may be set in the `flags` field:

- `PAM_SILENT`  Session service should not generate any messages.

The `argc` argument represents the number of module options passed in from the configuration file `pam.conf(4)`. `argv` specifies the module options, which are interpreted and processed by the session management service. If an unknown option is passed in, an error should be logged through `syslog(3C)` and the option ignored.

RETURN VALUES  Upon successful completion, `PAM_SUCCESS` should be returned. The following values may also be returned upon error:

- `PAM_SESSION_ERR`  Cannot make or remove an entry for the specified session.
- `PAM_IGNORE`  Ignore underlying session module regardless of whether the control flag is required, optional or sufficient.

ATTRIBUTES  See `attributes(5)` for description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

SEE ALSO  `pam(3PAM), pam_open_session(3PAM), syslog(3C), libpam(3LIB), pam.conf(4), attributes(5)`
The interfaces in libpam are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
pam_sm_setcred(3PAM)

NAME
pam_sm_setcred – service provider implementation for pam_setcred

SYNOPSIS
e [ flag ... ] file ... -lpam [ library ... ]
#include <security/pam_appl.h>
#include <security/pam_modules.h>

int pam_sm_setcred(pam_handle_t *pamh, int flags, int argc, const char **argv);

DESCRIPTION
In response to a call to pam_setcred(3PAM), the PAM framework calls
pam_sm_setcred() from the modules listed in the pam.conf(4) file. The
authentication provider supplies the back-end functionality for this interface function.

The pam_sm_setcred() function is called to set the credentials of the current user
associated with the authentication handle, pamh. The following flags may be set in the
flags field. Note that the first four flags are mutually exclusive:

- **PAM_ESTABLISH_CRED**
  Set user credentials for the authentication service.

- **PAM_DELETE_CRED**
  Delete user credentials associated with the authentication service.

- **PAM_REINITIALIZE_CRED**
  Reinitialize user credentials.

- **PAM_REFRESH_CRED**
  Extend lifetime of user credentials.

- **PAM_SILENT**
  Authentication service should not generate messages

If no flag is set, **PAM_ESTABLISH_CRED** is used as the default.

The argc argument represents the number of module options passed in from the
configuration file pam.conf(4). argv specifies the module options, which are
interpreted and processed by the authentication service. If an unknown option is
passed to the module, an error should be logged and the option ignored.

If the **PAM_SILENT** flag is not set, then pam_sm_setcred() should print any failure
status from the corresponding pam_sm_authenticate() function using the
conversation function.

The authentication status (success or reason for failure) is saved as module-specific
state in the authentication handle by the authentication module. The status should be
retrieved using pam_get_data(), and used to determine if user credentials should
be set.

RETURN VALUES
Upon successful completion, **PAM_SUCCESS** should be returned. The following values
may also be returned upon error:

- **PAM_CRED_UNAVAIL**
  Underlying authentication service can not retrieve user credentials.

- **PAM_CRED_EXPIRED**
  User credentials have expired.
**pam_sm_setcred(3PAM)**

<table>
<thead>
<tr>
<th>ATTRIBUTEType</th>
<th>ATTRIBUTETValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

**ATTRIBUTES**

See attributes(5) for description of the following attributes:

- **PAM_USER_UNKNOWN** User unknown to the authentication service.
- **PAM_CRED_ERR** Failure in setting user credentials.
- **PAM_IGNORE** Ignore underlying authentication module regardless of whether the control flag is required, optional, or sufficient.

**SEE ALSO**

pam(3PAM), pam_authenticate(3PAM), pam_get_data(3PAM), pam_sm_setcred(3PAM), pam_sm_authenticate(3PAM), libpam(3LIB), pam.conf(4), attributes(5)

**NOTES**

The `pam_sm_setcred()` function is passed the same module options that are used by `pam_sm_authenticate()`.

The interfaces in `libpam` are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
The `pam_start()` function is called to initiate an authentication transaction. `pam_start()` takes as arguments the name of the current service, `service`, the name of the user to be authenticated, `user`, the address of the conversation structure, `pam_conv`, and the address of a variable to be assigned the authentication handle `pamh`. Upon successful completion, `pamh` refers to a PAM handle for use with subsequent calls to the authentication library.

The `pam_conv` structure contains the address of the conversation function provided by the application. The underlying PAM service module invokes this function to output information to and retrieve input from the user. The `pam_conv` structure has the following entries:

```
struct pam_conv {
    int (*conv)(); /* Conversation function */
    void *appdata_ptr; /* Application data */
};
```

The `conv()` function is called by a service module to hold a PAM conversation with the application or user. For window applications, the application can create a new pop-up window to be used by the interaction.

The `num_msg` parameter is the number of messages associated with the call. The parameter `msg` is a pointer to an array of length `num_msg` of the `pam_message` structure.

The `pam_message` structure is used to pass prompt, error message, or any text information from the authentication service to the application or user. It is the responsibility of the PAM service modules to localize the messages. The memory used by `pam_message` has to be allocated and freed by the PAM modules. The `pam_message` structure has the following entries:

```
struct pam_message {
    int msg_style;
    char *msg;
};
```

The message style, `msg_style`, can be set to one of the following values:

- `PAM_PROMPT_ECHO_OFF`: Prompt user, disabling echoing of response.
- `PAM_PROMPT_ECHO_ON`: Prompt user, enabling echoing of response.
- `PAM_ERROR_MSG`: Print error message.
The maximum size of the message and the response string is **PAM_MAX_MSG_SIZE** as defined in `<security/pam.appl.h>`.

The structure **pam_response** is used by the authentication service to get the user’s response back from the application or user. The storage used by **pam_response** has to be allocated by the application and freed by the PAM modules. The **pam_response** structure has the following entries:

```c
struct pam_response{
    char *resp;
    int resp_retcode; /* currently not used, */
    /* should be set to 0 */
};
```

It is the responsibility of the conversation function to strip off NEWLINE characters for **PAM_PROMPT_ECHO_OFF** and **PAM_PROMPT_ECHO_ON** message styles, and to add NEWLINE characters (if appropriate) for **PAM_ERROR_MSG** and **PAM_TEXT_INFO** message styles.

The **appdata_ptr** argument is an application data pointer which is passed by the application to the PAM service modules. Since the PAM modules pass it back through the conversation function, the applications can use this pointer to point to any application-specific data.

The **pam_end()** function is called to terminate the authentication transaction identified by **pamh** and to free any storage area allocated by the authentication module. The argument, **status**, is passed to the **cleanup(|)** function stored within the **pam** handle, and is used to determine what module-specific state must be purged. A cleanup function is attached to the handle by the underlying PAM modules through a call to **pam_set_item(3PAM)** to free module specific data.

**RETURN VALUES**
Refer to **pam(3PAM)** for information on error related return values.

**ATTRIBUTES**
See **attributes(5)** for description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>
pam_start(3PAM)

SEE ALSO libpam(3LIB), pam(3PAM), pam_acct_mgmt(3PAM), pam_authenticate(3PAM),
pam_chauthtok(3PAM), pam_open_session(3PAM), pam_setcred(3PAM),
pam_set_item(3PAM), pam_strerror(3PAM), attributes(5)

NOTES The interfaces in libpam are MT-Safe only if each thread within the multithreaded
application uses its own PAM handle.
The `pam_strerror()` function maps the PAM error number in `errnum` to a PAM error message string, and returns a pointer to that string. The application should not free or modify the string returned.

The `pamh` argument is the PAM handle obtained by a prior call to `pam_start()`. If `pam_start()` returns an error, a null PAM handle should be passed.

The `pam_strerror()` function returns `NULL` if `errnum` is out-of-range.

See `attributes(5)` for description of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe with exceptions</td>
</tr>
</tbody>
</table>

The interfaces in `libpam` are MT-Safe only if each thread within the multithreaded application uses its own PAM handle.
The `pathfind()` function searches the directories named in `path` for the file `name`. The directories named in `path` are separated by colons (:). The `mode` argument is a string of option letters chosen from the set [rwxfbcdpugks]:

<table>
<thead>
<tr>
<th>Letter</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>readable</td>
</tr>
<tr>
<td>w</td>
<td>writable</td>
</tr>
<tr>
<td>x</td>
<td>executable</td>
</tr>
<tr>
<td>f</td>
<td>normal file</td>
</tr>
<tr>
<td>b</td>
<td>block special</td>
</tr>
<tr>
<td>c</td>
<td>character special</td>
</tr>
<tr>
<td>d</td>
<td>directory</td>
</tr>
<tr>
<td>p</td>
<td>FIFO (pipe)</td>
</tr>
<tr>
<td>u</td>
<td>set user ID bit</td>
</tr>
<tr>
<td>g</td>
<td>set group ID bit</td>
</tr>
<tr>
<td>k</td>
<td>sticky bit</td>
</tr>
<tr>
<td>s</td>
<td>size non-zero</td>
</tr>
</tbody>
</table>

Options read, write, and execute are checked relative to the real (not the effective) user ID and group ID of the current process.

If `name` begins with a slash, it is treated as an absolute path name, and `path` is ignored.

An empty `path` member is treated as the current directory. A slash (/) character is not prepended at the occurrence of the first match; rather, the unadorned `name` is returned.

**EXAMPLE 1** Example of finding the `ls` command using the PATH environment variable.

To find the `ls` command using the `PATH` environment variable:

```c
pathfind (getenv("PATH"), "ls", "rx")
```

**RETURN VALUES** The `pathfind()` function returns a `(char *)` value containing static, thread-specific data that will be overwritten upon the next call from the same thread.
If the file \textit{name} with all characteristics specified by \textit{mode} is found in any of the directories specified by \textit{path}, then \texttt{pathfind()} returns a pointer to a string containing the member of \textit{path}, followed by a slash character (\texttt{/}), followed by \textit{name}.

If no match is found, \texttt{pathname()} returns a null pointer, \texttt{((char *) 0)}.

\begin{verbatim}
ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

\begin{tabular}{||c|c||}
\hline
ATTRIBUTE TYPE & ATTRIBUTE VALUE \\
\hline MT-Level & MT-Safe \\
\hline
\end{tabular}
\end{verbatim}

\begin{verbatim}
SEE ALSO
sh(1), test(1), access(2), mknod(2), stat(2), getenv(3C), attributes(5)
\end{verbatim}

\begin{verbatim}
NOTES
The string pointed to by the returned pointer is stored in an area that is reused on subsequent calls to \texttt{pathfind()}. The string should not be deallocated by the caller.

When compiling multithreaded applications, the \_REENTRANT flag must be defined on the compile line. This flag should only be used in multithreaded applications.
\end{verbatim}
The functions `pctx_create()`, `pctx_capture()`, and `pctx_run()` allow a controlling process to acquire a controlled process and control its behavior by setting various events and handling them. The controlling process can start and stop the controlled process by calling `pctx_run()` and `pctx_release()`, respectively.

The `pctx_create()` function forks the caller and executes a named application in the child. It allows the caller to specify event handlers that should be called when various events occur in the controlled process. The set of handlers is listed on the `pctx_set_events(3CPC)` manual page.

Once the event handlers have been set, the controlled process can be run using `pctx_run()`. This function starts the event handling loop; it returns only when either the process has exited, the number of time samples has expired, or an error has occurred (for example, if the controlling process is not privileged, and the controlled process has executed a setuid program).

Every sample milliseconds the process is stopped and the `tick()` routine is called so that, for example, the performance counters can be sampled by the caller. No periodic sampling is performed if `sample` is 0.
Once `pctx_run()` has returned, the process can be released and the underlying storage freed using `pctx_release()`. Releasing the process will either allow the controlled process to continue (in the case of an existing captured process and its children) or kill the process (if it and its children were created using `pctx_create()`).

**RETURN VALUES**

Upon successful completion, `pctx_capture()` and `pctx_create()` return a valid handle. Otherwise, the functions print a diagnostic message and return `NULL`.

Upon successful completion, `pctx_run()` returns 0 with the controlled process either stopped or exited (if the controlled process has invoked `exit(2)`.) If an error has occurred (for example, if the controlled process has `exec`-ed a set-ID executable, if certain callbacks have returned error indications, or if the process was unable to respond to `proc(4)` requests) an error message is printed and the function returns −1.

**USAGE**

Within an event handler in the controlling process, the controlled process can be made to perform various system calls on its behalf. No system calls are directly supported in this version of the API, though system calls are executed by the `cpc_pctx` family of interfaces in `libcpc` such as `cpc_pctx_bind_event(3CPC)`. A specially created agent LWP is used to execute these system calls in the controlled process. See `proc(4)` for more details.

While executing the event handler functions, the library arranges for the signals `SIGTERM`, `SIGQUIT`, `SIGABRT`, and `SIGINT` to be blocked to reduce the likelihood of a keyboard signal killing the controlling process prematurely, thereby leaving the controlled process permanently stopped while the agent LWP is still alive inside the controlled process.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
<tr>
<td>Availability</td>
<td>SUNWcpcu (32-bit)</td>
</tr>
<tr>
<td></td>
<td>SUNWcpcux (64-bit)</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

**SEE ALSO**

`fork(2), cpc(3CPC), pctx_set_events(3CPC), proc(4), attributes(5)`.
pctx_set_events(3CPC)

NAME  pctx_set_events – associate callbacks with process events

SYNOPSIS  cc [ flag... ] file... -lpctx [ library... ]
#include <libpctx.h>

typedef enum {
  PCTX_NULL_EVENT = 0,
  PCTX_SYSC_EXEC_EVENT,
  PCTX_SYSC_FORK_EVENT,
  PCTX_SYSC_EXIT_EVENT,
  PCTX_SYSC_LWP_CREATE_EVENT,
  PCTX_INIT_LWP_EVENT,
  PCTX_FINI_LWP_EVENT,
  PCTX_SYSC_LWP_EXIT_EVENT
} pctx_event_t;

typedef int pctx_sysc_execfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               char *cmd, void *arg);

typedef void pctx_sysc_forkfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               pid_t child, void *arg);

typedef void pctx_sysc_exitfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               void *arg);

typedef int pctx_sysc_lwp_createfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               void *arg);

typedef int pctx_init_lwpfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               void *arg);

typedef int pctx_fini_lwpfn_t(pctx_t *pctx, pid_t pid, id_t lwpid,
               void *arg);

typedef int pctx_sysc_lwp_exitfn_t(pctx_t *pctx, pid_t pid, id_t
               lwpid, void *arg);

int pctx_set_events(pctx_t *pctx, ...);

DESCRIPTION  The pctx_set_events() function allows the caller (the controlling process) to
express interest in various events in the controlled process. See pctx_capture(3CPC)
for information about how the controlling process is able to create, capture and
manipulate the controlled process.

The pctx_set_events() function takes a pctx_t handle, followed by a variable
length list of pairs of pctx_event_t tags and their corresponding handlers,
terminated by a PCTX_NULL_EVENT tag.

Most of the events correspond closely to various classes of system calls, though two
additional pseudo-events (init_lwp and fini_lwp) are provided to allow callers to
perform various housekeeping tasks. The init_lwp handler is called as soon as the
library identifies a new LWP, while fini_lwp is called just before the LWP disappears.
Thus the classic "hello world" program would see an init_lwp event, a fini_lwp event and (process) exit event, in that order. The table below displays the interactions between the states of the controlled process and the handlers executed by users of the library.

<table>
<thead>
<tr>
<th>System Call</th>
<th>Handler</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>exec(2), execve(2)</td>
<td>fini_lwp</td>
<td>Invoked serially on all lwps in the process.</td>
</tr>
<tr>
<td></td>
<td>exec</td>
<td>Only invoked if the exec() system call succeeded.</td>
</tr>
<tr>
<td></td>
<td>init_lwp</td>
<td>If the exec succeeds, only invoked on lwp 1. If the exec fails, invoked serially on all lwps in the process.</td>
</tr>
<tr>
<td>fork(2), vfork(2), fork1(2)</td>
<td>fork</td>
<td>Only invoked if the fork() system call succeeded.</td>
</tr>
<tr>
<td>exit(2)</td>
<td>fini_lwp</td>
<td>Invoked on all lwps in the process.</td>
</tr>
<tr>
<td></td>
<td>exit</td>
<td>Invoked on the exiting lwp.</td>
</tr>
<tr>
<td>_lwp_create(2)</td>
<td>init_lwp</td>
<td>Only if the corresponding _lwp_create() system call succeeded.</td>
</tr>
<tr>
<td></td>
<td>_lwp_create</td>
<td></td>
</tr>
<tr>
<td>_lwp_exit(2)</td>
<td>fini_lwp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>_lwp_exit</td>
<td></td>
</tr>
</tbody>
</table>

Each of the handlers is passed the caller’s opaque handle, a pctx_t handle, the pid, and lwpid of the process and lwp generating the event. The lwp_exit, and (process) exit events are delivered before the underlying system calls begin, while the exec, fork, and _lwp_create events are only delivered after the relevant system calls complete successfully. The exec handler is passed a string that describes the command being executed. Catching the fork event causes the calling process to fork(2), then capture the child of the controlled process using pctx_capture() before handing control to the fork handler. The process is released on return from the handler.

**RETURN VALUES**

Upon successful completion, pctx_set_events( ) returns 0. Otherwise, the function returns −1.

**EXAMPLES**

**EXAMPLE 1 HandleExec example.**

This example captures an existing process whose process identifier is pid, and arranges to call the HandleExec routine when the process performs an exec(2).

```c
static void
HandleExec(pctx_t *pctx, pid_t pid, id_t lwpid, char *cmd, void *arg)
```

Extended Library Functions 375
EXAMPLE 1 HandleExec example.  (Continued)

{
    (void) printf("pid %d execed '%s'\n", (int)pid, cmd);
}

int main()
{
    ...
    pctx = pctx_capture(pid, NULL, 1, NULL);
    (void) pctx_set_events(pctx,
        PCTX_SYSC_EXEC_EVENT, HandleExec,
        ...
        PCTX_NULL_EVENT);
    (void) pctx_run(pctx, 0, 0, NULL);
    pctx_release(pctx);
}

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
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<td>SUNWcpcux (64-bit)</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

SEE ALSO exec(2), exit(2), fork(2), vfork(2), fork1(2), _lwp_create(2), _lwp_exit(2), cpc(3CPC), proc(4), attributes(5).
The `picld_log()` function logs the message specified in `msg` to the system log file using `syslog(3C)`. This function is used by the PICL daemon and the plug-in modules to log messages to inform users of any error or warning conditions.

This function does not return a value.

No errors are defined.

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also: `syslog(3C), attributes(5)`
NAME  picld_plugin_register - register plug-in with the daemon

SYNOPSIS
cc [flag ...] file ... -lpicltree [library ...]
#include <picltree.h>

int picld_plugin_register(picld_plugin_reg_t *regp);

DESCRIPTION
The picld_plugin_register() function is the function used by a plug-in module
to register itself with the PICL daemon upon initialization. The plug-in provides its
name and the entry points of the initialization and cleanup routines in the regp
argument.

typedef struct {
    int version;  /* PICLD_PLUGIN_VERSION */
    int critical; /* is plug-in critical? */
    char *name;   /* name of the plugin module */
    void (*plugin_init)(void); /* init/reinit function */
    void (*plugin_fini)(void); /* fini/cleanup function */
} picld_plugin_reg_t;

The plug-in module also specifies whether it is a critical module for the proper system
operation. The critical field in the registration information is set to
PICLD_PLUGIN_NON_CRITICAL by plug-in modules that are not critical to system
operation, and is set to PICLD_PLUGIN_CRITICAL by plug-in modules that are
critical to the system operation. An environment control plug-in module is an example
for a PICLD_PLUGIN_CRITICAL type of plug-in module.

The PICL daemon saves the information passed during registration in regp in the order
in which the plug-ins registered.

Upon initialization, the PICL daemon invokes the plugin_init() routine of each of the
registered plug-in modules in the order in which they registered. In their
plugin_init() routines, the plug-in modules collect the platform configuration
data and add it to the PICL tree using PTree interface.

When PICL daemon is running in degraded or failsafe mode, only the plug-in
modules that register themselves as critical modules are loaded and initialized. Any
other plug-in modules that are required by the critical plug-in module are also loaded
and initialized.

On reinitialization, the PICL daemon invokes the plugin_fini() routines of the
registered plug-in modules in the reverse order of registration. Then, the
plugin_init() entry points are invoked again in the order in which the plug-ins
registered.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a negative value is returned.

ERRORS
PICL_NOTSUPPORTED Version not supported
PICL_FAILURE General system failure
ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

libpicltree(3PICLTREE), attributes(5)
**picl_get_first_prop(3PICL)**

**NAME**  
picl_get_first_prop, picl_get_next_prop – get a property handle of a node

**SYNOPSIS**  
cc [flag ...] file ... -lpicl [library ...]  
#include <picl.h>

```c
int picl_get_first_prop(picl_nodehdl_t nodeh, piclprop_hdl_t *proph);
int picl_get_next_prop(picl_prophdl_t proph, picl_prophdl_t *nextprop);
```

**DESCRIPTION**  
The `picl_get_first_prop()` function gets the handle of the first property of the node specified by `nodeh` and copies it into the location given by `proph`.

The `picl_get_next_prop()` function gets the handle of the next property after the one specified by `proph` from the property list of the node, and copies it into the location specified by `nextprop`.

If there are no more properties, this function returns `PICL_ENDOFLIST`.

**RETURN VALUES**  
Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- `PICL_ENDOFLIST` is returned to indicate that there are no more properties.
- `PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- `PICL_INVALIDHANDLE` is returned if the specified handle never existed. This error may be returned for a previously valid handle if the daemon was brought down and restarted. When this occurs a client must revalidate any saved handles.

**ERRORS**  
- `PICL_NOTINITIALIZED`  
  Session not initialized
- `PICL_NORESPONSE`  
  Daemon not responding
- `PICL_NOTNODE`  
  Not a node
- `PICL_NOTPROP`  
  Not a property
- `PICL_INVALIDHANDLE`  
  Invalid handle
- `PICL_STALEHANDLE`  
  Stale handle
- `PICL_FAILURE`  
  General system failure
- `PICL_ENDOFLIST`  
  End of list

**ATTRIBUTES**  
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</tbody>
</table>
SEE ALSO  picl_get_prop_by_name(3PICL), attributes(5)
#include <picl.h>

int picl_get_next_by_row(picl_prophdl_t proph, picl_prophdl_t *rowh);

int picl_get_next_by_col(picl_prophdl_t proph, picl_prophdl_t *colh);

The `picl_get_next_by_row()` function copies the handle of the property that is in
the next row of the table and on the same column as the property `proph`. The handle is
copied into the location given by `rowh`.

The `picl_get_next_by_col()` function copies the handle of the property that is in
the next column of the table and on the same row as the property `proph`. The handle is
copied into the location given by `colh`.

If there are no more rows or columns, this function returns the value
`PICL_ENDOFLIST`.

**RETURN VALUES**

Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

- `PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the
  PICL tree was refreshed or reinitialized.

- `PICL_INVALIDHANDLE` is returned if the specified handle never existed. This error
  may be returned for a previously valid handle if the daemon was brought down and
  restarted. When this occurs a client must revalidate any saved handles.

**ERRORS**

- `PICL_NOTINITIALIZED` Session not initialized
- `PICL_NORESPONSE` Daemon not responding
- `PICL_NOTTABLE` Not a table
- `PICL_INVALIDHANDLE` Invalid handle
- `PICL_STALEHANDLE` Stale handle
- `PICL_FAILURE` General system failure
- `PICL_ENDOFLIST` General system failure

**ATTRIBUTES**

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</table>

**SEE ALSO**

picl_get_propval(3PICL), attributes(5)
NAME
picl_get_prop_by_name – get the handle of the property by name

SYNOPSIS
cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

int picl_get_prop_by_name(picl_nodehdl_t nodeh, char *name,
                         picl_prophdl_t *proph);

DESCRIPTION
The picl_get_prop_by_name() function gets the handle of the property of node
nodeh whose name is specified in name. The handle is copied into the location specified
by proph.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

PICL_PROPNOTFOUND is returned if the property of the specified name does not exist.

PICL_RESERVEDNAME is returned if the property name specified is one of the
reserved property names.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the
PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed. This error
may be returned for a previously valid handle if the daemon was brought down and
restarted. When this occurs a client must revalidate any saved handles.

ERRORS
PICL_NOTINITIALIZED Session not initialized
PICL_NORESPONSE Daemon not responding
PICL_NOTNODE Not a node
PICL_PROPNOTFOUND Property not found
PICL_RESERVEDNAME Reserved property name specified
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE Stale handle
PICL_FAILURE General system failure

ATTRIBUTES
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</table>

SEE ALSO
attributes(5)
The `picl_get_propinfo()` function gets the information about the property specified by handle `proph` and copies it into the location specified by `pinfo`. The property information includes the property type, access mode, size, and the name of the property as described on `libpicl(3PICL)` manual page.

The maximum size of a property value is specified by `PICL_PROPSIZE_MAX`. It is currently set to 512KB.

Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- `PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- `PICL_INVALIDHANDLE` is returned if the specified handle never existed. This error may be returned for a previously valid handle if the daemon was brought down and restarted. When this occurs a client must revalidate any saved handles.

See `attributes(5)` for descriptions of the following attributes:

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</table>

Libraries: `libpicl(3PICL), picl_get_propval(3PICL), picl_get_propval_by_name(3PICL), attributes(5)`
NAME
picl_get_propval, picl_get_propval_by_name – get the value of a property

SYNOPSIS
cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

int picl_get_propval(picl_prophdl_t proph, void *valbuf, size_t nbytes);

int picl_get_propval_by_name(picl_nodehdl_t nodeh, char *propname, void *valbuf, size_t nbytes);

DESCRIPTION
The picl_get_propval() function copies the value of the property specified by the handle proph into the buffer location given by valbuf. The size of the buffer valbuf in bytes is specified in nbytes.

The picl_get_propval_by_name() function gets the value of property named propname of the node specified by handle nodeh. The value is copied into the buffer location given by valbuf. The size of the buffer valbuf in bytes is specified in nbytes.

The picl_get_propval_by_name() function is used to get a reserved property’s value. An example of a reserved property is "_parent". Please refer to libpicl(3PICL) for a complete list of reserved property names.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

PICL_PROPNOTFOUND is returned if the property of the specified name does not exist.

PICL_PERMDENIED is returned if the client does not have sufficient permission to access the property.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed. This error may be returned for a previously valid handle if the daemon was brought down and restarted. When this occurs a client must revalidate any saved handles.

ERRORS
PICL_NOTINITIALIZED Session not initialized
PICL_NORESPONSE Daemon not responding
PICL_PERMDENIED Insufficient permission
PICL_VALUETOOBIG Value too big for buffer
PICL_NOTPROP Not a property
PICL_PROPNOTFOUND Property node found
PICL_NOTNODE Not a node
PICL_INVALIDHANDLE Invalid handle specified
PICL_STALEHANDLE Stale handle specified
PICL_FAILURE

General system failure

ATTRIBUTES
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SEE ALSO
libpicl(3PICL), picl_get_propinfo(3PICL), attributes(5)
NAME
picl_get_root – get the root handle of the PICL tree

SYNOPSIS
cc [flag ...] file ... -lpicl [library ...]  #include <picl.h>
int picl_get_root(picl_nodehdl_t *nodehandle);

DESCRIPTION
The picl_get_root() function gets the handle of the root node of the PICL tree and
copies it into the location given by nodehandle.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

ERRORS
PICL_NOTINITIALIZED  Session not initialized
PICL_NORESPONSE  Daemon not responding
PICL_FAILURE  General system failure

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
picl_initialize(3PICL), picl_shutdown(3PICL), attributes(5)
**picl_initialize(3PICL)**

**NAME**  
`picl_initialize` – initiate a session with the PICL daemon

**SYNOPSIS**  
```c
cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

int picl_initialize(void);
```

**DESCRIPTION**  
The `picl_initialize()` function opens the daemon door file and initiates a session with the PICL daemon running on the system.

**RETURN VALUES**  
Upon successful completion, 0 is returned. On failure, this function returns a non-negative integer, `PICL_FAILURE`.

**ERRORS**  
- `PICL_NOTSUPPORTED`: Version not supported
- `PICL_FAILURE`: General system failure
- `PICL_NORESPONSE`: Daemon not responding

**ATTRIBUTES**  
See attributes(5) for descriptions of the following attributes:

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</table>

**SEE ALSO**  
`picl_shutdown(3PICL)`, attributes(5)
**NAME**
picl_set_propval, picl_set_propval_by_name – set the value of a property to the specified value

**SYNOPSIS**
```
cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

int picl_set_propval(picl_prophdl_t proph, void *valbuf, size_t nbytes);
int picl_set_propval_by_name(picl_nodehdl_t nodeh, const char *pname, void *valbuf, size_t nbytes);
```

**DESCRIPTION**
The `picl_set_propval()` function sets the value of the property specified by the handle `proph` to the value contained in the buffer `valbuf`. The argument `nbytes` specifies the size of the buffer `valbuf`.

The `picl_set_propval_by_name()` function sets the value of the property named `pname` of the node specified by the handle `nodeh` to the value contained in the buffer `valbuf`. The argument `nbytes` specifies the size of the buffer `valbuf`.

**RETURN VALUES**
Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- **PICL_PERMDENIED**: Returned if the client does not have sufficient permission to access the property.
- **PICL_STALEHANDLE**: Returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- **PICL_INVALIDHANDLE**: Returned if the specified handle never existed. This error may be returned for a previously valid handle if the daemon was brought down and restarted. When this occurs a client must revalidate any saved handles.

**ERRORS**
- **PICL_NOTINITIALIZED**: Session not initialized
- **PICL_NORESPONSE**: Daemon not responding
- **PICL_PERMDENIED**: Insufficient permission
- **PICL_NOTWRITABLE**: Property is read-only
- **PICL_VALUETOOBIG**: Value too big
- **PICL_NOTPROP**: Not a property
- **PICL_NOTNODE**: Not a node
- **PICL_INVALIDHANDLE**: Invalid handle specified
- **PICL_STALEHANDLE**: Stale handle specified
- **PICL_FAILURE**: General system failure
picl_set_propval(3PICL)

ATTRIBUTES

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</table>

SEE ALSO

attributes(5)
picl_shutdown() - shutdown the session with the PICL daemon

SYNOPSIS
cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

void picl_shutdown(void);

DESCRIPTION
The picl_shutdown() function terminates the session with the PICL daemon and
frees up any resources allocated.

RETURN VALUES
The picl_shutdown() function does not return a value.

ERRORS
PICL_NOTINITIALIZED Session not initialized
PICL_FAILURE General system failure

ATTRIBUTES
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</tbody>
</table>

SEE ALSO picl_initialize(3PICL), attributes(5)
picl_strerror(3PICL)

NAME   picl_strerror – get error message string

SYNOPSIS cc [flag ...] file ... -lpicl [library ...]
#include <picl.h>

char *picl_strerror(int errnum);

DESCRIPTION The picl_strerror() function maps the error number in errnum to an error
message string, and returns a pointer to that string. The returned string should not be
overwritten.

RETURN VALUES The picl_strerror() function returns NULL if errnum is out-of-range.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO libpicl(3PICL), attributes(5)
NAME
picl_wait – wait for PICL tree to refresh

SYNOPSIS
cc [flags] file ... -lpicl [library ...]
#include <picl.h>

int picl_wait(int to_secs);

DESCRIPTION
The picl_wait() function blocks the calling thread until the PICL tree is refreshed.
The to_secs argument specifies the timeout for the call in number of seconds. A value
of −1 for to_secs specifies no timeout.

RETURN VALUES
The picl_wait() function returns 0 to indicate that PICL tree has refreshed.
Otherwise, a non-negative integer is returned to indicate error.

ERRORS
PICL_NOTINITIALIZED  Session not initialized
PICL_NORESPONSE      Daemon not responding
PICL_TIMEDOUT         Timed out waiting for refresh
PICL_FAILURE          General system failure

ATTRIBUTES
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</table>

SEE ALSO
attributes(5)
The `pow()` function computes the value of `x` raised to the power `y`, \( x^y \). If `x` is negative, `y` must be an integer value.

Upon successful completion, `pow()` returns the value of `x` raised to the power `y`.

- If `x` is 0 and `y` is 0, 1.0 is returned.
- If `y` is NaN, or `y` is non-zero and `x` is NaN, NaN is returned. If `y` is 0.0 and `x` is NaN, NaN is returned.
- If `x` is 0.0 and `y` is negative, `-HUGE_VAL` is returned and `errno` may be set to `EDOM` or `ERANGE`.
- If the correct value would cause overflow, `+HUGE_VAL` is returned, and `errno` is set to `ERANGE`.
- If the correct value would cause underflow to 0, 0 is returned and `errno` may be set to `ERANGE`.

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by Standards other than XPG4.

The `pow()` function will fail if:

- `EDOM` The value of `x` is negative and `y` is non-integral.
- `ERANGE` The value to be returned would have caused overflow.

The `pow()` function may fail if:

- `EDOM` The value of `x` is 0.0 and `y` is negative.
- `ERANGE` The correct value would cause underflow.

An application wishing to check for error situations should set `errno` to 0 before calling `pow()`. If `errno` is non-zero on return, or the return value is NaN, an error has occurred.

See `attributes(5)` for descriptions of the following attributes:

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See also `exp(3M), isnan(3M), matherr(3M), attributes(5), standards(5)`
NAME
printDmiAttributeValues – print data in input DmiAttributeValues list

SYNOPSIS
cce [ flag ... ] file ... -ldmi -lnsl -1rwt001 [ library ... ]
#include <dmi/util.hh>

void printDmiAttributeValues(DmiAttributeValues_t *values);

DESCRIPTION
The printDmiAttributeValues() function prints the data in the input
DmiAttributeValues list. The function prints "unknown data" for those values that
contain invalid data.

ATTRIBUTES
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</table>

SEE ALSO
libdmi(3LIB), attributes(5)
printDmiDataUnion(3DMI)

NAME     printDmiDataUnion – print data in input data union
SYNOPSIS  
cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/util.hh>

void printDmiDataUnion(DmiDataUnion_t *data);

DESCRIPTION The printDmiDataUnion() function prints the data in the input data union. The output depends on the type of DMI data in the union.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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SEE ALSO libdmi(3LIB), attributes(5)
NAME
printDmiString – print a DmiString

SYNOPSIS
cc [ flag ... ] file ... -ldmi -lnsl -lrwtool [ library ... ]
#include <dmi/util.hh>

void printDmiString(DmiString_t *dstr);

DESCRIPTION
The printDmiString() function prints a DmiString.

ATTRIBUTES
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SEE ALSO
newDmiString(3DMI), libdmi(3LIB), attributes(5)
ptree_add_node(3PICLTREE)

NAME  ptree_add_node, ptree_delete_node – add or delete node to or from tree

SYNOPSIS
  cc [flag...] file ... -lpicltree [library ...]
  #include <picltree.h>
  int ptree_add_node(picl_nodehdl_t parh, picl_nodehdl_t chdh);
  int ptree_delete_node(ptree_delete_node nodeh);

DESCRIPTION
  The ptree_add_node() function adds the node specified by handle chdh as a child node to the node specified by the handle parh. PICL_CANTPARENT is if the child node already has a parent.

  The ptree_delete_node() function deletes the node specified by handle nodeh and all its descendant nodes from the tree.

RETURN VALUES
  Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

  PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.

  PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS
  PICL_NOTNODE     Node a node
  PICL_CANTPARENT  Already has a parent
  PICL_TREEBUSY    PICL tree is busy
  PICL_INVALIDHANDLE  Invalid handle
  PICL_STALEHANDLE  Stale handle
  PICL_FAILURE     General system failure

ATTRIBUTES
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SEE ALSO
  attributes(5)
NAME
ptree_add_prop, ptree_delete_prop – add or delete a property

SYNOPSIS
cc [flag...] file ... -lpicltree [library...]
#include <picltree.h>

int ptree_add_prop(picl_nodehdl_t nodeh, picl_prophdl_t proph);
int proph(picl_prophdl_t proph);

DESCRIPTION
The ptree_add_prop() function adds the property specified by the handle proph to
the list of properties of the node specified by handle nodeh.

The ptree_delete_prop() function deletes the property from the property list of
the node. For a table property, the entire table is deleted.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the
PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS
PICL_NOTTABLE Not a table
PICL_NOTPROP Not a property
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE Stale handle
PICL_PROPEXISTS Property already exists
PICL_FAILURE General system failure

ATTRIBUTES
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SEE ALSO
ptree_create_prop(3PICLTREE), attributes(5)
ptree_create_node(3PICLTREE)

NAME
ptree_create_node, ptree_destroy_node – create or destroy a node

SYNOPSIS
cc [flag...] file ... -lpicltree [library ...]
#include <picltree.h>

int ptree_create_node(char *name, char *clname, picl_nodehdl_t *nodeh);

int ptree_destroy_node(picl_nodehdl_t nodeh);

DESCRIPTION
The ptree_create_node() function creates a node and sets the "name" property value to the string specified in name and the "class" property value to the string specified in clname. The handle of the new node is copied into the location given by nodeh.

The ptree_destroy_node() function destroys the node specified by nodeh and frees up any allocated space. The node to be destroyed must have been previously deleted by ptree_delete_node (see ptree_add_node(3PICLTREE)). Otherwise, PICL_CANTDESTROY is returned.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS
PICL_INVALIDARG Invalid argument
PICL_VALUETOObIG Value exceeds maximum size
PICL_NOTSUPPORTED Property version not supported
PICL_CANTDESTROY Attempting to destroy before delete
PICL_TREEBUSY PICL tree is busy
PICL_NOTNODE Not a node
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE Stale handle
PICL_FAILURE General system failure

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
ptree_add_node(3PICLTREE), attributes(5)
ptree_create_prop(3PICLTREE)

NAME
ptree_create_prop, ptree_destroy_prop – create or destroy a property

SYNOPSIS
cc [flag ...] file ... -lpicltree [library ...]
#include <picltree.h>

int ptree_create_prop(ptree_propinfo_t *pinfo, void *valbuf,
                      picl_prophdl_t *proph);

int ptree_destroy_prop(picl_prophdl_t proph);

DESCRIPTION
The ptree_create_prop() function creates a property using the information
specified in pinfo, which includes the name, type, access mode, and size of the
property, as well as the read access function for a volatile property. The value of the
property is specified in the buffer valbuf, which may be NULL for volatile properties.
The handle of the property created is copied into the location given by proph. See
libpicltree(3PICLTREE) for more information on the structure of
ptree_propinfo_t structure.

The ptree_destroy_prop() function destroys the property specified by the handle
proph. For a table property, the entire table is destroyed. The property to be destroyed
must have been previously deleted.

RETURN VALUES
Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the
PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS
PICL_NOTSUPPORTED Property version not supported
PICL_VALUETOOBIG Value exceeds maximum size
PICL_NOTPROP Not a property
PICL_CANTDESTROY Attempting to destroy before delete
PICL_RESERVEDNAME Property name is reserved
PICL_INVREFERENCE Invalid reference property value
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE Stale handle
PICL_FAILURE General system failure

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
ptree_create_prop(3PCLTREE)

SEE ALSO libpicltree(3PCLTREE), ptree_add_prop(3PCLTREE), attributes(5)
ptree_create_table, ptree_add_row_to_table – create a table object

SYNOPSIS

```c
#include <picltree.h>

int ptree_create_table(picl_prophdl_t *tbl_hdl);
int ptree_add_row_to_table(picl_prophdl_t tbl_hdl, int nprops,
                           picl_prophdl_t *proph);
```

DESCRIPTION

The `ptree_create_table()` function creates a table object and returns the handle of the table in `tbl_hdl`.

The `ptree_add_row_to_table()` function adds a row of properties to the table specified by `tbl_hdl`. The handles of the properties of the row are specified in the `proph` array and `nprops` specifies the number of handles in the array. The number of columns in the table is determined from the first row added to the table. If extra column values are specified in subsequent rows, they are ignored. The row is appended to the end of the table.

RETURN VALUES

Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- `PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- `PICL_INVALIDHANDLE` is returned if the specified handle never existed.

ERRORS

- `PICL_INVALIDARG` Invalid argument
- `PICL_NOTPROP` Not a property
- `PICL_NOTTABLE` Not a table
- `PICL_INVALIDHANDLE` Invalid handle
- `PICL_STALEHANDLE` Stale handle
- `PICL_FAILURE` General system failure

ATTRIBUTES

See `attributes(5)` for descriptions of the following attributes:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

`attributes(5)`
**ptree_get_first_prop(3PICLTREE)**

**NAME**  
ptree_get_first_prop, ptree_get_next_prop – get a property handle of the node

**SYNOPSIS**  
cc [flag...] file ... -lpicltree [library...]
#include <picltree.h>

```c
int ptree_get_first_prop(picl_nodehdl_t nodeh, picl_prophdl_t *proph);
int ptree_get_next_prop(picl_prophdl_t proph, picl_prophdl_t *nextproph);
```

**DESCRIPTION**  
The `ptree_get_first_prop()` function gets the handle of the first property of the node specified by `nodeh` and copies it into the location specified by `proph`.

The `ptree_get_next_prop()` function gets the handle of the next property after the one specified by `proph` from the list of properties of the node and copies it into the location specified by `nextproph`.

**RETURN VALUES**  
Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- `PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- `PICL_INVALIDHANDLE` is returned if the specified handle never existed.

**ERRORS**  
- `PICL_NOTPROP` Not a property
- `PICL_NOTNODE` Not a node
- `PICL_ENDOFLIST` End of list
- `PICL_INVALIDHANDLE` Invalid handle
- `PICL_STALEHANDLE` Stale handle
- `PICL_FAILURE` General system failure

**ATTRIBUTES**  
See attributes(5) for descriptions of the following attributes:

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<tr>
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</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**  
ptree_get_prop_by_name(3PICLTREE), attributes(5)
NAME | ptree_get_next_by_row, ptree_get_next_by_col – access a table property
SYNOPSIS | cc [flag ...] file ... -lpicltree [library ...]

```c
#include <picltree.h>

int ptree_get_next_by_row(picl_prophdl_t proph, picl_prophdl_t *rowh);
int ptree_get_next_by_col(picl_prophdl_t proph, picl_prophdl_t *colh);
```

DESCRIPTION | The `ptree_get_next_by_row()` function copies the handle of the property that is in the next column of the table and on the same row as the property `proph`. The handle is copied into the location given by `rowh`.

The `ptree_get_next_by_col()` function copies the handle of the property that is in the next row of the table and on the same column as the property `proph`. The handle is copied into the location given by `colh`.

If there are no more rows or columns, this function returns the value `PICL_ENDOFLIST`.

RETURN VALUES | Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

`PICL_STALEHANDLE` is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.

`PICL_INVALIDHANDLE` is returned if the specified handle never existed.

ERRORS | `PICL_NOTTABLE` Not a table
`PICL_INVALIDHANDLE` Invalid handle
`PICL_STALEHANDLE` Stale handle
`PICL_ENDOFLIST` End of list
`PICL_FAILURE` General system failure

ATTRIBUTES | See attributes(5) for descriptions of the following attributes:

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<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO | ptree_create_table(3PICLTREE), attributes(5)
ptree_get_prop_by_name(3PICLTREE)

NAME  ptree_get_prop_by_name – get a property handle by name

SYNOPSIS cc [flag ...] file ... -lpicltree [library ...]
#include <picltree.h>

int ptree_get_prop_by_name(picl_nodehdl_t nodeh, char *name,
                         picl_prophdl_t *proph);

DESCRIPTION The ptree_get_prop_by_name() function gets the handle of the property, whose
name is specified in name, of the node specified by the handle nodeh. The property
handle is copied into the location specified by proph.

RETURN VALUES Upon successful completion, 0 is returned. On failure, a non-negative integer is
returned to indicate an error.

PICL_RESERVEDNAME is returned if the name specified is a PICL reserved name
property. Reserved name properties do not have an associated property handle. Use
ptree_get_propval_by_name(3PICLTREE) to get the value of a reserved property.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the
PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS PICL_NOTNODE Not a node
PICL_RESERVEDNAME Property name is reserved
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE Stale handle
PICL_PROPNOTFOUND Property not found
PICL_FAILURE General system failure

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO ptree_get_first_prop(3PICLTREE),
ptree_get_propval_by_name(3PICLTREE), attributes(5)
The `ptree_get_propinfo()` function gets the information about the property specified by handle `proph` and copies it into the location specified by `pi`. See `libpicltree(3PICLTREE)` for more information about `ptree_propinfo_t` structure.

Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

- **PICL_STALEHANDLE** is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.
- **PICL_INVALIDHANDLE** is returned if the specified handle never existed.

### Attributes

See `attributes(5)` for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

### See Also

- `libpicltree(3PICLTREE)`, `ptree_create_prop(3PICLTREE)`, `attributes(5)`
ptree_get_propval(3PICLTREE)

NAME    ptree_get_propval, ptree_get_propval_by_name – get the value of a property

SYNOPSIS cc [flag ...] file ... -lpicltree [library ...]
#include <picltree.h>

int ptree_get_propval(picl_prophdl_t proph, void *valbuf, size_t nbytes);

int ptree_get_propval_by_name(picl_nodehdl_t nodeh, void *name, 
                              void *valbuf, size_t nbytes);

DESCRIPTION The ptree_get_propval() function gets the value of the property specified by the 
           handle proph and copies it into the buffer specified by valbuf. The size of the buffer 
           valbuf is specified in nbytes.

The ptree_get_propval_by_name() function gets the value of the property, 
whose name is specified by name, from the node specified by handle nodeh. The value 
is copied into the buffer specified by valbuf. The size of the buffer is specified by nbytes.

For volatile properties, the read access function provided by the plug-in publishing the 
property is invoked.

RETURN VALUES Upon successful completion, 0 is returned. On failure, a non-negative integer is 
           returned to indicate an error.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the 
PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS    PICL_VALUE_TOO_BIG    Value too big
          PICL_NOTPROP         Not a property
          PICL_NOT_NODE        Not a node
          PICL_INVALIDHANDLE  Invalid handle
          PICL_STALEHANDLE    Stale handle
          PICL_PROPNOTFOUND   Property not found
          PICL_FAILURE        General system failure

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE_TYPE</th>
<th>ATTRIBUTE_VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO ptree_update_propval(3PICLTREE), attributes(5)
ptree_get_root – get the root node handle

SYNOPSIS

cc [flag ...] file ... -lpicltree [library ...]

#include <picltree.h>

int ptree_get_root(picl_nodehdl_t *nodeh);

DESCRIPTION

The ptree_get_root() function copies the handle of the root node of the PICL tree into the location specified by nodeh.

RETURN VALUES

Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

ERRORS

PICL_INVALIDARG Invalid argument
PICL_FAILURE General system failure

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

libpicltree(3PICLTREE), ptree_create_node(3PICLTREE), attributes(5)
ptree_update_propval(3PICLTREE)

NAME  ptree_update_propval, ptree_update_propval_by_name – update a property value

SYNOPSIS  cc [flag...] file... -lpicltree [library...]
#include <picltree.h>

int ptree_update_propval(picl_prophdl_t proph, void *valbuf, size_t nbytes);

int ptree_update_propval_by_name(picl_nodehdl_t nodeh, char *name, void *valbuf, size_t nbytes);

DESCRIPTION  The ptree_update_propval() function updates the value of the property specified by proph with the value specified in the buffer valbuf. The size of the buffer valbuf is specified in nbytes.

The ptree_update_propval_by_name() function updates the value of the property, whose name is specified by name, of the node specified by handle nodeh. The new value is specified in the buffer valbuf, whose size is specified in nbytes.

For volatile properties, the write access function provided by the plug-in publishing the property is invoked.

RETURN VALUES  Upon successful completion, 0 is returned. On failure, a non-negative integer is returned to indicate an error.

PICL_STALEHANDLE is returned if the handle is no longer valid. This occurs if the PICL tree was refreshed or reinitialized.

PICL_INVALIDHANDLE is returned if the specified handle never existed.

ERRORS  PICL_VALUETOOBIG     Value too big
PICL_NOTPROP      Not a property
PICL_NOTNODE      Not a node
PICL_INVALIDHANDLE Invalid handle
PICL_STALEHANDLE  Stale handle
PICL_PROPNOTFOUND Property not found

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  ptree_get_propval(3PICLTREE), attributes(5)
read_vtoc(3EXT)

NAME
read_vtoc, write_vtoc – read and write a disk’s VTOC

SYNOPSIS
ce [ flag ... ] file ... -ladm [ library ... ]
#include <sys/vtoc.h>

int read_vtoc(int fd, struct vtoc *vtoc);
int write_vtoc(int fd, struct vtoc *vtoc);

DESCRIPTION
The read_vtoc() function returns the VTOC (volume table of contents) structure
that is stored on the disk associated with the open file descriptor fd.

The write_vtoc() function stores the VTOC structure on the disk associated with
the open file descriptor fd.

The fd argument refers to any slice on a raw disk.

RETURN VALUES
Upon successful completion, read_vtoc() returns a positive number indicating the
slice index associated with the open file descriptor. Otherwise, it returns a negative
number indicating one of the following errors:

VT_EIO An I/O error occurred.
VT_ERROR An unknown error occurred.

Upon successful completion, write_vtoc() returns 0. Otherwise, it returns a
negative number indicating one of the following errors:

VT_EIO An I/O error occurred.
VT_ERROR An unknown error occurred.
VT_EINVAL The VTOC contains an incorrect field.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
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<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO
fmthard(1M), format(1M), prtvtoc(1M), ioctl(2), attributes(5), dkio(7I)

BUGS
The write_vtoc() function cannot write a VTOC on an unlabeled disk. Use
format(1M) for this purpose.
reg_ci_callback(3DMI)

NAME
reg_ci_callback – provide a component instrumentation with a transient program number

SYNOPSIS
cc [ flag ... ] file ... -ldmici [ library ... ]
#include <dmi/ci_callback_svc.hh>

u_long reg_ci_callback();

DESCRIPTION
The reg_ci_callback() function provides a component instrumentation with a transient program number. The instrumentation uses this number to register its RPC service provider. The prognum member of the DmiRegisterInfo structure is populated with the return value of this function.

RETURN VALUES
Upon successful completion, the reg_ci_callback() function returns a transient program number of type u_long.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-level</td>
<td>Unafe</td>
</tr>
</tbody>
</table>

SEE ALSO
attributes(5)
These routines are used to compile regular expressions and match the compiled expressions against lines. The regular expressions compiled are in the form used by ed(1).

The parameter instring is a null-terminated string representing the regular expression.

The parameter expbuf points to the place where the compiled regular expression is to be placed. If expbuf is NULL, compile() uses malloc(3C) to allocate the space for the compiled regular expression. If an error occurs, this space is freed. It is the user's responsibility to free unneeded space after the compiled regular expression is no longer needed.

The parameter endbuf is one more than the highest address where the compiled regular expression may be placed. This argument is ignored if expbuf is NULL. If the compiled expression cannot fit in (endbuf−expbuf) bytes, compile() returns NULL and regerrno (see below) is set to 50.

The parameter string is a pointer to a string of characters to be checked for a match. This string should be null-terminated.

The parameter expbuf is the compiled regular expression obtained by a call of the function compile().

The function step() returns non-zero if the given string matches the regular expression, and zero if the expressions do not match. If there is a match, two external character pointers are set as a side effect to the call to step(). The variables set in step() are loc1 and loc2. loc1 is a pointer to the first character that matched the regular expression. The variable loc2 points to the character after the last character that matches the regular expression. Thus if the regular expression matches the entire line, loc1 points to the first character of string and loc2 points to the null at the end of string.

The purpose of step() is to step through the string argument until a match is found or until the end of string is reached. If the regular expression begins with *, step() tries to match the regular expression at the beginning of the string only.
The `advance()` function is similar to `step()`, but it only sets the variable `loc2` and always restricts matches to the beginning of the string.

If one is looking for successive matches in the same string of characters, `locs` should be set equal to `loc2`, and `step()` should be called with `string` equal to `loc2`. `locs` is used by commands like `ed` and `sed` so that global substitutions like `s/y*//g` do not loop forever, and is `NULL` by default.

The external variable `nbra` is used to determine the number of subexpressions in the compiled regular expression. `braslist` and `braelist` are arrays of character pointers that point to the start and end of the `nbra` subexpressions in the matched string. For example, after calling `step()` or `advance()` with string `sabcdefg` and regular expression `\(abcdef\)`, `braslist[0]` will point at `a` and `braelist[0]` will point at `g`. These arrays are used by commands like `ed` and `sed` for substitute replacement patterns that contain the `\n` notation for subexpressions.

Note that it is not necessary to use the external variables `regerrno`, `nbra`, `loc1`, `loc2`, `locs`, `braelist`, and `braslist` if one is only checking whether or not a string matches a regular expression.

**EXAMPLE 1**

The following is similar to the regular expression code from `grep`:

```c
#include<regex.h>
...
if(compile(*argv, (char *)0, (char *)0) == (char *)0)
   regerr(regerrno);
...
if (step(linebuf, expbuf))
   succeed();
```

**RETURN VALUES**

If `compile()` succeeds, it returns a non-`NULL` pointer whose value depends on `expbuf`. If `expbuf` is non-`NULL`, `compile()` returns a pointer to the byte after the last byte in the compiled regular expression. The length of the compiled regular expression is stored in `reglength`. Otherwise, `compile()` returns a pointer to the space allocated by `malloc(3C)`.

The functions `step()` and `advance()` return non-zero if the given string matches the regular expression, and zero if the expressions do not match.

**ERRORS**

If an error is detected when compiling the regular expression, a `NULL` pointer is returned from `compile()` and `regerrno` is set to one of the non-zero error numbers indicated below:

<table>
<thead>
<tr>
<th>ERROR</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Range endpoint too large.</td>
</tr>
<tr>
<td>16</td>
<td>Bad Number.</td>
</tr>
</tbody>
</table>

414 man pages section 3: Extended Library Functions • Last Revised 29 Dec 1996
ERROR MEANING
25 \"digit\" out of range.
36 Illegal or missing delimiter.
41 No remembered string search.
42 \(~\) imbalance.
43 Too many \(.
44 More than 2 numbers given in \[\&~\].
45 ] expected after \.
46 First number exceeds second in \[\&~\].
49 ] imbalance.
50 Regular expression overflow.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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<th>ATTRIBUTE VALUE</th>
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<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO ed(1), grep(1), sed(1), malloc(3C), attributes(5), regexp(5)

NOTES When compiling multi-threaded applications, the _REENTRANT flag must be defined on the compile line. This flag should only be used in multi-threaded applications.
remainder(3M)

NAME   remainder – remainder function

SYNOPSIS  
```
#include <math.h>

double remainder(double x, double y);
```

DESCRIPTION  The remainder() function returns the floating point remainder \( r = x - ny \) when \( y \) is non-zero. The value \( n \) is the integral value nearest the exact value \( x/y \). When \( |n - x/y| = \frac{1}{2} \), the value \( n \) is chosen to be even.

The behavior of remainder() is independent of the rounding mode.

RETURN VALUES  The remainder() function returns the floating point remainder \( r = x - ny \) when \( y \) is non-zero.

When \( y \) is 0, remainder() returns NaN and sets errno to EDOM.

If the value of \( x \) is ±Inf, remainder() returns NaN and sets errno to EDOM.

If \( x \) or \( y \) is NaN, then the function returns NaN.

ERRORS  The remainder() function will fail if:

EDOM The \( y \) argument is 0 or the \( x \) argument is positive or negative infinity.

USAGE  The remainder() function computes the remainder \( x \text{ REM } y \) required by ANSI/IEEE 754 (IEC 559).

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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<tr>
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</tbody>
</table>

SEE ALSO  fmod(3M), attributes(5)
#include <math.h>
double rint(double x);

The rint() function returns the integral value (represented as a double) nearest \( x \) in the direction of the current IEEE754 rounding mode.

If the current rounding mode rounds toward negative infinity, then rint() is identical to floor(3M). If the current rounding mode rounds toward positive infinity, then rint() is identical to ceil(3M).

Upon successful completion, the rint() function returns the integer (represented as a double precision number) nearest \( x \) in the direction of the current IEEE754 rounding mode.

When \( x \) is \( \pm \infty \), rint() returns \( x \).

If the value of \( x \) is NaN, NaN is returned.

No errors will occur.

See attributes(5) for descriptions of the following attributes:

```
<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
```

ceil(3M), floor(3M), isnan(3M), attributes(5)
rsm_create_localmemory_handle(3RSM)

NAME
rsm_create_localmemory_handle, rsm_free_localmemory_handle – create or free local memory handle

SYNOPSIS
cc [flags...] file... -lrsm [library...]
#include <rsmapi.h>

int rsm_create_localmemory_handle(rsmapi_controller_handle_t handle, rsm_localmemory_handle_t *l_handle, caddr_t local_vaddr, size_t length);

int rsm_free_localmemory_handle(rsmapi_controller_handle_t handle, rsm_localmemory_handle_t l_handle);

DESCRIPTION
The rsm_create_localmemory_handle() and rsm_free_localmemory_handle() functions are supporting functions for rsm_memseg_import_putv(3RSM) and rsm_memseg_import_getv(3RSM).

The rsm_create_localmemory_handle() function creates a local memory handle to be used in the I/O vector component of a scatter-gather list of subsequent rsm_memseg_import_putv() and rsm_memseg_import_getv() calls. The handle argument specifies the controller handle obtained from rsm_get_controller(3RSM). The l_handle argument is a pointer to the location for the function to return the local memory handle. The local_vaddr argument specifies the local virtual address; it should be aligned at a page boundary. The length argument specifies the length of memory spanned by the handle.

The rsm_free_localmemory_handle() function unlocks the memory range for the local handle specified by l_handle and releases the associated system resources. The handle argument specifies the controller handle. All handles created by a process are freed when the process exits, but the process should call rsm_free_localmemory_handle() as soon as possible to free the system resources.

RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

ERRORS
The rsm_create_localmemory_handle() and rsm_free_localmemory_handle() functions can return the following errors:

RSMERR_BAD_CTLR_HNDL Invalid controller handle.
RSMERR_BAD_LOCALMEM_HNDL Invalid local memory handle.

The rsm_create_localmemory_handle() function can return the following errors:

RSMERR_BAD_LENGTH Invalid length.
RSMERR_BAD_ADDRESS Invalid address.
RSMERR_INSUFFICIENT_MEM Insufficient memory.
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  rsm_memseg_import_putv(3RSM), attributes(5)
The controller functions provide mechanisms for obtaining access to a controller, determining the characteristics of the controller, and releasing the controller.

The `rsm_get_controller()` function acquires a controller handle through the `controller` argument. The `name` argument is the specific controller instance (for example, "sci0" or "loopback"). This controller handle is used for subsequent RSMAPI calls.

The `rsm_get_controller_attr()` function obtains a controller’s attributes through the `attr` argument. The `chdl` argument is the controller handle obtained by the `rsm_get_controller()` call. The attribute structure is defined in the `<rsmapi>` header.

The `rsm_release_controller()` function releases the resources associated with the controller identified by the controller handle `chdl`, obtained by calling `rsm_get_controller()`. Each `rsm_release_controller()` call must have a corresponding `rsm_get_controller()` call. It is illegal to access a controller or segments exported or imported using a released controller.

Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

The `rsm_get_controller()`, `rsm_get_controller_attr()`, and `rsm_release_controller()` functions can return the following errors:

- **RSMERR_BAD_CTLR_HNDL**
  - Invalid controller handle.

The `rsm_get_controller()` and `rsm_get_controller_attr()` functions can return the following errors:

- **RSMERR_BAD_ADDR**
  - Bad address.

The `rsm_get_controller()` function can return the following errors:

- **RSMERR_CTLR_NOT_PRESENT**
  - Controller not present.

- **RSMERR_INSUFFICIENT_MEM**
  - Insufficient memory.

- **RSMERR_BAD_LIBRARY_VERSION**
  - Invalid library version.
See attributes(5) for descriptions of the following attributes:

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<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO rsm_memseg_export_create(3RSM), rsm_memseg_import_connect(3RSM), attributes(5)
The `rsm_get_interconnect_topology()` and `rsm_free_interconnect_topology()` functions provide for access to the interconnect controller and connection data. The key interconnect data required for export and import operations includes the respective cluster nodeids and the controller names. To facilitate applications in the establishment of proper and efficient export and import policies, a delineation of the interconnect topology is provided by this interface. The data provided includes local nodeid, local controller name, its hardware address, and remote connection specification for each local controller. An application component exporting memory can thus find the set of existing local controllers and correctly assign controllers for the creation and publishing of segments. Exported segments may also be efficiently distributed over the set of controllers consistent with the hardware interconnect and application software. An application component which is to import memory must be informed of the segment id(s) and controller(s) used in the exporting of memory, this needs to be done using some out-of-band mechanism. The topology data structures are defined in the `<rsmapi.h>` header.

The `rsm_get_interconnect_topology()` returns a pointer to the topology data in a location specified by the `topology_data` argument.

The `rsm_free_interconnect_topology()` frees the resources allocated by `rsm_get_interconnect_topology()`.

Upon successful completion, `rsm_get_interconnect_topology()` returns 0. Otherwise, an error value is returned to indicate the error.

The `rsm_get_interconnect_topology()` function can return the following errors:

- RSMERR_BAD_TOPOLOGY_PTR: Invalid topology pointer.
- RSMERR_INSUFFICIENT_MEM: Insufficient memory.
- RSMERR_BAD_ADDR: Bad address.

See attributes(5) for descriptions of the following attributes:

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</table>
### SEE ALSO
attributes(5)

<table>
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**rsm_get_interconnect_topology**(3RSM)
# NAME
rsm_get_segmentid_range - get segment ID range

# SYNOPSIS
cc [flags...] file... -lrsm [library...]
#include <rsmapi.h>

int rsm_get_segmentid_range(const char *appid, rsm_segment_id_t *baseid, uint_t *length);

# DESCRIPTION
RSM segment IDs can be either specified by the application or generated by the system using the rsm_memseg_export_publish(3RSM) function. Applications that specify segment IDs require a reserved range of segment IDs that they can use. This can be achieved by using rsm_get_segmentid_range() and by reserving a range of segment IDs in the segment ID configuration file, /etc/rsm/rsm.segmentid. The rsm_get_segmentid_range() function can be used by applications to obtain the segment ID range reserved for them. The appid argument is a null-terminated string that identifies the application. The baseid argument points to the location where the starting segment ID of the reserved range is returned. The length argument points to the location where the number of reserved segment IDs is returned.

The application can use any value starting at baseid and less than baseid+length. The application should use an offset within the range of reserved segment IDs to obtain a segment ID such that if the baseid or length is modified, it will still be within its reserved range.

It is the responsibility of the system administrator to make sure that the segment ID ranges are properly administered (such that they are non-overlapping, the file on various nodes of the cluster have identical entries, and so forth.) Entries in the /etc/rsm/rsm.segmentid file are of the form:

```
#keyword appid baseid length
reserve SUNWfoo 0x600000 1000
```

The fields in the file are separated by tabs or blanks. The first string is a keyword "reserve", followed by the application identifier (a string without spaces), the baseid (the starting segment ID of the reserved range in hexadecimal), and the length (the number of segmentids reserved). Comment lines contain a "#" in the first column. The file should not contain blank or empty lines. Segment IDs reserved for the system are defined in the <usr/include/rsm/rsm_common.h> header and cannot be used by the applications.

# RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

# ERRORS
The rsm_get_segmentid_range() function can return the following errors:

- **RSMERR_BAD_ADDR** The address passed is invalid.
- **RSMERR_BAD_APPID** The appid is not defined in configuration file.
- **RSMERR_BAD_CONF** The configuration file is not present or not readable, or the configuration file format is incorrect.
ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO

rsm_memseg_export_publish(3RSM), attributes(5)
# rsm_intr_signal_post(3RSM)

## NAME
rsm_intr_signal_post, rsm_intr_signal_wait – signal or wait for an event

## SYNOPSIS
```c
#include <rsmapi.h>

int rsm_intr_signal_post(void *memseg, uint_t flags);
int rsm_intr_signal_wait(void *memseg, int timeout);
```

## DESCRIPTION
The `rsm_intr_signal_post()` and `rsm_intr_signal_wait()` functions are event functions that allow synchronization between importer processes and exporter processes. A process may block to wait for an event occurrence by calling `rsm_intr_signal_wait()`. A process can signal a waiting process when an event occurs by calling `rsm_intr_signal_post()`.

The `rsm_intr_signal_post()` function signals an event occurrence. Either an import segment handle (`rsm_memseg_import_handle_t`) or an export segment handle (`rsm_memseg_export_handle_t`) may be type cast to a void pointer for the `memseg` argument. If `memseg` refers to an import handle, the exporting process is signalled. If `memseg` refers to an export handle, all importers of that segment are signalled. The `flags` argument may be set to `RSM_SIGPOST_NO_ACCUMULATE`; this will cause this event to be discarded if an event is already pending for the target segment.

The `rsm_intr_signal_wait()` function allows a process to block and wait for an event occurrence. Either an import segment handle (`rsm_memseg_import_handle_t`) or an export segment handle (`rsm_memseg_export_handle_t`) may be type cast to a void pointer for the `memseg` argument. The process blocks for up to `timeout` milliseconds for an event to occur; if the timeout value is -1, the process blocks until an event occurs or until interrupted.

## RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

## ERRORS
The `rsm_intr_signal_post()` and `rsm_intr_signal_wait()` functions can return the following error:

- **RSMERR_BAD_SEG_HNDL** Invalid segment handle.

The `rsm_intr_signal_post()` function can return the following error:

- **RSMERR_REMOTE_NODE_UNREACHABLE** Remote node not reachable.

The `rsm_intr_signal_wait()` function can return the following errors:

- **RSMERR_TIMEOUT** Timer expired.
- **RSMERR_INTERRUPTED** Wait interrupted.
ATTRIBUTES

See `attributes(5)` for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO `rsm_memseg_get_pollfd(3RSM), attributes(5)`
rsm_memseg_export_create(3RSM)

NAME  rsm_memseg_export_create, rsm_memseg_export_destroy,
rsm_memseg_export_rebind – resource allocation and management functions for
export memory segments

SYNOPSIS  cc [flags...] file... -lrsmtree [library...]
#include <rsmapi.h>

int rsm_memseg_export_create(rsmapi_controller_handle_t controller,
                            rsm_memseg_export_handle_t *memseg, void *vaddr, size_t length,
                            uint_t flags);

int rsm_memseg_export_destroy(rsm_memseg_export_handle_t memseg);

int rsm_memseg_export_rebind(rsm_memseg_export_handle_t memseg,
                            void *vaddr, offset_t off, size_t length);

DESCRIPTION  The rsm_memseg_export_create(), rsm_memseg_export_destroy(), and
rsm_memseg_export_rebind() functions provide for allocation and management
of resources supporting export memory segments. Exporting a memory segment
involves the application allocating memory in its virtual address space through the
System V shared memory interface or normal operating system memory allocation
functions. This is followed by the calls to create the export segment and bind physical
pages to back to allocated virtual address space.

The rsm_memseg_export_create() creates a new memory segment. Physical
memory pages are allocated and are associated with the segment. The segment
lifetime is the same as the lifetime of the creating process or until a destroy operation
is performed. The controller argument is the controller handle obtained from a prior
call to rsm_get_controller(3RSM). The export memory segment handle is
obtained through the memseg argument for use in subsequent operations. The vaddr
argument specifies the process virtual address for the segment. It must be aligned
according to the controller page size attribute. The length argument specifies the size of
the segment in bytes and must be in multiples of the controller page size. The flags
argument is a bitmask of flags. The RSM_ALLOW_REBIND flag indicates that unbind
and rebind is allowed on the segment during its lifetime. The RSM_LOCK_OPS flag
indicates that this segment can be used for lock operations.

The rsm_memseg_export_destroy() function deallocates the physical memory
pages associated with the segment and disconnects all importers of the segment. The
memseg argument is the export memory segment handle obtained by a call to
rsm_memseg_export_create(3RSM).

The rsm_memseg_export_rebind() function releases the current backing pages
associated with the segment and allocates new physical memory pages. This operation
is transparent to the importers of the segment. It is the responsibility of the application
to prevent data access to the export segment until the rebind operation has completed.
Segment data access during rebind does not cause a system failure but data content
results are undefined. The memseg argument is the export segment handle pointer
obtained from rsm_memseg_export_create(3RSM). The vaddr argument must be
aligned with respect to the page size attribute of the controller. The length argument
modulo controller page size must be 0. The off argument is currently unused.
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

The `rsm_memseg_export_create()`, `rsm_memseg_export_destroy()`, and `rsm_memseg_export_rebind()` functions can return the following errors:

- **RSMERR_BAD_SEG_HNDL**: Invalid segment handle.
- **RSMERR_BAD_CTLR_HNDL**: Invalid controller handle.
- **RSMERR_CTLR_NOT_PRESENT**: Controller not present.
- **RSMERR_BAD_LENGTH**: Length zero or length exceeds controller limits.
- **RSMERR_BAD_ADDR**: Invalid address.
- **RSMERR_INSUFFICIENT_MEM**: Insufficient memory.
- **RSMERR_INSUFFICIENT_RESOURCES**: Insufficient resources.
- **RSMERR_PERM_DENIED**: Permission denied.
- **RSMERR_NOT_CREATOR**: Not creator of segment.
- **RSMERR_REBIND_NOT_ALLOWED**: Rebind not allowed.

The `rsm_memseg_export_create()` function can return the following errors:

- **RSMERR_BAD_MEM_ALIGNMENT**: The address is not aligned on a page boundary.

The `rsm_memseg_export_rebind()` function can return the following errors:

- **RSMERR_INTERRUPTED**: The operation was interrupted by a signal.

The `rsm_memseg_export_destroy()` function can return the following errors:

- **RSMERR_POLLFD_IN_USE**: Poll file descriptor in use.

Exporting a memory segment involves the application allocating memory in its virtual address space through the System V Shared Memory interface or other normal operating system memory allocation methods such as `valloc()` (see `malloc(3C)`) or `mmap(2)`. Memory for a file mapped with `mmap()` must be mapped `MAP_PRIVATE`.

See `attributes(5)` for descriptions of the following attributes:

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</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
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</table>

**Extended Library Functions** 429
rsm_memseg_export_create(3RSM)

<table>
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</table>

SEE ALSO rsm_get_controller(3RSM), rsm_memseg_export_publish(3RSM), attributes(5)
rsm_memseg_export_publish(3RSM)

NAME
rsm_memseg_export_publish, rsm_memseg_export_unpublish,
rsm_memseg_export_republish - allow or disallow a memory segment to be imported
by other nodes

SYNOPSIS
cc [flags...1 file... -lrsm [library...]
#include <rsmapi.h>

int rsm_memseg_export_publish(rsm_memseg_export_handle_t memseg,
   rsm_memseg_id_t *segment_id, rsmapi_access_entry_t access_list[],
   uint_t access_list_length);

int rsm_memseg_export_unpublish(rsm_memseg_export_handle_t memseg);

int rsm_memseg_export_republish(rsm_memseg_export_handle_t memseg,
   rsmapi_access_entry_t access_list[], uint_t
   access_list_length);

DESCRIPTION
The rsm_memseg_export_publish(), rsm_memseg_export_unpublish(), and
rsm_memseg_export_republish() functions allow or disallow a memory
segment to be imported by other nodes.

The rsm_memseg_export_publish(3RSM) function allows the export segment
specified by the memseg argument to be imported by other nodes. It also assigns a
unique segment identifier to the segment and defines the access control list for the
segment. The segment_id argument is a pointer to an identifier which is unique on the
publishing node. It is the responsibility of the application to manage the assignment of
unique segment identifiers. The identifier can be optionally initialized to 0, in which
case the system will return a unique segment identifier value. The access_list argument
is composed of pairs of nodeid and access permissions. For each nodeid specified in
the list, the associated read/write permissions are provided by three octal digits for
owner, group, and other, as for Solaris file permissions. In the access control each octal
digit may have the following values:

2 write access
4 read only access
6 read and write access

An access permissions value of 0624 specifies: (1) an importer with the same uid as the
exporter has read and write access; (2) an importer with the same gid as the exporter
has write access only; and (3) all other importers have read access only. When an
access control list is provided, nodes not included in the list will be prevented from
importing the segment. However, if the access list is NULL (this will require the length
access_list_length to be specified as 0 as well), then no nodes will be excluded from
importing and the access permissions on all nodes will equal the owner-group-other
file creation permissions of the exporting process. Corresponding to the access_list
argument, the access_list_length argument specifies the number of entries in the
access_list array.
The `rsm_memseg_export_unpublish()` function disallows the export segment specified by `memseg` from being imported. All the existing import connections are forcibly disconnected.

The `rsm_memseg_export_republish()` function changes the access control list for the exported and published segment. Although the current import connections remain unaffected by this call, new connections are constrained by the new access list.

**RETURN VALUES**
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

**ERRORS**
The `rsm_memseg_export_publish()`, `rsm_memseg_export_unpublish()`, and `rsm_memseg_export_republish()` functions can return the following errors:

- **RSMERR_BAD_SEG_HNDL** — Invalid segment handle.
- **RSMERR_NOT_CREATOR** — Not creator of segment.

The `rsm_memseg_export_publish()` and `rsm_memseg_export_republish()` functions can return the following errors, with the exception that only `rsm_memseg_export_publish()` can return the errors related to the segment identifier:

- **RSMERR_SEGID_IN_USE** — Segment identifier in use.
- **RSMERR_RESERVED_SEGID** — Segment identifier reserved.
- **RSMERR_BAD_SEGID** — Invalid segment identifier.
- **RSMERR_BAD_ACL** — Invalid access control list.
- **RSMERR_SEG_ALREADY_PUBLISHED** — Segment already published.
- **RSMERR_INSUFFICIENT_MEM** — Insufficient memory.
- **RSMERR_INSUFFICIENT_RESOURCES** — Insufficient resources.
- **RSMERR_LOCKS_NOT_SUPPORTED** — Locks not supported.
- **RSMERR_BAD_ADDR** — Bad address.

The `rsm_memseg_export_republish()` and `rsm_memseg_export_unpublish()` functions can return the following errors:

- **RSMERR_SEG_NOT_PUBLISHED** — Segment not published.
- **RSMERR_INTERRUPTED** — The operation was interrupted by a signal.

**ATTRIBUTES**
See attributes(5) for descriptions of the following attributes:

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rsm_memseg_export_publish(3RSM)

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SEE ALSO  

rsm_memseg_export_create(3RSM), attributes(5)
rsm_memseg_get_pollfd(3RSM)

NAME
rsm_memseg_get_pollfd, rsm_memseg_release_pollfd – get or release a poll descriptor

SYNOPSIS
cc [flags...] file... -lrsm [library...]
#include <rsmapi.h>

int rsm_memseg_get_pollfd(void *memseg, struct pollfd *fd);
int rsm_memseg_release_pollfd(void *memseg);

DESCRIPTION
The rsm_memseg_get_pollfd() and rsm_memseg_release_pollfd() functions provide an alternative to rsm_intr_signal_wait(3RSM); the waiting process may multiplex event waiting using the poll(2) function after first obtaining a poll descriptor using rsm_memseg_get_pollfd(). The descriptor may subsequently be released using rsm_memseg_release_pollfd().

As a result of a call rsm_memseg_get_pollfd(), the specified pollfd structure is initialized with a descriptor for the specified segment (memseg) and the event generated by rsm_intr_signal_post(3RSM). Either an export segment handle or an import segment handle may be type cast to a void pointer. The pollfd argument may subsequently be used with the poll(2) function to wait for the event. If memseg references an export segment, the segment must be currently published. If memseg references an import segment, the segment must be connected.

The rsm_memseg_release_pollfd() function decrements the reference count of the pollfd structure associated with the specified segment. A segment unpublish, destroy or unmap operation will fail if the reference count is non-zero.

RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

ERRORS
The rsm_memseg_get_pollfd() and rsm_memseg_release_pollfd() function can return the following errors:
RSMERR_BAD_SEG_HNDL Invalid segment handle.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
poll(2), rsm_intr_signal_post(3RSM), attributes(5)
### NAME
rsm_memseg_import_connect, rsm_memseg_import_disconnect – create or break logical connection between import and export segments

### SYNOPSIS

```c
cc [flags...] file... -lrsms [library...]
#include <rsmapi.h>

int rsm_memseg_import_connect(rsmapi_controller_handle_t controller,
    rsm_node_id_t nodeid, rsm_memseg_id_t segment_id,
    rsm_permission_t perm, rsm_memseg_import_handle_t *memseg);

int rsm_memseg_import_disconnect(rsm_memseg_import_handle_t *memseg);
```

### DESCRIPTION
The `rsm_memseg_import_connect()` function provides a means of creating an import segment called `memseg` and establishing a logical connection with an export segment identified by the `segment_id` on the node specified by `node_id`. The controller specified by `controller` must have a physical connection with the controller (see `rsm_get_interconnect_topology(3RSM)`) used while exporting the segment identified by `segment_id` on node specified by `node_id`. The `perm` argument specifies the mode of access that the importer is requesting for this connection. In the connection process, the mode of access and the importers userid and groupid are compared with the access permissions specified by the exporter. If the request mode is not valid, the connection request is denied. The `perm` argument is limited to the following octal values:

- 0400 read mode
- 0200 write mode
- 0600 read/write mode

The `rsm_memseg_import_disconnect()` function breaks the logical connection between the import segment and the exported segment and deallocates the resources associated with the import segment handle `memseg`.

### RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

### ERRORS
The `rsm_memseg_import_connect()` and `rsm_memseg_import_disconnect()` functions can return the following errors:

- **RSMERR_BAD_SEG_HNDL** Invalid segment handle.

The `rsm_memseg_import_connect()` function can return the following errors:

- **RSMERR_BAD_CTLR_HNDL** Invalid controller handle.
- **RSMERR_CTLR_NOT_PRESENT** Controller not present.
- **RSMERR_PERM_DENIED** Permission denied.
rsm_memseg_import_connect(3RSM)

RSMERR_INSUFFICIENT_MEM
   Insufficient memory.

RSMERR_INSUFFICIENT_RESOURCES
   Insufficient resources.

RSMERR_SEG_NOT_PUBLISHED_TO_NODE
   Segment not published to node.

RSMERR_SEG_NOT_PUBLISHED
   Segment not published at all.

RSMERR_BAD_ADDR
   Bad address.

RSMERR_REMOTE_NODE_UNREACHABLE
   Remote node unreachable.

RSMERR_INTERRUPTED
   Connection interrupted.

The rsm_memseg_import_disconnect() function can return the following errors:

RSMERR_SEG_STILL_MAPPED
   Segment still mapped, need to unmap before disconnect.

RSMERR_POLLFD_IN_USE
   Poll file descriptor in use.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
rsm_memseg_import_map(3RSM), attributes(5)
When using interconnects that allow memory mapping (see \rsm_memseg_import_map(3RSM)), standard CPU memory operations may be used for accessing memory of a segment. If a mapping is not provided, then explicitly calling these functions facilitates reading from a segment. Depending on the attributes of the extension library of the specific interconnect, these functions may involve performing an implicit mapping before performing the data transfer. Applications can be made interconnect-independent with respect to segment reads by using these functions. The data access error detection is performed through the use of barriers (see \rsm_memseg_import_open_barrier(3RSM)). The default barrier operation mode is \texttt{RSM\_BARRIER\_MODE\_IMPLICIT}, meaning that around every get operation open and close barrier are performed automatically. Alternatively, explicit error handling may be set up for these functions (see \rsm_memseg_import_set_mode(3RSM)). In either case the barrier should be initialized prior to using these functions using \rsm_memseg_import_init_barrier(3RSM).

The \texttt{rsm\_memseg\_import\_get()} function copies \texttt{length} bytes from the imported segment \texttt{im\_memseg} beginning at location \texttt{offset} from the start of the segment to a local memory buffer pointed to by \texttt{dest\_addr}.

The \texttt{rsm\_memseg\_import\_get8()} function copies \texttt{rep\_cnt} number of 8-bit quantities from successive locations starting from \texttt{offset} in the imported segment to successive local memory locations pointed to by \texttt{datap}.

The \texttt{rsm\_memseg\_import\_get16()} functions copies \texttt{rep\_cnt} number of 16-bit quantities from successive locations starting from \texttt{offset} in the imported segment to successive local memory locations pointed to by \texttt{datap}. The offset must be aligned at half-word address boundary.
The `rsm_memseg_import_get32()` function copies `rep_cnt` number of 32-bit quantities from successive locations starting from `offset` in the imported segment to successive local memory locations pointed to by `datap`. The offset must be aligned at word address boundary.

The `rsm_memseg_import_get64()` function copies `rep_cnt` number of 64-bit quantities from successive locations starting from `offset` in the imported segment to successive local memory locations pointed to by `datap`. The offset must be aligned at double-word address boundary.

The data transfer functions that transfer small quantities of data (that is, 8-, 16-, 32-, and 64-bit quantities) perform byte swapping prior to the data transfer, in the event that the source and destination have incompatible endian characteristics.

**RETURN VALUES**

Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

**ERRORS**

These functions can return the following errors:

- `RSMERR_BAD_SEG_HNDL` Invalid segment handle.
- `RSMERR_BAD_ADDR` Bad address.
- `RSMERR_BAD_MEM_ALIGNMENT` Invalid memory alignment for pointer.
- `RSMERR_BAD_OFFSET` Invalid offset.
- `RSMERR_BAD_LENGTH` Invalid length.
- `RSMERR_PERM_DENIED` Permission denied.
- `RSMERR_INSUFFICIENT_RESOURCES` Insufficient resources.
- `RSMERR_BARRIER_UNINITIALIZED` Barrier not initialized.
- `RSMERR_BARRIER_FAILURE` I/O completion error.
- `RSMERR_CONN_ABORTED` Connection aborted.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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**SEE ALSO**

- `rsm_memseg_import_init_barrier(3RSM)`, `rsm_memseg_import_open_barrier(3RSM)`, `rsm_memseg_import_set_mode(3RSM)`, attributes(5)
rsm_memseg_import_init_barrier(3RSM)

NAME  
rsm_memseg_import_init_barrier, rsm_memseg_import_destory_barrier – create or destroy barrier for imported segment

SYNOPSIS  
cc [flags...] file... -lrsm [library...]  
#include <rsmapi.h>

```c
int rsm_memseg_import_init_barrier(rsm_memseg_import_handle_t memseg, rsm_barrier_type_t type, rsmapi_barrier_t *barrier);
int rsm_memseg_import_destroy_barrier(rsmapi_barrier_t *barrier);
```

DESCRIPTION  
The `rsm_memseg_import_init_barrier()` function creates a barrier for the imported segment specified by `memseg`. The barrier type is specified by the `type` argument. Currently, only `RSM_BAR_DEFAULT` is supported as a barrier type. A handle to the barrier is obtained through the `barrier` argument and is used in subsequent barrier calls.

The `rsm_memseg_import_destroy_barrier()` function deallocates all the resources associated with the barrier.

RETURN VALUES  
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

ERRORS  
The `rsm_memseg_import_init_barrier()` and `rsm_memseg_import_destroy_barrier()` functions can return the following errors:

- RSMERR_BAD_SEG_HNDL  Invalid segment handle.
- RSMERR_BAD_BARRIER_PTR  Invalid barrier pointer.

The `rsm_memseg_import_init_barrier()` function can return the following errors:

- RSMERR_INSUFFICIENT_MEM  Insufficient memory.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

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SEE ALSO  
rsm_memseg_import_open_barrier(3RSM), rsm_memseg_import_set_mode(3RSM), attributes(5)
The `rsm_memseg_import_map()` and `rsm_memseg_import_unmap()` functions provide for mapping and unmapping operations on imported segments. The mapping operations are only available for native architecture interconnects such as Dolphin-SCI or Wildcat. Mapping a segment allows that segment to be accessed by CPU memory operations, saving the overhead of calling the memory access primitives described on the `rsm_memseg_import_get(3RSM)` and `rsm_memseg_import_put(3RSM)` manual pages.

The `rsm_memseg_import_map()` function maps an import segment into caller's address space for the segment to be accessed by CPU memory operations. The `im_memseg` argument represents the import segment that is being mapped. The location where the process's address space is mapped to the segment is pointed to by the `address` argument. The `attr` argument can be one of the following:

- RSM_MAP_NONE: The system will choose available virtual address to map and return its value in the `address` argument.
- RSM_MAP_FIXED: The import segment should be mapped at the requested virtual address specified in the `address` argument.

The `perm` argument determines whether read, write or a combination of accesses are permitted to the data being mapped. It can be either RSM_PERM_READ, RSM_PERM_WRITE, or RSM_PERM_RDWR.

The `offset` argument is the byte offset location from the base of the segment being mapped to `address`. The `length` argument indicates the number of bytes from offset to be mapped.

The `rsm_memseg_import_unmap()` function unmaps a previously mapped import segment.

Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

The `rsm_memseg_import_map()` and `rsm_memseg_import_unmap()` functions can return the following errors:

- RSMERR_BAD_SEG_HNDL: Invalid segment handle.
The `rsm_memseg_import_map()` function can return the following errors:

- RSMERR_BAD_ADDR: Invalid address.
- RSMERR_BAD_LENGTH: Invalid length.
- RSMERR_BAD_MEM_ALIGNMENT: The address is not aligned on a page boundary.
- RSMERR_BAD_OFFSET: Invalid offset.
- RSMERR_BAD_PERMS: Invalid permissions.
- RSMERR_CONN_ABORTED: Connection aborted.
- RSMERR_MAP_FAILED: Map failure.
- RSMERR_SEG_ALREADY_MAPPED: Segment already mapped.
- RSMERR_SEG_NOT_CONNECTED: Segment not connected.

**ATTRIBUTES**
See `attributes(5)` for descriptions of the following attributes:

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**SEE ALSO**
- `rsm_memseg_import_connect(3RSM)`, `rsm_memseg_import_get(3RSM)`, `rsm_memseg_import_put(3RSM)`, `rsm_memseg_get_pollfd(3RSM)`, `attributes(5)`
rsm_memseg_import_open_barrier(3RSM)

NAME
rsm_memseg_import_open_barrier, rsm_memseg_import_order_barrier,
    rsm_memseg_import_close_barrier - remote memory access error detection functions

SYNOPSIS
cc [flags...] file... -lrsms [library...]  
#include <rsmapi.h>

int rsm_memseg_import_open_barrier(rsmapi_barrier_t *barrier);
int rsm_memseg_import_order_barrier(rsmapi_barrier_t *barrier);
int rsm_memseg_import_close_barrier(rsmapi_barrier_t *barrier);

DESCRIPTION
The rsm_memseg_import_open_barrier() and
rsm_memseg_import_close_barrier() functions provide a means of remote
memory access error detection when the barrier mode is set to
RSM_BARRIER_MODE_EXPLICIT. Open and close barrier operations define a
span-of-time interval for error detection. A successful close barrier guarantees that
remote memory access covered between the open barrier and close barrier have
completed successfully. Any individual failures which may have occurred between the
open barrier and close barrier occur without any notification and the failure is not
reported until the close barrier.

The rsm_memseg_import_order_barrier() function imposes the order-of-write
completion whereby, with an order barrier, the write operations issued before the
order barrier are all completed before the operations after the order barrier. Effectively,
with the order barrier call, all writes within one barrier scope are ordered with respect
to those in another barrier scope.

RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is
returned to indicate the error.

ERRORS
The rsm_memseg_import_open_barrier(),
rsm_memseg_import_order_barrier(), and
rsm_memseg_import_close_barrier() functions can return the following errors:
RSMERR_BAD_SEG_HNDL           Invalid segment handle
RSMERR_BAD_BARRIER_PTR          Invalid barrier pointer.

The rsm_memseg_close_barrier() and rsm_memseg_order_barrier() functions can return the following errors:
RSMERR_BARRIER_UNINITIALIZED    Barrier not initialized.
RSMERR_BARRIER_NOT_OPENED       Barrier not opened.
RSMERR_BARRIER_FAILURE          Memory access error.
RSMERR_CONN_ABORTED             Connection aborted.
rsm_memseg_import_open_barrier(3RSM)

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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SEE ALSO

rsm_memseg_import_init_barrier(3RSM),
rsm_memseg_import_set_mode(3RSM), attributes(5)
rsm_memseg_import_put(3RSM)

NAME
rsm_memseg_import_put, rsm_memseg_import_put8, rsm_memseg_import_put16,
rsm_memseg_import_put32, rsm_memseg_import_put64 – write to a segment

SYNOPSIS
cc [flags...] file... -lrsm [library...]
#include <rsmapi.h>

int rsm_memseg_import_put(rsm_memseg_import_handle_t im_memseg,
    off_t offset, void *src_addr, size_t length);

int rsm_memseg_import_put8(rsm_memseg_import_handle_t im_memseg,
    off_t offset, uint8_t *datap, ulong_t rep_cnt);

int rsm_memseg_import_put16(rsm_memseg_import_handle_t im_memseg,
    off_t offset, uint16_t *datap, ulong_t rep_cnt);

int rsm_memseg_import_put32(rsm_memseg_import_handle_t im_memseg,
    off_t offset, uint32_t *datap, ulong_t rep_cnt);

int rsm_memseg_import_put64(rsm_memseg_import_handle_t im_memseg,
    off_t offset, uint64_t *datap, ulong_t rep_cnt);

DESCRIPTION
When using interconnects that allow memory mapping (see rsm_memseg_import_map(3RSM)), standard CPU memory operations may be used for accessing memory of a segment. If, however, a mapping is not provided, then explicitly calling these functions facilitates writing to a segment. Depending on the attributes of the extension library for the interconnect, these functions may involve doing an implicit mapping before performing the data transfer. Applications can be made interconnect-independent with respect to segment writes by using these functions. The data access error detection is performed through the use of barriers (see rsm_memseg_import_open_barrier(3RSM)). The default barrier operation mode is RSM_BARRIER_MODE_IMPLICIT, which means that around every put operation open and close barrier operations are performed automatically. Explicit error handling may also be set up for these functions (see rsm_memseg_import_set_mode(3RSM)).

The `rsm_memseg_import_put()` function copies `length` bytes from local memory with start address `src_addr` to the imported segment `im_memseg` beginning at location `offset` from the start of the segment.

The `rsm_memseg_import_put8()` function copies `rep_cnt` number of 8-bit quantities from successive local memory locations pointed to by `datap` to successive locations starting from `offset` in the imported segment.

The `rsm_memseg_import_put16()` function copies `rep_cnt` number of 16-bit quantities from successive local memory locations pointed to by `datap` to successive locations starting from `offset` in the imported segment. The `offset` must be aligned at half-word address boundary.

The `rsm_memseg_import_put32()` function copies `rep_cnt` number of 32-bit quantities from successive local memory locations pointed to by `datap` to successive locations starting from `offset` in the imported segment. The `offset` must be aligned at word address boundary.
The `rsm_memseg_import_put64()` function copies `rep_cnt` number of 64-bit quantities from successive local memory locations pointed to by `datap` to successive locations starting from `offset` in the imported segment. The offset must be aligned at double-word address boundary.

The data transfer functions that transfer small quantities of data (that is, 8-, 16-, 32-, and 64-bit quantities) perform byte swapping prior to the data transfer, in the event that the source and destination have incompatible endian characteristics.

**RETURN VALUES**
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

**ERRORS**
These functions can return the following errors:

- `RSMERR_BAD_SEG_HNDL` Invalid segment handle.
- `RSMERR_BAD_ADDR` Bad address.
- `RSMERR_BAD_MEM_ALIGNMENT` Invalid memory alignment for pointer.
- `RSMERR_BAD_OFFSET` Invalid offset.
- `RSMERR_BAD_LENGTH` Invalid length.
- `RSMERR_PERM_DENIED` Permission denied.
- `RSMERR_INSUFFICIENT_RESOURCES` Insufficient resources.
- `RSMERR_BARRIER_UNINITIALIZED` Barrier not initialized.
- `RSMERR_BARRIER_FAILURE` I/O completion error.
- `RSMERR_CONN_ABORTED` Connection aborted.

**ATTRIBUTES**
See `attributes(5)` for descriptions of the following attributes:

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**SEE ALSO**
`rsm_memseg_import_get(3RSM)`, `rsm_memseg_import_init_barrier(3RSM)`, `rsm_memseg_import_open_barrier(3RSM)`, `rsm_memseg_import_set_mode(3RSM)`, `attributes(5)`
rsm_memseg_import_putv(3RSM)

NAME
rsm_memseg_import_putv, rsm_memseg_import_getv – write to a segment using a list of I/O requests

SYNOPSIS
cc [flags...] file... -lrasm [library...]
#include <rsmapi.h>

int rsm_memseg_import_putv(rsm_scat_gath_t *sg_io);
int rsm_memseg_import_getv(rsm_scat_gath_t *sg_io);

DESCRIPTION
The rsm_memseg_import_putv() and rsm_memseg_import_getv() functions provide for using a list of I/O requests rather than a single source and destination address as is done for the rsm_memseg_import_put(3RSM) and rsm_memseg_import_get(3RSM) functions.

The I/O vector component of the scatter-gather list (sg_io), allows specifying local virtual addresses or local_memory_handles. When a local address range is used repeatedly, it is efficient to use a handle because allocated system resources (that is, locked down local memory) are maintained until the handle is freed. The supporting functions for handles are rsm_create_localmemory_handle(3RSM) and rsm_free_localmemory_handle(3RSM).

Virtual addresses or handles may be gathered into the vector for writing to a single remote segment, or a read from a single remote segment may be scattered to the vector of virtual addresses or handles.

Implicit mapping is supported for the scatter-gather type of access. The attributes of the extension library for the specific interconnect are used to determine whether mapping is necessary before any scatter-gather access. If mapping of the imported segment is a prerequisite for scatter-gather access and the mapping has not already been performed, an implicit mapping is performed for the imported segment. The I/O for the vector is then initiated.

I/O for the entire vector is initiated before returning. The barrier mode attribute of the import segment determines if the I/O has completed before the function returns. A barrier mode attribute setting of IMPLICIT guarantees that the transfer of data is completed in the order as entered in the I/O vector. An implicit barrier open and close surrounds each list entry. If an error is detected, I/O for the vector is terminated and the function returns immediately. The residual count indicates the number of entries for which the I/O either did not complete or was not initiated.

Optionally, the scatter-gather list allows support for an implicit signal post after the I/O for the entire vector has completed. This alleviates the need to do an explicit signal post after every I/O transfer operation. The means of enabling the implicit signal post involves setting the flags field within the scatter-gather list to RSM_IMPLICIT_SIGPOST. The flags field may also be set to RSM_SIG_POST_NO_ACCUMULATE, which will be passed on to the signal post operation when RSM_IMPLICIT_SIGPOST is set.

RETURN VALUES
Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

446  man pages section 3: Extended Library Functions • Last Revised 8 Jun 2001
The `rsm_memseg_import_putv()` and `rsm_memseg_import_getv()` functions can return the following errors:

- **RSMERR_BAD_SGIO**  
  Invalid scatter-gather structure pointer.
- **RSMERR_BAD_SEG_HNDL**  
  Invalid segment handle.
- **RSMERR_BAD_CTLR_HNDL**  
  Invalid controller handle.
- **RSMERR_BAD_OFFSET**  
  Invalid offset.
- **RSMERR_BAD_LENGTH**  
  Invalid length.
- **RSMERR_BAD_ADDR**  
  Bad address.
- **RSMERR_INSUFFICIENT_RESOURCES**  
  Insufficient resources.
- **RSMERR_INTERRUPTED**  
  The operation was interrupted by a signal.
- **RSMERR_PERM_DENIED**  
  Permission denied.
- **RSMERR_BARRIER_FAILURE**  
  I/O completion error.
- **RSMERR_REMOTE_NODE_UNREACHABLE**  
  Remote node not reachable.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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**SEE ALSO**

`rsm_create_localmemory_handle(3RSM)`,
`rsm_free_localmemory_handle(3RSM)`, attributes(5)
rsm_memseg_import_set_mode(3RSM)

NAME  rsm_memseg_import_set_mode, rsm_memseg_import_get_mode – set or get mode for barrier scoping

SYNOPSIS  cc [flags... ] file... -lrsm [library... ]
            #include <rsmapi.h>

            int rsm_memseg_import_set_mode(rsm_memseg_import_handle_t memseg,  
                                       rsm_barrier_mode_t mode);

            int rsm_memseg_import_get_mode(rsm_memseg_import_handle_t memseg,  
                                           rsm_barrier_mode_t *mode);

DESCRIPTION  The rsm_memseg_import_set_mode() function provides support for optional explicit barrier scoping in the functions described on the rsm_memseg_import_get(3RSM) and rsm_memseg_import_put(3RSM) manual pages. The two valid barrier modes are RSM_BARRIER_MODE_EXPLICIT and RSM_BARRIER_MODE_IMPLICIT. By default, the barrier mode is set to RSM_BARRIER_MODE_IMPLICIT. When the mode is RSM_BARRIER_MODE_IMPLICIT, an implicit barrier open and barrier close is applied to the put operation. Irrespective of the mode set, the barrier must be initialized using the rsm_memseg_import_init_barrier(3RSM) function before any barrier operations, either implicit or explicit, are used.

The rsm_memseg_import_get_mode() function obtains the current value of the mode used for barrier scoping in put functions.

RETURN VALUES  Upon successful completion, these functions return 0. Otherwise, an error value is returned to indicate the error.

ERRORS  The rsm_memseg_import_set_mode() and rsm_memseg_import_get_mode() functions can return the following errors:

            RSMERR_BAD_SEG_HNDL     Invalid segment handle.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  rsm_memseg_import_get(3RSM), rsm_memseg_import_init_barrier(3RSM), rsm_memseg_import_put(3RSM), attributes(5)
scalb – load exponent of a radix-independent floating-point number

SYNOPSIS

#include <math.h>

double scalb(double x, double n);

DESCRIPTION

The `scalb()` function computes \( x \times r^n \), where \( r \) is the radix of the machine’s floating point arithmetic. When \( r \) is 2, `scalb()` is equivalent to `ldexp(3C)`.

RETURN VALUES

Upon successful completion, the `scalb()` function returns \( x \times r^n \).

- If the correct value would overflow, `scalb()` returns ±HUGE_VAL (according to the sign of \( x \)) and sets `errno` to `ERANGE`.
- If the correct value would underflow to 0.0, `scalb()` returns 0 and sets `errno` to `ERANGE`.
- The `scalb()` function returns \( x \) when \( x \) is ±Inf.
- If \( x \) or \( n \) is NaN, then `scalb()` returns NaN.

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS

The `scalb()` function will fail if:

- `ERANGE`  The correct value would overflow or underflow.

USAGE

An application wishing to check for error situations should set `errno` to 0 before calling `scalb()`. If `errno` is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES

See `attributes(5)` for descriptions of the following attributes:

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SEE ALSO

`ldexp(3C)`, `matherr(3M)`, `attributes(5)`
scalbn(3M)

NAME
scalbn – load exponent of a radix-independent floating-point number

SYNOPSIS
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double scalbn(double x, int n);

DESCRIPTION
The scalbn() function computes \( x \times r^n \), where \( r \) is the radix of the machine’s floating point arithmetic.

RETURN VALUES
Upon successful completion, the scalbn() function returns \( x \times r^n \).

If the correct value would overflow, scalbn() returns ±HUGE_VAL (according to the sign of \( x \)).

The scalbn() function returns \( x \) when \( x \) is ±Inf.

If \( x \) is NaN, then scalbn() returns NaN.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
attributes(5)
SCF_Card_exchangeAPDU – send a command APDU to a card and read the card’s response

**SYNOPSIS**

```
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Card_exchangeAPDU(SCF_Card_t card, const uint8_t *sendBuffer, size_t sendLength, uint8_t *recvBuffer, size_t *recvLength);
```

**PARAMETERS**

- **card** The card (from SCF_Terminal_getCard(3SMARTCARD)) to communicate with.
- **sendBuffer** A pointer to a buffer containing the command APDU.
- **sendLength** The number of bytes in the sendBuffer (that is, the size of the command APDU).
- **recvBuffer** A pointer to a buffer in which the card’s reply APDU should be stored. This buffer can be the same as the sendBuffer to allow the application to conserve memory usage. The buffer must be large enough to store the expected reply.
- **recvLength** The caller specifies the maximum size of the recvBuffer in recvLength. The library uses this value to prevent overflowing the buffer. When the reply is received, the library sets recvLength to the actual size of the reply APDU that was stored in the recvBuffer.

**DESCRIPTION**

The SCF_Card_exchangeAPDU() function sends a binary command to the card and reads the reply. The application is responsible for constructing a valid command and providing a receive buffer large enough to hold the reply. Generally, the command and reply will be ISO7816-formatted APDUs (Application Protocol Data Units), but the SCF library does not examine or verify the contents of the buffers.

If the caller needs to perform a multi-step transaction that must not be interrupted, SCF_Card_lock(3SMARTCARD) should be used to prevent other applications from communicating with the card during the transaction. Similarly, calls to SCF_Card_exchangeAPDU() must be prepared to retry the call if SCF_STATUS_CARDLOCKED is returned.

An ISO7816-formatted command APDU always begins with a mandatory 4 byte header (CLA, INS, P1, and P2), followed by a variable length body (zero or more bytes). For details on the APDUs supported by a specific card, consult the documentation provided by the card manufacturer or applet vendor.

An ISO7816-formatted reply APDU consists of zero or more bytes of data, followed by a mandatory 2 byte status trailer (SW1 and SW2).

**RETURN VALUES**

If the APDU is successfully sent and a reply APDU is successfully read,
SCF_STATUS_SUCCESS is returned with recvBuffer and recvLength set appropriately. Otherwise, an error value is returned and both recvBuffer and recvLength remain unaltered.
The SCF_Card_exchangeAPDU() function will fail if:

- **SCF_STATUS_BADARGS** Neither sendBuffer, recvBuffer, nor recvLength can be null pointers. The value of recvLength must be at least 2.
- **SCF_STATUS_BADHANDLE** The card has been closed or is invalid.
- **SCF_STATUS_CARDLOCKED** The APDU cannot be sent because the card is locked by another application.
- **SCF_STATUS_CARDREMOVED** The card object cannot be used because the card represented by the SCF_Card_t has been removed.
- **SCF_STATUS_COMMERROR** The connection to the server was closed.
- **SCF_STATUS_FAILED** An internal error occurred.
- **SCF_STATUS_NOSPACE** The specified size of recvBuffer is too small to hold the complete reply APDU.

**EXAMPLE 1** Send a command to the card.

```c
SCF_Status_t status;
SCF_Card_t myCard;
uint8_t commandAPDU[] = {0x00, 0xa4, 0x00, 0x00, 0x02, 0x3f, 0x00};
uint8_t replyAPDU[256];
uint32_t commandSize = sizeof(commandAPDU);
uint32_t replySize = sizeof(replyAPDU);
/* (...call SCF_Terminal_getCard to open myCard...) */
status = SCF_Card_exchangeAPDU(myCard, commandAPDU, commandSize,
                                replyAPDU, &replySize);
if (status != SCF_STATUS_SUCCESS) exit(1);
printf("Received a %d byte reply.\n", replySize);
printf("SW1=0x%02.2x SW2=0x%02.2x\n",
       replyAPDU[replySize-2], replyAPDU[replySize-1]);
/* ... */
```

**ATTRIBUTES** See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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<th>ATTRIBUTE VALUE</th>
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</table>

**SEE ALSO** libsmartcard(3LIB), SCF_Card_lock(3SMARTCARD), SCF_Terminal_getCard(3SMARTCARD), attributes(5)
### SCF_Card_lock(3SMARTCARD)

**NAME**
SCF_Card_lock, SCF_Card_unlock – perform mutex locking on a card

**SYNOPSIS**
```c
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>
SCF_Status_t SCF_Card_lock(SCF_Card_t card, unsigned int timeout);
SCF_Status_t SCF_Card_unlock(SCF_Card_t card);
```

**PARAMETERS**
- `card` The card (from SCF_Terminal_getCard(3SMARTCARD)) to be locked.
- `timeout` The maximum number of seconds SCF_Card_lock() should wait for a card locked by another application to become unlocked. A value of 0 results in SCF_Card_lock() returning immediately if a lock cannot be immediately obtained. A value of SCF_TIMEOUT_MAX results in SCF_Card_lock() waiting forever to obtain a lock.

**DESCRIPTION**
Locking a card allows an application to perform a multi-APDU transaction (that is, multiple calls to SCF_Card_exchangeAPDU(3SMARTCARD)) without interference from other smartcard applications. The lock is enforced by the server, so that other applications that attempt to call SCF_Card_exchangeAPDU() or SCF_Card_reset(3SMARTCARD) will be denied access to the card. Applications should restrict use of locks only to brief critical sections. Otherwise it becomes difficult for multiple applications to share the same card.

When a lock is granted to a specific SCF_Card_t card object, only that object can be used to access the card and subsequently release the lock. If a misbehaving application holds a lock for an extended period, the lock can be broken by having the user remove and reinsert the smartcard.

It is an error to attempt to lock a card when the caller already holds a lock on the card (that is, calling SCF_Card_lock() twice in a succession). Unlocking a card that is not locked (or was already unlocked) can be performed without causing an error.

An application might find that it is unable to lock the card, or communicate with it because SCF_Card_exchangeAPDU() keeps returning SCF_STATUS_CARDLOCKED. If this situation persists, it might indicate that another application has not released its lock on the card. The user is able to forcibly break a lock by removing the card and reinserting it, after which the application must call SCF_Terminal_getCard(3SMARTCARD) to access the "new" card. In this situation an application should retry for a reasonable period of time, and then alert the user that the operation could not be completed because the card is in use by another application and that removing or reinserting the card will resolve the problem.

**RETURN VALUES**
If the card is successfully locked or unlocked, SCF_STATUS_SUCCESS is returned. Otherwise, the lock status of the card remains unchanged and an error value is returned.

**ERRORS**
The SCF_Card_lock() and SCF_Card_lock() functions will fail if:
SCF_Card_lock(3SMARTCARD)

<table>
<thead>
<tr>
<th>SCF_STATUS_BADHANDLE</th>
<th>The specified card has been closed or is invalid.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCF_STATUS_CARDLOCKED</td>
<td>There is a lock present on the card, but it is not held by the specified card object. For example, the caller is attempting to unlock a card locked by another application.</td>
</tr>
<tr>
<td>SCF_STATUS_CARDREMOVED</td>
<td>The card object cannot be used because the card represented by the SCF_Card_t has been removed.</td>
</tr>
<tr>
<td>SCF_STATUS_COMMERROR</td>
<td>The connection to the server was lost.</td>
</tr>
<tr>
<td>SCF_STATUS_DOUBLELOCK</td>
<td>The caller has already locked this card and is attempting to lock it again.</td>
</tr>
<tr>
<td>SCF_STATUS_FAILED</td>
<td>An internal error occurred.</td>
</tr>
<tr>
<td>SCF_STATUS_TIMEOUT</td>
<td>The timeout expired before the call was able to obtain the lock.</td>
</tr>
</tbody>
</table>

**EXAMPLES**

**EXAMPLE 1** Use a card lock.

```c
SCF_Status_t status;
SCF_Card_t myCard;

/* (...call SCF_Terminal_getCard to open myCard...) */

status = SCF_Card_lock(myCard, 15);
if (status == SCF_STATUS_TIMEOUT) {
    printf("Unable to get a card lock, someone else has a lock.\n");
    exit(0);
}
else if (status != SCF_STATUS_SUCCESS) exit(1);

/* Send the first APDU */
SCF_Card_exchangeAPDU(myCard, ...);

/* Send the second APDU */
SCF_Card_exchangeAPDU(myCard, ...);

status = SCF_Card_unlock(myCard);

/* ... */
```

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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454  man pages section 3: Extended Library Functions • Last Revised 15 May 2002
SCF_Card_lock(3SMARTCARD)

SEE ALSO
libsmartcard(3LIB), SCF_Card_exchangeAPDU(3SMARTCARD),
SCF_Card_reset(3SMARTCARD), SCF_Terminal_getCard(3SMARTCARD),
attributes(5)
SCF_Card_reset(3SMARTCARD)

NAME
SCF_Card_reset – perform a reset of a smartcard

SYNOPSIS
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Card_reset(SCF_Card_t card);

PARAMETERS
card The card (from SCF_Terminal_getCard(3SMARTCARD)) to be reset

DESCRIPTION
The SCF_Card_reset() function causes the specified smartcard to be reset by the terminal.

A card can be reset only if it has not been locked (with SCF_Card_lock(3SMARTCARD)) by another client. A client wishing to reset a card should either first call SCF_Card_lock() to obtain the card lock, or be prepared to retry the reset operation if it fails because another client holds the card lock.

When the card is reset, any SCF_Card_t object representing the card will continue to remain valid after the reset. When the reset occurs, an SCF_EVENT_CARDRESET event will be sent to all registered event listeners for the terminal (assuming they registered for this event). This is the only notification of a reset provided to SCF clients. When a client receives this event, it should be prepared to reinitialize any state on the card that might have been interrupted by the reset. New information about the card (for example, ATR, if it changed) can also be available from SCF_Card_getInfo(3SMARTCARD).

RETURN VALUES
If the card is successfully reset, SCF_STATUS_SUCCESS is returned. Otherwise, the status of the card remains unchanged and an error value is returned.

ERRORS
The SCF_Card_reset() function will fail if:

SCF_STATUS_BADHANDLE The specified card has been closed or is invalid.

SCF_STATUS_CARDLOCKED The card cannot be reset because another client holds a lock on the card.

SCF_STATUS_CARDREMOVED The card cannot be reset because the card represented by the SCF_Card_t has been removed.

SCF_STATUS_COMMERROR The connection to the server was lost.

SCF_STATUS_FAILED An internal error occurred.

EXAMPLES
EXAMPLE 1 Reset a card.

SCF_Status_t status;
SCF_Card_t myCard;

/* (...call SCF_Terminal_getCard to open myCard...) */

status = SCF_Card_lock(myCard, SCF_TIMEOUT_MAX);
if (status != SCF_STATUS_SUCCESS) exit(1);
EXAMPLE 1  Reset a card.  (Continued)

    status = SCF_Card_reset(myCard);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    status = SCF_Card_unlock(myCard);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    /* ... */

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  libsmartcard(3LIB), SCF_Card_getInfo(3SMARTCARD),
           SCF_Card_lock(3SMARTCARD),
           SCF_Terminal_addEventListener(3SMARTCARD),
           SCF_Terminal_getCard(3SMARTCARD), attributes(5)
**SCF_Session_close**

**NAME**
SCF_Session_close, SCF_Terminal_close, SCF_Card_close – close a smartcard session, terminal, or card

**SYNOPSIS**
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Session_close(SCF_Session_t session);

SCF_Status_t SCF_Terminal_close(SCF_Terminal_t terminal);

SCF_Status_t SCF_Card_close(SCF_Card_t card);

**PARAMETERS**
card An object that was returned from
SCF_Terminal_getCard(3SMARTCARD)

session An object that was returned from
SCF_Session_getSession(3SMARTCARD)

terminal An object that was returned from
SCF_Session_getTerminal(3SMARTCARD)

**DESCRIPTION**
These functions release the resources (memory, threads, and others) that were allocated within the library when the session, terminal, or card was opened. Any storage allocated by calls to SCF_Session_getInfo(3SMARTCARD), SCF_Terminal_getInfo(3SMARTCARD), or SCF_Card_getInfo(3SMARTCARD) is deallocated when the associated object is closed. Attempts to access results from these interfaces after the object has been closed results in undefined behavior.

If a card that was locked by SCF_Card_lock(3SMARTCARD) is closed, the lock is automatically released. When a terminal is closed, any event listeners on that terminal object are removed and any cards that were obtained with the terminal are closed. Similarly, closing a session will close any terminals or cards obtained with that session. These are the only cases where the library will automatically perform a close.

Once closed, a session, terminal, or card object can no longer be used by an SCF function. Any attempt to do so results in an SCF_STATUS_BADHANDLE error. The sole exception is that closing an object, even if already closed, is always a successful operation.

**RETURN VALUES**
Closing a handle is always a successful operation that returns SCF_STATUS_SUCCESS. The library can safely detect handles that are invalid or already closed.

**EXAMPLES**

**EXAMPLE 1** Close each object explicitly.

```c
SCF_Status_t status;
SCF_Session_t mySession;
SCF_Terminal_t myTerminal;
SCF_Card_t myCard;

status = SCF_Session_getSession(&mySession);
if (status != SCF_STATUS_SUCCESS) exit(1);
status = SCF_Session_getTerminal(mySession, NULL, &myTerminal);
if (status != SCF_STATUS_SUCCESS) exit(1);
```

458 man pages section 3: Extended Library Functions • Last Revised 14 May 2002
EXAMPLE 1 Close each object explicitly.  

(Continued)

status = SCF_Terminal_getCard(myTerminal, &myCard);
if (status != SCF_STATUS_SUCCESS) exit(1);

/* (Do interesting things with smartcard...) */

SCF_Card_close(myCard);
SCF_Terminal_close(myTerminal);
SCF_Session_close(mySession);

EXAMPLE 2 Allow the library to close objects.

SCF_Status_t status;
SCF_Session_t mySession;
SCF_Terminal_t myTerminal;
SCF_Card_t myCard;

status = SCF_Session_getSession(&mySession);
if (status != SCF_STATUS_SUCCESS) exit(1);
status = SCF_Session_getTerminal(mySession, NULL, &myTerminal);
if (status != SCF_STATUS_SUCCESS) exit(1);
status = SCF_Terminal_getCard(myTerminal, &myCard);
if (status != SCF_STATUS_SUCCESS) exit(1);

/* (Do interesting things with smartcard...) */

SCF_Session_close(mySession);
/* myTerminal and myCard have been closed by the library. */

ATTRIBUTES
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SEE ALSO
libsmartcard(3LIB), SCF_Card_getInfo(3SMARTCARD),
SCF_Card_lock(3SMARTCARD), SCF_Session_getInfo(3SMARTCARD),
SCF_Session_getSession(3SMARTCARD),
SCF_Session_getTerminal(3SMARTCARD),
SCF_Terminal_getCard(3SMARTCARD),
SCF_Terminal_getInfo(3SMARTCARD), attributes(5)
SCF_Session_freeInfo, SCF_Terminal_freeInfo, SCF_Card_freeInfo – deallocate information storage

cc [ flag... ] file... -Ismartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Session_freeInfo(SCF_Session_t session, void *value);
SCF_Status_t SCF_Terminal_freeInfo(SCF_Terminal_t terminal, void *value);
SCF_Status_t SCF_Card_freeInfo(SCF_Card_t card, void *value);

PARAMETERS

card
An object that was returned from SCF_Terminal_getCard(3SMARTCARD). This object must be associated with the information value being freed.

session
An object that was returned from SCF_Session_getSession(3SMARTCARD). This object must be associated with the information value being freed.

terminal
An object that was returned from SCF_Session_getTerminal(3SMARTCARD). This object must be associated with the information value being freed.

value
A pointer that was returned from a call to SCF_Session_getInfo(3SMARTCARD), SCF_Terminal_getInfo(3SMARTCARD), or SCF_Card_getInfo(3SMARTCARD).

DESCRIPTION

When information is requested for an object (for example, by using SCF_Session_getInfo()), the result is placed in memory allocated for that request. This memory must eventually be deallocated, or a memory leak will result. The deallocation of memory can occur in one of two ways.

- The simplest method is to allow the smartcard library to automatically deallocate memory when the object associated with the information is closed. For example, when SCF_Card_close(3SMARTCARD) is called, any information obtained from SCF_Card_getInfo() for that card object is deallocated. The application is not required to call SCF_Card_freeInfo() at all.

- If the object persists for a long period of time, the application can explicitly request the information to be deallocated without closing the object, so that memory is not wasted on unneeded storage. Similarly, if an application repeatedly requests information about an object (even the same information), the application can explicitly request deallocation as needed, so that memory usage does not continue to increase until the object is closed. In general, requesting information to be deallocated can be used to reduce runtime memory bloat.

Attempts to access deallocated memory result in undefined behavior.
If the information is successfully deallocated, SCF_STATUS_SUCCESS is returned. Otherwise, an error value is returned.

Errors

These functions will fail if:

- **SCF_STATUS_BADARGS** The specified value cannot be deallocated, possibly because of an invalid pointer, a value already deallocated, or because the value is not associated with the specified session, terminal, or card.
- **SCF_STATUS_BADHANDLE** The specified session, terminal, or card has been closed or is invalid.
- **SCF_STATUS_FAILED** An internal error occurred.

**Examples**

**Example 1** Free information.

```c
char *terminalName;
SCF_Status_t status;
SCF_Terminal_t myTerminal;

/* (...call SCF_Session_getTerminal to open myTerminal...) */

status = SCF_Terminal_getInfo(myTerminal, "name", &terminalName);
if (status != SCF_STATUS_SUCCESS) exit(1);
printf("The terminal name is %s\n", terminalName);

status = SCF_Terminal_freeInfo(myTerminal, terminalName);
if (status != SCF_STATUS_SUCCESS) exit(1);
```

**Attributes**

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**See Also**

libsmartcard(3LIB), SCF_Session_getInfo(3SMARTCARD),
SCF_Session_getSession(3SMARTCARD),
SCF_Session_getTerminal(3SMARTCARD),
SCF_Terminal_getCard(3SMARTCARD), attributes(5)
### SCF_Session_getInfo(3SMARTCARD)

**NAME**

SCF_Session_getInfo, SCF_Terminal_getInfo, SCF_Card_getInfo – retrieve information about a session, terminal, or card.

**SYNOPSIS**

```c
#include <smartcard/scf.h>

SCF_Status_t SCF_Session_getInfo(SCF_Session_t session, const char *name, void *value);

SCF_Status_t SCF_Terminal_getInfo(SCF_Terminal_t terminal, const char *name, void *value);

SCF_Status_t SCF_Card_getInfo(SCF_Card_t card, const char *name, void *value);
```

**PARAMETERS**

- `card` An object that was returned from `SCF_Terminal_getCard(3SMARTCARD)`.
- `name` The name of a property for which a value is to be returned. The name is case-sensitive.
- `session` An object that was returned from `SCF_Session_getSession(3SMARTCARD)`.
- `terminal` An object that was returned from `SCF_Session_getTerminal(3SMARTCARD)`.
- `value` The value of the property. The actual type of the value depends on what property was being queried.

**DESCRIPTION**

These functions obtain information about a session, terminal, or card. The information returned represents the current state of the object and can change between calls.

Each call allocates new storage for the returned result. This storage is tracked internally and is deallocated when the object is closed. An application repeatedly asking for information can cause memory bloat until the object is closed. The application can optionally call `SCF_Session_freeInfo(3SMARTCARD)`, `SCF_Terminal_freeInfo(3SMARTCARD)`, or `SCF_Card_freeInfo(3SMARTCARD)` to cause immediate deallocation of the value. Applications must not use other means such as `free(3C)` to deallocate the memory.

Applications must not access values that have been deallocated. For example, accessing a Card’s ATR after the card has been closed results in undefined behavior.

For a session, the valid property names and value types are:

- **terminalNames** (pointer to char ***)
  The list of terminal names that can currently be used in this session. The returned value is an array of char *, each element of the list is a pointer to a terminal name. The end of the array is denoted by a null pointer. The first element of the list is the default terminal for the session, which will be used when `SCF_Session_getTerminal()` is called with a null pointer for the terminal name.
For a terminal, the standard property names and value types are as follows. Some terminal drivers can define additional driver-specific properties.

- **name** (pointer to char *)
  The name of the terminal. If the default terminal was used (a null pointer was passed to `SCF_Session_getTerminal`), the value will contain the actual name of the default terminal. For example, "MyInternalCardReader".

- **type** (pointer to char *)
  The type of the terminal. For example, "SunISCI".

- **devname** (pointer to char *)
  Information about how the device is attached to the system. This can be a UNIX device name (for example, "/dev/scmi2c0") or some other terminal-specific string describing its relation to the system.

For a card, the valid property names and value types are:

- **type** (pointer to char *)
  The type of the smartcard, as recognized by the framework (for example, "Cyberflex"). If the framework does not recognize the card type, "UnknownCard" is returned.

- **atr** (pointer to struct SCF_BinaryData_t *)
  The Answer To Reset (ATR) data returned by the card when it was last inserted or reset. The structure member `length` denotes how many bytes are in the ATR. The structure member `data` is a pointer to the actual ATR bytes.

**RETURN VALUES**

Upon success, `SCF_STATUS_SUCCESS` is returned and `value` will contain the requested information. Otherwise, an error value is returned and `value` remains unaltered.

**ERRORS**

These functions will fail if:

- `SCF_STATUS_BADARGS` Either `name` or `value` is a null pointer.
- `SCF_STATUS_BADHANDLE` The session, terminal, or card has been closed or is invalid.
- `SCF_STATUS_FAILED` An internal error occurred.
- `SCF_STATUS_UNKNOWNPROPERTY` The property specified by `name` was not found.

**EXAMPLES**

**EXAMPLE 1** Simple string information.

```c
SCF_Status_t status;
SCF_Terminal_t myTerminal;
const char *myName, *myType;

/* (...call SCF_Session_getTerminal to open myTerminal...) */

status = SCF_Terminal_getInfo(myTerminal, "name", &myName);
if (status != SCF_STATUS_SUCCESS) exit(1);
status = SCF_Terminal_getInfo(myTerminal, "type", &myType);
```

Extended Library Functions 463
EXAMPLE 1 Simple string information.

```c
if (status != SCF_STATUS_SUCCESS) exit(1);

printf("The terminal called %s is a %s\n", myName, myType);
```

EXAMPLE 2 Display the names of all terminals available in the session.

```c
SCF_Status_t status;
SCF_Session_t mySession;
const char **myList; /* Technically "const char * const *". */
int i;
/* (...call SCF_Session_getSession to open mySession... */

status = SCF_Session_getInfo(mySession, "terminalnames", &myList);
if (status != SCF_STATUS_SUCCESS) exit(1);

printf("The following terminals are available:\n");
for (i=0; myList[i] != NULL; i++) {
    printf("%d: %s\n", i, myList[i]);
}
```

EXAMPLE 3 Display the card’s ATR.

```c
SCF_Status_t status;
SCF_Card_t myCard;
struct SCF_BinaryData_t *myATR;
int i;
/* (...call SCF_Terminal_getCard to open myCard...) */

status = SCF_Card_getInfo(myCard, "atr", &myATR);
if (status != SCF_STATUS_SUCCESS) exit(1);

printf("The card’s ATR is: 0x");
for (i=0; i < myATR->length; i++) {
    printf("%02.2x", myATR->data[i]);
}
printf(\"\n");
```

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SCF_Session_getInfo(3SMARTCARD)

SEE ALSO libsmartcard(3LIB), SCF_Session_freeInfo(3SMARTCARD),
SCF_Session_getSession(3SMARTCARD),
SCF_Session_getTerminal(3SMARTCARD),
SCF_Terminal_getCard(3SMARTCARD), attributes(5)
SCF_Session_getSession(3SMARTCARD)

NAME  SCF_Session_getSession – establish a context with a system’s smartcard framework

SYNOPSIS  cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Session_getSession(SCF_Session_t *session);

PARAMETERS  session  A pointer to an SCF_Session_t. If a session is successfully established, the session will be returned through this parameter.

DESCRIPTION  The SCF_Session_getSession() function establishes a session with the Solaris Smart Card Framework (SCF). Once a session has been opened, the session can be used with SCF_Session_getTerminal(3SMARTCARD) to access a smartcard terminal (reader). Information about the session can be obtained by calling SCF_Session_getInfo(3SMARTCARD).

When the session is no longer needed, SCF_Session_close(3SMARTCARD) should be called to end the session and release session resources. Closing a session will also close any terminals and cards opened within the session.

An application usually needs to open only a single session. For example, multiple terminals can be opened from the same session. If an application opens additional sessions, each call will return independent (different) sessions.

RETURN VALUES  Upon success, SCF_STATUS_SUCCESS is returned and session contains a valid session. If a session could not be established, an error value is returned and session remains unaltered.

ERRORS  The SCF_Session_getSession() function will fail if:

SCF_STATUS_BADARGS  The session argument is a null pointer.

SCF_STATUS_COMMERROR  The library was unable to contact the smartcard server daemon (ocfserv(1M)), or the library was unable to obtain a session from the server.

SCF_STATUS_FAILED  An internal error occurred.

EXAMPLES  EXAMPLE 1  Establish a session with the framework.

SCF_Status_t status;
SCF_Session_t mySession;

status = SCF_Session_getSession(&mySession);
if (status != SCF_STATUS_SUCCESS) exit(1);

/* Proceed with other smartcard operations. */

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:
SCF_Session_getSession(3SMARTCARD)

<table>
<thead>
<tr>
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SEE ALSO
libsmartcard(3LIB), SCF_Session_close(3SMARTCARD),
SCF_Session_getInfo(3SMARTCARD),
SCF_Session_getTerminal(3SMARTCARD), attributes(5)
SCF_Session_getTerminal(3SMARTCARD)

NAME
SCF_Session_getTerminal — establish a context with a smartcard terminal (reader)

SYNOPSIS
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Session_getTerminal(SCF_Session_t session, const char *terminalName, SCF_Terminal_t *terminal);

PARAMETERS
- **session**: The session (from SCF_Session_getSession(3SMARTCARD)) containing a terminal to be opened.
- **terminal**: A pointer to an SCF_Terminal_t. If the terminal is successfully opened, a handle for the terminal will be returned through this parameter.
- **terminalName**: Specifies the name of the terminal to access. If terminalName is a null pointer, it indicates that the library should connect with the default terminal for the session.

DESCRIPTION
The SCF_Session_getTerminal() function establishes a context with a specific smartcard terminal (also known as a reader) in the session. Terminal objects are used for detecting card movement (insertion or removal) and to create card objects for accessing a specific card.

The list of available terminal names can be retrieved by calling SCF_Session_getInfo(3SMARTCARD). Unless the user explicitly requests a specific terminal, applications should use the session’s default terminal by calling SCF_Session_getTerminal() with a null pointer for the terminal name. This eliminates the need to first process an available-terminal list with just one element on systems with only a single smartcard terminal. On multi-terminal systems, the user can preconfigure one of the terminals as the default (or preferred) terminal. See USAGE below.

If SCF_Session_getTerminal() is called multiple times in the same session to access the same physical terminal, the same SCF_Terminal_t will be returned in each call. Multithreaded applications must take care to avoid having one thread close a terminal that is still needed by another thread. This can be accomplished by coordination within the application or by having each thread open a separate session to avoid interference.

When the terminal is no longer needed, SCF_Terminal_close(3SMARTCARD) should be called to release terminal resources. Closing a terminal will also close any cards opened from the terminal.

RETURN VALUES
Upon success, SCF_STATUS_SUCCESS is returned and terminal contains the opened terminal. Otherwise, an error value is returned and terminal remains unaltered.

ERRORS
The SCF_Session_getTerminal() function will fail if:

- **SCF_STATUS_BADARGS**: The terminal argument is a null pointer.
- **SCF_STATUS_BADHANDLE**: The session was closed or is invalid.
SCF_STATUS_BADTERMINAL  The specified terminalName is not valid for this session, or the default terminal could not be opened because there are no terminals available in this session.

SCF_STATUS_COMMERROR  The connection to the server was lost.

SCF_STATUS_FAILED  An internal error occurred.

EXAMPLE 1 Use the default terminal.
SCF_Status_t status;
SCF_Session_t mySession;
SCF_Terminal_t myTerminal;
char *myName;

/* (...call SCF_Session_getSession to open mySession...) */

status = SCF_Session_getTerminal(mySession, NULL, &myTerminal);
if (status != SCF_STATUS_SUCCESS) exit(1);

status = SCF_Terminal_getInfo(myTerminal, "name", &myName);
if (status != SCF_STATUS_SUCCESS) exit(1);

printf("Please insert a card into the terminal named %s\n", myName);

/* ... */

EXAMPLE 2 Open a terminal by name.
SCF_Status_t status;
SCF_Session_t mySession;
SCF_Terminal_t myTerminal;
char *myName;

/* (...call SCF_Session_getSession to open mySession...) */

/*
 * The name should be selected from the list of terminal names available from SCF_Session_getInfo, but it could also be read from an application’s config file or from user input.
 */

myName = "SunInternalReader";

status = SCF_Session_getTerminal(mySession, myName, &myTerminal);
if (status == SCF_STATUS_BADTERMINAL) {
    printf("There is no terminal named %s\n", myName);
    exit(1);
} else if (status != SCF_STATUS_SUCCESS) exit(2);

/* ... */

USAGE  When using the Solaris OCF smartcard framework, the default reader is specified by the ocf.client.default.defaultreader property. If this property is not set, the first available reader is chosen as the default. Users can set the
SCF_Session_getTerminal(3SMARTCARD)

SCF_DEFAULT_TERMINAL environment variable to the name of a terminal to override the normal default. The smartcard utility can also be used to add terminals to or remove terminals from the system. See smartcard(1M) for information on how to add or modify the OCF property.

Terminals can be accessed only by the user who expected to have physical access to the terminal. By default, this user is assumed to be the owner of /dev/console and the superuser. Certain terminals such as Sun Ray appliances can use a different method to restrict access to the terminal.

The framework also uses the DISPLAY environment variable to further restrict which terminals are listed for a user. By default, terminals are associated with the ":0" display. Sun Ray terminals are associated with the display for that session, for example ":25". If the DISPLAY environment variable is not set or is a display on another host, it is treated as though it were set to ":0". Terminals not associated with the user's DISPLAY are not listed. To override this behaviour, the SCF_FILTER_KEY environment variable can be set to the desired display, for example ":0", ":25", and so on. To list all terminals to which a user has access, SCF_FILTER_KEY can be set to the special value of ":*".

ATTRIBUTES
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SEE ALSO
smartcard(1M), libsmartcard(3LIB), SCF_Session_getInfo(3SMARTCARD), SCF_Session_getSession(3SMARTCARD), SCF_Terminal_close(3SMARTCARD), attributes(5)
SCF_strerror(3SMARTCARD)

NAME
SCF_strerror – get a string describing a status code

SYNOPSIS
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

const char *SCF_strerror(SCF_Status_t error);

PARAMETERS
error A value returned from a smartcard SCF function call. A list of all
current codes is contained in <smartcard/scf.h>

DESCRIPTION
The SCF_strerror() function provides a mechanism for generating a brief message
that describes each SCF_Status_t error code. An application might use the message
when displaying or logging errors.

The string returned by the function does not contain any newline characters. Returned
strings must not be modified or freed by the caller.

RETURN VALUES
A pointer to a valid string is always returned. If the provided error is not a valid SCF
error code, a string is returned stating that the error code is unknown. A null pointer is
never returned.

EXAMPLES
EXAMPLE 1 Report a fatal error.

SCF_Status_t status;
SCF_Session_t mySession;

status = SCF_Session_getSession(&mySession);
if (status != SCF_STATUS_SUCCESS) {
   printf("Smartcard startup error: %s\n", SCF_strerror(status));
   exit(1);
}

/* ... */

USAGE
Messages returned from SCF_strerror() are in the native language specified by the
LC_MESSAGES locale category; see setlocale(3C). The C locale is used if the native
strings could not be loaded.

ATTRIBUTES
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SEE ALSO
libsmartcard(3LIB), SCF_Session_getSession(3SMARTCARD),
strerror(3C), attributes(5)
SCF_Terminal_addEventListener(3SMARTCARD)

NAME
SCF_Terminal_addEventListener, SCF_Terminal_updateEventListener,
SCF_Terminal_removeEventListener – receive asynchronous event notification

SYNOPSIS
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Terminal_addEventListener(SCF_Terminal_t
terminal, SCF_Event_t events, void (*callback)(SCF_Event_t,
SCF_Terminal_t, void *), void *userData, SCF_ListenerHandle_t*
listenerHandle);

SCF_Status_t SCF_Terminal_updateEventListener(SCF_Terminal_t
terminal, SCF_ListenerHandle_t listenerHandle, SCF_Event_t events);

SCF_Status_t SCF_Terminal_removeEventListener(SCF_Terminal_t
terminal, SCF_ListenerHandle_t listenerHandle);

PARAMETERS

terminal A terminal (from SCF_Session_getTerminal(3SMARTCARD))
to which the event listener should be added or removed.

events Events to deliver to the callback. An event will not be delivered if
it is not listed. The caller can register for multiple events by
performing a bitwise OR of the desired events. The valid events
are:

SCF_EVENT_ALL
All of the events listed below will be delivered.

SCF_EVENT_CARDINSERTED
A smartcard was inserted into the terminal.

SCF_EVENT_CARDREMOVED
A smartcard was removed from the terminal.

SCF_EVENT_CARDPRESENT
Indicates that a card was present in the terminal when the event
listener was first added. This event allows event listeners to
determine the initial state of the terminal before an insert or
remove event occurs. Either this event or the
SCF_EVENT_CARDABSENT (see below) event will be delivered
only once upon adding an event listener and immediately
before any other events are delivered. Future card movements
will generate SCF_EVENT_CARDINSERTED and
SCF_EVENT_CARDREMOVED events, but not
SCF_EVENT_CARDPRESENT or SCF_EVENT_CARDABSENT
events. An event listener can assume that if a
SCF_EVENT_CARDPRESENT event is delivered, the next card
movement event will be a SCF_EVENT_CARDREMOVED.

SCF_EVENT_CARDABSENT
Indicates that a card was not present in the terminal when the
event listener was first added. This event allows event listeners
to determine the initial state of the terminal before an insert or
remove event occurs. Either this event or the
SCF_EVENT_CARDPRESENT event (see above) will be delivered
only once upon adding an event listener and immediately
before any other events are delivered. Future card movements
will generate SCF_EVENT_CARDINSERTED and
SCF_EVENT_CARDREMOVED events, but not
SCF_EVENT_CARDPRESENT or SCF_EVENT_CARDABSENT
events. An event listener can assume that if a
SCF_EVENT_CARDABSENT event is delivered, the next card
movement event will be a SCF_EVENT_CARDINSERTED.

SCF_EVENT_CARDRESET
The smartcard currently present has been reset (see
SCF_Card_reset(3SMARTCARD)).

SCF_EVENT_TERMINALCLOSED
The terminal is in the process of being closed (due to a call to
SCF_Session_close(3SMARTCARD) or
SCF_Terminal_close(3SMARTCARD)), so no further events
will be delivered. The terminal argument provided to the
callback will still be valid.

SCF_EVENT_COMMERROR
The connection to the server has been lost. No further events
will be delivered.

callback
A function pointer that will be executed when the desired event
occurs. The function must take three arguments. The first is a
SCF_Event_t containing the event that occurred. The second
argument is an SCF_Terminal_t containing the terminal on
which the event occurred. The third is a void * that can be used to
provide arbitrary data to the callback when it is executed.

userData
A pointer to arbitrary user data. The data is not accessed by the
library. The pointer is simply provided to the callback when an
event is issued. This argument can safely be set to NULL if not
needed. The callback must be able to handle this case.

listenerHandle
A unique "key" that is provided by
SCF_Terminal_addEventListener() to refer to a specific
event listener registration. This allows multiple event listeners to
be selectively updated or removed.

DESCRIPTION
These functions allow an application to receive notification of events on a terminal as
they occur. The concept is similar to a signal handler. When an event occurs, a thread
in the SCF library will execute the provided callback function. Once added, the listener
will receive events until it is removed or either the terminal or session is closed.

When the callback function is executed, the callback arguments specify the event that
occurred and the terminal on which it occurred. Additionally, each callback will receive
the userData pointer that was provided when the listener was added. The library does

Extended Library Functions  473
SCF_Terminal_addEventListener(3SMARTCARD)

not make a copy of the memory pointed to by userData, so applications must take care not to deallocate that memory until it is known that the callback will no longer access it (for example, by removing the event listener). Each invocation of the callback will be for exactly one event. If the library needs to deliver multiple events, they will be dispatched one at a time. Because the callback is executed from a thread, any operations it performs must be thread safe. For each callback registration, the library creates a new thread to deliver events to that callback. The callback is expected to perform minimal work and return quickly.

An application can add multiple callbacks on a terminal. Any event that occurs will be delivered to all listeners that registered for that event type. The same callback can be registered multiple times. Each call to SCF_Terminal_addEventListener() will result in a new SCF_ListenerHandle_t. The events a callback receives can be changed by calling SCF_Session_updateEventListener() with the handle that was returned when the listener was initially added. If the listener is set to receive no events (that is, the events parameter has no bits set), the listener will remain registered but will not receive any events. To remove a listener and release allocated resources, use SCF_Terminal_removeEventListener() or close the terminal.

RETURN VALUES

If the event listener was successfully added or removed, SCF_STATUS_SUCCESS is returned. Otherwise, an error value is returned and the internal list of registered event listeners remains unaltered.

ERRORS

These functions will fail if:

- SCF_STATUS_BADARGS
  - The callback function pointer and/or listenerHandle is null, or an unknown event was specified.

- SCF_STATUS_BADHANDLE
  - The specified terminal has been closed or is invalid, or the event listener handle could not be found to update or remove.

- SCF_STATUS_COMMERROR
  - The connection to the server was lost.

- SCF_STATUS_FAILED
  - An internal error occurred.

EXAMPLES

EXAMPLE 1  Register for card movements.

```c
struct myState_t {
   int isStateKnown;
   int isCardPresent;
};

void myCallback(SCF_Event_t event, SCF_Terminal_t eventTerminal,
                void *data) {
   struct myState_t *state = data;
   if (event == SCF_EVENT_CARDINSERTED) {
      printf("--- Card inserted ---\n");
      state->isCardPresent = 1;
   } else if (event == SCF_EVENT_CARDDISCONNECTED) {
      printf("--- Card removed ---\n");
      state->isCardPresent = 0;
```

474  man pages section 3: Extended Library Functions • Last Revised 28 Feb 2001
EXAMPLE 1 Register for card movements.  (Continued)

    state->isStateKnown = 1;
}

main() {
    SCF_Status_t status;
    SCF_Terminal_t myTerminal;
    SCF_ListenerHandle_t myListener;
    struct myState_t myState;

    /* {...call SCF_Session_getTerminal to open myTerminal...} */

    myState.isStateKnown = 0;
    status = SCF_Terminal_addEventListener(myTerminal,
                                           SCF_EVENT_CARDINSERTED|SCF_EVENT_CARDREMOVED, &myCallback,
                                           &myState, &myListener);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    while(1) {
        if (!myState.isStateKnown)
            printf("Waiting for first event...
");
        else {
            if (myState.isCardPresent)
                printf("Card is present.
");
            else
                printf("Card is not present.
");
        }
        sleep(1);
    }
}

EXAMPLE 2 Use different callbacks for each event.

void myInsertCallback(SCF_Event_t event, SCF_Terminal_t eventTerminal,
                      void *data) {
    /* ... */
}

void myRemoveCallback(SCF_Event_t event, SCF_Terminal_t eventTerminal,
                       void *data) {
    /* ... */
}

main () {
    SCF_Status_t status;
    SCF_Terminal_t terminal;
    SCF_ListenerHandle_t myListener1, myListener2, myListener3;
    int foo, bar;

    /* {...call SCF_Session_getTerminal to open myTerminal...} */

    status = SCF_Terminal_addEventListener(myTerminal,
                                           SCF_EVENT_CARDINSERTED, &myInsertCallback, &foo,
                                           SCF_EVENT_CARDREMOVED, &myRemoveCallback, &bar,
                                           &myListener1);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    while(1) {
        if (!myState.isStateKnown)
            printf("Waiting for first event...
");
        else {
            if (myState.isCardPresent)
                printf("Card is present.
");
            else
                printf("Card is not present.
");
        }
        sleep(1);
    }
}

Extended Library Functions  475
SCF_Terminal_addEventListener(3SMARTCARD)

EXAMPLE 2 Use different callbacks for each event.  
(Continued)

    &myListener1);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    status = SCF_Terminal_addEventListener(myTerminal,
        SCF_EVENT_CARDREMOVED, &myRemoveCallback, &foo,
        &myListener2);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    status = SCF_Terminal_addEventListener(myTerminal,
        SCF_EVENT_CARDREMOVED, &myRemoveCallback, &bar,
        &myListener3);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    /*
     * At this point, when each insertion occurs, myInsertCallback
     * will be called once (with a pointer to foo). When each removal
     * occurs, myRemoveCallback will be called twice. One call will
     * be given a pointer to foo, and the other will be given a
     * pointer to bar.
     */

    status = SCF_Terminal_removeEventListener(myTerminal,
        myListener2);
    if (status != SCF_STATUS_SUCCESS) exit(1);

    /*
     * Now, when a removal occurs, myRemoveCallback will only be
     * called once, with a pointer to bar.
     */

    /* ... */
}

EXAMPLE 3 Use initial state events to show user the terminal state in a GUI.

void myCallback(SCF_Event_t event, SCF_Terminal_t eventTerminal,
    void *unused) {
    if (event == SCF_EVENT_CARDPRESENT) {
        /* Set initial icon to a terminal with a card present. */
    }
    else if (event == SCF_EVENT_CARDABSENT) {
        /* Set initial icon to a terminal without a card present. */
    }
    else if (event == SCF_EVENT_CARDINSERTED) {
        /* Show animation for card being inserted into a terminal. */
    }
    else if (event == SCF_EVENT_CARDREMOVED) {
        /* Show animation for card being removed from a terminal. */
    }
}

main() {
    SCF_Terminal_t myTerminal;
    SCF_ListenerHandle_t myListener;
SCF_Terminal_addEventListener(3SMARTCARD)

EXAMPLE 3 Use initial state events to show user the terminal state in a GUI. (Continued)

/* {...call SCF_Session_getTerminal to open myTerminal...} */

status = SCF_Terminal_addEventListener(myTerminal,
    SCF_EVENT_ALL, &myCallback, NULL, &myListener);
if (status != SCF_STATUS_SUCCESS) exit(1);

/* ... */
}

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SEE ALSO libsmartcard(3LIB), SCF_Card_reset(3SMARTCARD),
SCF_Session_close(3SMARTCARD),
SCF_Session_getTerminal(3SMARTCARD),
SCF_Session_updateEventListener(3SMARTCARD),
SCF_Terminal_close(3SMARTCARD),
SCF_Terminal_removeEventListener(3SMARTCARD), attributes(5)
SCF_Terminal_getCard(3SMARTCARD)

NAME
SCF_Terminal_getCard – establish a context with a smartcard

SYNOPSIS
cc [ flag... ] file... -lsmartcard [ library...]
#include <smartcard/scf.h>

SCF_Status_t SCF_Terminal_getCard(SCF_Terminal_t terminal,
                                   SCF_Card_t *card);

PARAMETERS

card A pointer to a SCF_Card_t. If the smartcard is successfully
       opened, a handle for the card will be returned through this
       parameter.

terminal The terminal (from
          SCF_Session_getTerminal(3SMARTCARD)) containing a
          smartcard to open.

DESCRIPTION
The SCF_Terminal_getCard() function establishes a context with a specific
smartcard in a terminal. Card objects can be used to send APDUs (Application
Protocol Data Units) to the card with SCF_Card_exchangeAPDU(3SMARTCARD).
When the card is no longer needed, SCF_Card_close(3SMARTCARD) should be
called to release allocated resources.

If SCF_Terminal_getCard() is called multiple times in the same session to access
the same physical card (while the card remains inserted), the same SCF_Card_t
will be returned in each call. The library cannot identify specific cards, so when a card is
reinserted it will be represented by a new SCF_Card_t. Multithreaded applications
must take care to avoid having one thread close a card that is still needed by another
thread. This can be accomplished by coordination within the application, or by having
each thread open a separate session to avoid interference.

RETURN VALUES
If a working card is present in the reader, SCF_STATUS_SUCCESS is returned and card
is a valid reference to the card. Otherwise, an error value is returned and card remains
unaltered.

ERRORS
The SCF_Terminal_getCard() function will fail if:

SCF_STATUS_BADARGS The card argument is a null pointer.
SCF_STATUS_BADHANDLE The specified terminal has been closed or is invalid.
SCF_STATUS_FAILED An internal error occurred.
SCF_STATUS_NOCARD No card is present in the terminal.

EXAMPLES
EXAMPLE 1 Access a smartcard.

SCF_Status_t status;
SCF_Terminal_t myTerminal;
SCF_Card_t myCard;

/* (...call SCF_Session_getTerminal to open myTerminal...) */

status = SCF_Terminal_getCard(myTerminal, &myCard);
if (status == SCF_STATUS_NOCARD) {
...
SCF_Terminal_getCard(3SMARTCARD)

EXAMPLE 1 Access a smartcard.  (Continued)

    printf("Please insert your smartcard and try again.\n");
    exit(0);
} else if (status != SCF_STATUS_SUCCESS) exit(1);

/* (...go on to use the card with SCF_Card_exchangeAPDU()...) */

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SEE ALSO  libsmartcard(3LIB), SCF_Card_close(3SMARTCARD),
SCF_Card_exchangeAPDU(3SMARTCARD), SCF_Card_getInfo(3SMARTCARD),
SCF_Card_lock(3SMARTCARD), SCF_Session_getTerminal(3SMARTCARD),
attributes(5)
# SCF_Card_waitForCardRemoved

SCF_Card_waitForCardRemoved() function differs from SCF_Terminal_waitForCardAbsent() in that it checks to see if a specific card has been removed. If another card (or even the same card) has since been reinserted, SCF_Card_waitForCardRemoved() will report that the old card was removed, while the SCF_Terminal_waitForCardAbsent() will instead report that there is a card present.

If the desired state is already true, the function will immediately return SCF_STATUS_SUCCESS. Otherwise it will wait for a change to the desired state, or for the timeout to expire, whichever occurs first.

Unlike an event listener (SCF_Terminal_addEventListener(3SMARTCARD)), these functions return the state of the terminal, not just events. To use an electronics analogy, event listeners are edge-triggered, while these functions are level-triggered.

## RETURN VALUES

If the desired state is reached before the timeout expires, SCF_STATUS_SUCCESS is returned. If the timeout expires, SCF_STATUS_TIMEOUT is returned. Otherwise, an error value is returned.

## ERRORS

These functions will fail if:

- SCF_STATUS_BADHANDLE: The specified terminal or card has been closed or is invalid.
SCF_Status_t status;
SCF_Terminal_t myTerminal;

/* (...call SCF_Session_getTerminal to open myTerminal...) */
status = SCF_Terminal_waitForCardAbsent(myTerminal, 0);
while (status == SCF_STATUS_TIMEOUT) {
    printf("Please remove the card from the terminal!\n");
    status = SCF_Terminal_waitForCardAbsent(myTerminal, 5);
}

if (status == SCF_STATUS_SUCCESS)
    printf("Thank you.\n");
else
    exit(1);

/* ... */

EXAMPLE 3 Demonstrate the difference between the card-specific and terminal-specific calls.

SCF_Status_t status;
SCF_Terminal_t myTerminal;
SCF_Card_t myCard;

/* (...call SCF_Session_getTerminal to open myTerminal...) */
status = SCF_Terminal_getCard(myTerminal, &myCard);
if (status != SCF_STATUS_SUCCESS) exit(1);
SCF_Terminal_waitForCardPresent(3SMARTCARD)

EXAMPLE 3 Demonstrate the difference between the card-specific and terminal-specific calls. (Continued)

    /*
    * While we sleep, assume user removes the card
    * and inserts another card.
    */
    sleep(10);

    status = SCF_Terminal_waitForCardAbsent(myTerminal, 0);
    /*
    * In this case, status is expected to be SCF_STATUS_TIMEOUT, as there
    * is a card present.
    */

    status = SCF_Card_waitForCardRemoved(myCard, 0);
    /*
    * In this case, status is expected to be SCF_STATUS_SUCCESS, as the
    * card returned from SCF_Terminal_getCard was indeed removed (even
    * though another card is currently in the terminal).
    */

    /* ... */

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

libsmartcard(3LIB), SCF_Session_getTerminal(3SMARTCARD),
SCF_Terminal_addEventListener(3SMARTCARD),
SCF_Terminal_getCard(3SMARTCARD), attributes(5)
sendfile(3EXT)

NAME
sendfile – send files over sockets or copy files to files

SYNOPSIS
cc [flag ...] file ... -lsendfile [library ...]
#include <sys/sendfile.h>

ssize_t sendfile(int out_fd, int in_fd, off_t *off, size_t len);

DESCRIPTION
The sendfile() function copies data from out_fd to in_fd starting at offset off and of length len bytes. The in_fd argument should be a file descriptor to a regular file opened for reading. See open(2). The out_fd argument should be a file descriptor to a regular file opened for writing or to a connected AF_INET or AF_INET6 socket of SOCK_STREAM type. See socket(3SOCKET). The off argument is a pointer to a variable holding the input file pointer position from which the data will be read. After sendfile() has completed, the variable will be set to the offset of the byte following the last byte that was read. The sendfile() function does not modify the current file pointer of in_fd, but does modify the file pointer for out_fd if it is a regular file.

The sendfile() function can also be used to send buffers by pointing in_fd to SFV_FD_SELF.

RETURN VALUES
Upon successful completion, sendfile() returns the total number of bytes written to out_fd and also updates the offset to point to the byte that follows the last byte read. Otherwise, it returns −1, and errno is set to indicate an error.

ERRORS
The sendfile() function will fail if:
EAFNOSUPPORT The implementation does not support the specified address family for socket.
EAGAIN Mandatory file or record locking is set on either the file descriptor or output file descriptor if it points at regular files. O_NDELAY or O_NONBLOCK is set, and there is a blocking record lock. An attempt has been made to write to a stream that cannot accept data with the O_NDELAY or the O_NONBLOCK flag set.
EBADF The out_fd or in_fd argument is either not a valid file descriptor, out_fd is not opened for writing, or in_fd is not opened for reading.
EINVAL The offset cannot be represented by the off_t structure, or the length is negative when cast to ssize_t.
EIO An I/O error occurred while accessing the file system.
ENOTCONN The socket is not connected.
EOPNOTSUPP The socket type is not supported.
EPIPE The out_fd argument is no longer connected to the peer endpoint.

USAGE
The sendfile() function has a transitional interface for 64-bit file offsets. See lf64(5).
**EXAMPLE 1** Sending a Buffer Over a Socket

The following example demonstrates how to send the buffer `buf` over a socket. At the end, it prints the number of bytes transferred over the socket from the buffer. It assumes that `addr` will be filled up appropriately, depending upon where to send the buffer.

```c
int tfd;
off_t baddr;
struct sockaddr_in sin;
char buf[64 * 1024];
in_addr_t addr;

tfd = socket(AF_INET, SOCK_STREAM, 0);
if (tfd == -1) {
    perror("socket");
    exit(1);
}

sin.sin_family = AF_INET;
sin.sin_addr = addr; /* Fill in the appropriate address. */
sin.sin_port = htons(2345);
if (connect(tfd, (struct sockaddr *)&sin, sizeof(sin))<0) {
    perror("connect");
    exit(1);
}

baddr = (off_t)buf;
len = sendfile(tfd, SFV_FD_SELF, &baddr, len);
if (len == -1) {
    perror("sendfile");
    exit(1);
}

printf("Transfered %d bytes from buffer to socket0 len);
```

**EXAMPLE 2** Transferring Files to Sockets

The following program demonstrates a transfer of files to sockets:

```c
int ffd, tfd;
off_t off;
struct sockaddr_in sin;
in_addr_t addr;
int len;
struct stat stat_buf;

ffd = open("file", O_RDONLY);
if (ffd == -1) {
    perror("open");
    exit(1);
}

tfd = socket(AF_INET, SOCK_STREAM, 0);
if (tfd == -1) {
    perror("socket");
    exit(1);
}
```

EXAMPLE 2 Transferring Files to Sockets  (Continued)

    perror("socket");
    exit(1);

    sin.sin_family = AF_INET;
    sin.sin_addr = addr; /* Fill in the appropriate address. */
    sin.sin_port = htons(2345);
    if (connect(tfd, (struct sockaddr *) &sin, sizeof(sin)) <0) {
        perror("connect");
        exit(1);
    }

    if (fstat(ffd, &stat_buf) == -1) {
        perror("fstat");
        exit(1);
    }

    len = sendfile(tfd, ffd, &off, stat_buf.st_size);

    if (len == -1) {
        perror("sendfile");
        exit(1);
    }

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>SUNWcsl(32–bit)</td>
</tr>
<tr>
<td></td>
<td>SUNWcslx (64–bit)</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

FILES  /usr/lib/libsendfile.so shared object file

SEE ALSO  open(2), socket(3SOCKET), attributes(5), lf64(5)
DESCRIPTION

The `sendfilev()` function attempts to write data from the `sfvcnt` buffers specified by the members of `vec` array: `vec[0]`, `vec[1]`, ..., `vec[sfvcnt-1]`. `fd` is a file descriptor to a regular file or to a `AF_NCA`, `AF_INET`, or `AF_INET6` family type `SOCK_STREAM` socket that is open for writing.

This function is analogous to the `writev()` system call. See `writev(2)`. However, instead of sending out chunks of data, `sendfilev()` can read input data from data buffers or file descriptors.

The following is the `sendfilevec` structure:

```c
typedef struct sendfilevec {
    int sfv_fd; /* input fd */
    uint_t sfv_flag; /* Flags. see below */
    off_t sfv_off; /* offset to start reading from */
    size_t sfv_len; /* amount of data */
} sendfilevec_t;
```

#define SFV_FD_SELF (-2)

To send a file, open the file for reading. Point `sfv_fd` to the file descriptor returned as a result. See `open(2)`. `sfv_off` should contain the offset within the file. `sfv_len` should have the length of the file to be transferred.

The `xferred` parameter is updated to record the total number of bytes written to `out_fd`.

The `sfv_flag` field is reserved and should be set to zero.

To send data directly from the address space of the process, set `sfv_fd` to `SFV_FD_SELF`. `sfv_off` should point to the data, with `sfv_len` containing the length of the buffer.

PARAMETERS

The `sendfilev()` function supports the following parameters:

- `fd`:
  - A file descriptor to a regular file or to a `AF_NCA`, `AF_INET`, or `AF_INET6` family type `SOCK_STREAM` socket that is open for writing. For `AF_NCA`, the protocol type should be zero.

- `vec`:
  - An array of `SENDFILEVEC_T`, as defined in the `sendfilevec` structure above.

- `sfvcnt`:
  - The number of members in `vec`.
sendfilev(3EXT)

RETURN VALUES
Upon successful completion, sendfilev() returns total number of bytes written to out_fd. Otherwise, it returns -1, and errno is set to indicate an error. xferred contains the amount of data successfully transferred, which can be used to discover the error vector.

ERRORS

- **EAFNOSUPPORT**
  The implementation does not support the specified address family for socket.

- **EPROTOTYPE**
  The socket type is not supported.

- **EBADF**
  The fildes argument is not a valid descriptor open for writing or an sfv_fd is invalid or not open for reading.

- **EACCES**
  The process does not have appropriate privileges or one of the files pointed by sfv_fd does not have appropriate permissions.

- **EPIPE**
  The fildes argument is a socket that has been shut down for writing.

- **EIO**
  An I/O error occurred while accessing the file system.

- **EFAULT**
  The vec argument points to an illegal address.

- **EINVAL**
  The sfvcnt argument was less than or equal to 0. One of the sfv_len in vec array was less than or equal to 0, or greater than the file size. An sfv_fd is not seekable.

- **EAGAIN**
  Mandatory file or record locking is set on either the file descriptor or output file descriptor if it points at regular files. O_NDELAY or O_NONBLOCK is set, and there is a blocking record lock. An attempt has been made to write to a stream that cannot accept data with the O_NDELAY or the O_NONBLOCK flag set.

USAGE
The sendfilev() function has a transitional interface for 64-bit file offsets. See lfd64(5).

EXAMPLES
The following example sends 2 vectors, one of HEADER data and a file of length 100 over sockfd. sockfd is in a connected state, that is, socket(), accept(), and bind() operation are complete.

```c
#include <sys/sendfile.h>

int main (int argc, char argv[])
{
  int sockfd;
```
sendfilev(3EXT)

```c
ssize_t ret;
size_t xfer;
struct sendfilevec vec[2];

vec[0].sfv_fd = SFV_FD_SELF;
vec[0].sfv_flag = 0;
vec[0].sfv_off = "HEADER_DATA";
vec[0].sfv_len = strlen("HEADER_DATA");
vec[1].sfv_fd = open("input_file", ....);
vec[1].sfv_flag = 0;
vec[1].sfv_off = 0;
vec[1].sfv_len = 100;

ret = sendfilev(sockfd, vec, 2, &xfer);
```

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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<td>MT-Level</td>
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</tr>
</tbody>
</table>

**SEE ALSO**
open(2), writev(2), attributes(5)
The `significand()` function, along with the `logb(3M)` and `scalb(3M)` functions, allows users to verify compliance to ANSI/IEEE Std 754-1985 by running certain test vectors distributed by the University of California.

If \( x \) equals \( \text{sig} \times 2^n \) with \( 1 < \text{sig} < 2 \), then \( \text{significand}(x) \) returns \( \text{sig} \) for exercising the fraction-part(F) test vector. \( \text{significand}(x) \) is not defined when \( x \) is either 0, \( \pm \text{Inf} \) or NaN.

For exceptional cases, `matherr(3M)` tabulates the values to be returned as dictated by various Standards.

### Attributes

See `attributes(5)` for descriptions of the following attributes:

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</tr>
</tbody>
</table>

### See Also

`logb(3M)`, `matherr(3M)`, `scalb(3M)`, `attributes(5)`
The `sin()` function computes the sine of its argument `x`, measured in radians.

Upon successful completion, `sin()` returns the sine of `x`.

If `x` is NaN or ±Inf, NaN is returned.

No errors will occur.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>MT-Safe</td>
</tr>
</tbody>
</table>

See also `asin(3M), isnan(3M), attributes(5)`
#include <math.h>

double sinh(double x);

The sinh() function computes the hyperbolic sine of x.

Upon successful completion, sinh() returns the hyperbolic sine of x.

If the result would cause an overflow, ±HUGE_VAL is returned and errno is set to ERANGE.

If x is NaN, NaN is returned.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

The sinh() function will fail if:

ERANGE The result would cause overflow.

An application wishing to check for error situations should set errno to 0 before calling sinh(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
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</thead>
<tbody>
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</tbody>
</table>

SEE ALSO asinh(3M), cosh(3M), isnan(3M), matherr(3M), tanh(3M), attributes(5), standards(5)
NAME sqrt – square root function

SYNOPSIS cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>

double sqrt(double x);

DESCRIPTION The sqrt() function computes the square root of x.

RETURN VALUES Upon successful completion, sqrt() returns the square root of x.

If x is NaN, NaN is returned.

If x is negative, NaN is returned and errno is set to EDOM.

ERRORS The sqrt() function will fail if:

EDOM The value of x is negative.

USAGE An application wishing to check for error situations should set errno to 0 before calling sqrt(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

<table>
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</table>

SEE ALSO isnan(3M), attributes(5)
NAME

SSAgentIsAlive(3SNMP), SSAGetTrapPort, SSARegSubtable, SSARegSubagent, SSARegSubtree, SSASendTrap, SSASubagentOpen – Sun Solstice Enterprise Agent registration and communication helper functions

SYNOPSIS

cc [ flag ... ] file ... -lssagent -lssasnmp [ library .. ]
#include <impl.h>

extern int SSAgentIsAlive(IPAddress *agent_addr, int *port, char *
community, struct timeval *timeout);

extern int SSAGetTrapPort();

extern int SSARegSubagent(Agent* agent);

int SSARegSubtable(SSA_Table *table);

int SSARegSubtree(SSA_Subtree *subtree);

extern void SSASendTrap(char *name);

extern int SSASubagentOpen(int *num_of_retry, char *agent_name);

DESCRIPTION

The SSAgentIsAlive() function returns TRUE if the master agent is alive, otherwise returns FALSE. The agent_addr parameter is the address of the agent. Specify the security token in the community parameter. You can specify the maximum amount of time to wait for a response with the timeout parameter.

The SSAGetTrapPort() function returns the port number used by the Master Agent to communicate with the subagent.

The SSARegSubagent() function enables a subagent to register and unregister with a Master Agent. The agent parameter is a pointer to an Agent structure containing the following members:

int timeout; /* optional */
int agent_id; /* required */
int agent_status; /* required */
char *personal_file; /* optional */
char *config_file; /* optional */
char *executable; /* optional */
char *version_string; /* optional */
char *protocol; /* optional */
int process_id; /* optional */
char *name; /* optional */
int system_up_time; /* optional */
int watch_dog_time; /* optional */
Address address; /* required */
struct _Agent; /* reserved */
struct _Subtree; /* reserved */

The agent_id member is an integer value returned by the SSASubagentOpen() function. After calling SSASubagentOpen(), you pass the agent_id in the SSARegSubagent() call to register the subagent with the Master Agent.

The following values are supported for agent_status:
SSA OPER STATUS ACTIVE
SSA OPER STATUS NOT IN SERVICE
SSA OPER STATUS DESTROY

You pass SSA OPER STATUS DESTROY as the value in a SSARegSubagent() function call when you want to unregister the agent from the Master Agent.

Address has the same structure as sockaddr_in, that is a common UNIX structure containing the following members:

- short sin_family;
- ushort_t sin_port;
- struct in_addr sin_addr;
- char sin_zero[8];

The SSARegSubtable() function registers a MIB table with the Master Agent. If this function is successful, an index number is returned, otherwise 0 is returned. The table parameter is a pointer to a SSA_Table structure containing the following members:

- int regTblIndex; /* index value */
- int regTblAgentID; /* current agent ID */
- Oid regTblOID; /* Object ID of the table */
- int regTblStartColumn; /* start column index */
- int regTblEndColumn; /* end column index */
- int regTblStartRow; /* start row index */
- int regTblEndRow; /* end row index */
- int regTblStatus; /* status */

The regTblStatus can have one of the following values:

SSA OPER STATUS ACTIVE
SSA OPER STATUS NOT IN SERVICE

The SSARegSubtree() function registers a MIB subtree with the master agent. If successful this function returns an index number, otherwise 0 is returned. The subtree parameter is a pointer to a SSA_Subtree structure containing the following members:

- int regTreeIndex; /* index value */
- int regTreeAgentID; /* current agent ID */
- Oid name; /* Object ID to register */
- int regtreeStatus; /* status */

The regtreeStatus can have one of the following values:

SSA OPER STATUS ACTIVE
SSA OPER STATUS NOT IN SERVICE

The SSASendTrap() function instructs the Master Agent to send a trap notification, based on the keyword passed with name. When your subagent MIB is compiled by mibcodegen, it creates a lookup table of the trap notifications defined in the MIB. By passing the name of the trap notification type as name, the subagent instructs the Master Agent to construct the type of trap defined in the MIB.
The SSASubagentOpen() function initializes communication between the subagent and the Master Agent. You must call this function before calling SSASRegSubagent() to register the subagent with the Master Agent. The SSASubagentOpen() function returns a unique agent ID that is passed in the SSASRegSubagent() call to register the subagent. If 0 is returned as the agent ID, the attempt to initialize communication with the Master Agent was unsuccessful. Since UDP is used to initialize communication with the Master Agent, you may want to set the value of num_of_retry to make multiple attempts.

The value for agent_name must be unique within the domain for which the Master Agent is responsible.

**ATTRIBUTES**
See attributes(5) for descriptions of the following attributes:

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<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

**SEE ALSO** attributes(5)
### SSAOidCmp(3SNMP)

#### NAME
SSAOidCmp, SSAOidCpy, SSAOidDup, SSAOidFree, SSAOidInit, SSAOidNew, SSAOidString, SSAOidStrToOid, SSAOidZero – Sun Solstice Enterprise Agent OID helper functions

#### SYNOPSIS
```c
#include <impl.h>

int SSAOidCmp(Oid *oid1, Oid *oid2);
int SSAOidCpy(Oid *oid1, Oid *oid2, char *error_label);
Oid *SSAOidDup(Oid *oid1, char *error_label);
void SSAOidFree(Oid *oid);
int SSAOidInit(Oid *oid, Subid *subids, int len, char *error_label);
Oid *SSAOidNew();
char *SSAOidString(Oid *oid);
Oid *SSAOidStrToOid(char* name, char *error_label);
void SSAOidZero(Oid *oid);
```

#### DESCRIPTION
The `SSAOidCmp()` function performs a comparison of the given OIDs. This function returns:

- 0 if `oid1` is equal to `oid2`
- 1 if `oid1` is greater than `oid2`
- -1 if `oid1` is less than `oid2`

The `SSAOidCpy()` function makes a deep copy of `oid2` to `oid1`. This function assumes `oid1` has been processed by the `SSAOidZero()` function. Memory is allocated inside `oid1` and the contents of `oid2`, not just the pointer, is copied to `oid1`. If an error is encountered, an error message is stored in the `error_label` buffer.

The `SSAOidDup()` function returns a clone of `oid`, by using the deep copy. Error information is stored in the `error_label` buffer.

The `SSAOidFree()` function frees the OID instance, with its content.

The `SSAOidNew()` function returns a new OID.

The `SSAOidInit()` function copies the Subid array from `subids` to the OID instance with the specified length `len`. This function assumes that the OID instance has been processed by the `SSAOidZero()` function or no memory is allocated inside the OID instance. If an error is encountered, an error message is stored in the `error_label` buffer.

The `SSAOidString()` function returns a char pointer for the printable form of the given `oid`. 

---

496  man pages section 3: Extended Library Functions • Last Revised 17 Dec 1996
The `SSAOidStrToOid()` function returns a new OID instance from `name`. If an error is encountered, an error message is stored in the `error_label` buffer.

The `SSAOidZero()` function frees the memory used by the OID object for buffers, but not the OID instance itself.

**RETURN VALUES**
The `SSAOidNew()` and `SSAOidStrToOid()` functions return 0 if an error is detected.

**ATTRIBUTES**
See `attributes(5)` for descriptions of the following attributes:

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</tbody>
</table>

**SEE ALSO**
`attributes(5)`
SSAStringCpy(3SNMP)

NAME
SSAStringCpy, SSAStringInit, SSAStringToChar, SSAStringZero – Sun Solstice
Enterprise Agent string helper functions

SYNOPSIS

```
#include <impl.h>

void *SSAStringZero(String *string);

int SSAStringInit(String *string, uchar_t *chars, int len, char
  *error_label);

int SSAStringCpy(String *string1, String *string2, char *error_label);

char *SSAStringToChar(String string);
```

DESCRIPTION

The SSAStringCpy() function makes a deep copy of string2 to string1. This function
assumes that string1 has been processed by the SSAStringZero() function. Memory
is allocated inside the string1 and the contents of string2, not just the pointer, is copied
to the string1. If an error is encountered, an error message is stored in the error_label
buffer.

The SSAStringInit() function copies the char array from chars to the string
instance with the specified length len. This function assumes that the string instance
has been processed by the SSAStringZero() function or no memory is allocated
inside the string instance. If an error is encountered, an error message is stored in the
error_label buffer.

The SSAStringToChar() function returns a temporary char array buffer for printing
purposes.

The SSAStringZero() function frees the memory inside of the String instance, but
not the string object itself.

RETURN VALUES

The SSAStringInit() and SSAStringCpy() functions return 0 if successful and
−1 if error.

ATTRIBUTES

See attributes (5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO
attributes(5)
strccpy(3GEN)

NAME
strccpy, streadd, strcadd, strecpy – copy strings, compressing or expanding escape codes

SYNOPSIS
cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

char *strccpy(char *output, const char *input);
char *streadd(char *output, const char *input);
char *strecpy(char *output, const char *input, const char *exceptions);
char *streadd(char *output, const char *input, const char *exceptions);

DESCRIPTION
strccpy() copies the input string, up to a null byte, to the output string, compressing
the C-language escape sequences (for example, \n, \001) to the equivalent character.
A null byte is appended to the output. The output argument must point to a space big
equivalent character.

strccpy() returns the output argument.

strcadd() is identical to strccpy(), except that it returns the pointer to the null
byte that terminates the output.

strecpy() copies the input string, up to a null byte, to the output string, expanding
non-graphic characters to their equivalent C-language escape sequences (for example,
\n, \001). The output argument must point to a space big enough to accommodate the result; four times
the space pointed to by input is guaranteed to be big enough (each character could become \ and 3 digits). Characters in the exceptions string are not
expanded. The exceptions argument may be zero, meaning all non-graphic characters
are expanded. strecpy() returns the output argument.

streadd() is identical to strecpy(), except that it returns the pointer to the null
byte that terminates the output.

EXAMPLES
EXAMPLE 1 Example of expanding and compressing escape codes.

/* expand all but newline and tab */
strccpy(output, input, "\n\t");

/* concatenate and compress several strings */
cp = streadd(output, input1);
cp = streadd(cp, input2);
cp = streadd(cp, input3);

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
string(3C), strfind(3GEN), attributes(5)
When compiling multi-thread applications, the `REENTRANT` flag must be defined on the compile line. This flag should only be used in multi-thread applications.
NAME  strfind, strspn, strtrns, str – string manipulations

SYNOPSIS  

cc [ flag ... ] file ... -lgen [ library ... ]
#include <libgen.h>

int strfind(const char *as1, const char *as2);
char *strspn(const char *string, const char *tc);
char *strtrns(const char *string, const char *old, const char *new,
               char *result);

DESCRIPTION  The strfind() function returns the offset of the first occurrence of the second string, as2, if it is a substring of string as1. If the second string is not a substring of the first string strfind() returns −1.

The strspn() function trims characters from a string. It searches from the end of string for the first character that is not contained in tc. If such a character is found, strspn() returns a pointer to the next character; otherwise, it returns a pointer to string.

The strtrns() function transforms string and copies it into result. Any character that appears in old is replaced with the character in the same position in new. The new result is returned.

USAGE  When compiling multithreaded applications, the _REENTRANT flag must be defined on the compile line. This flag should only be used in multithreaded applications.

EXAMPLES  EXAMPLE 1 An example of the strfind() function.

/* find offset to substring "hello" within as1 */
i = strfind(as1, "hello");
/* trim junk from end of string */
s2 = strspn(s1, "*?#$%");
*s2 = '\0';
/* transform lower case to upper case */
as1[] = "abcdefghijklmnopqrstuvwxyz";
as2[] = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
s2 = strtrns(s1, a1, a2, s2);

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO  string(3C), attributes(5)
NAME  sysevent_free – free memory for sysevent handle

SYNOPSIS  

cc [flag ...] file ...-lsysevent [library ...]
#include <libsysevent.h>

void sysevent_free(sysevent_t *ev);

PARAMETERS  
ev          handle to event an event buffer

DESCRIPTION  
The sysevent_free() function deallocates memory associated with an event buffer.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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<tbody>
<tr>
<td>Interface Stability</td>
<td>Evolving</td>
</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  
attributes(5)
NAME

sysevent_get_attr_list – get attribute list pointer

SYNOPSIS

cc [flag ...] file ... -lsysevent -lnvpair [library ...]
#include <libsysevent.h>
#include <libnvpair.h>

int sysevent_get_attr_list(sysevent_t *ev, nvlist_t **attr_list);

PARAMETERS

ev handle to a system event
attr_list address of a pointer to attribute list (nvlist_t)

DESCRIPTION

The sysevent_get_attr_list() function updates attr_list to point to a searchable name-value pair list associated with the sysevent event, ev. The interface manages the allocation of the attribute list, but it is up to the caller to free the list when it is no longer needed with a call to nvlist_free(). See nvlist_alloc(3NVPAIR).

RETURN VALUES

The sysevent_get_attr_list() function returns 0 if the attribute list for ev is found to be valid. Otherwise it returns −1 and sets errno to indicate the error.

ERRORS

The sysevent_get_attr_list() function will fail if:

ENOMEM Insufficient memory available to allocate an nvlist.
EINVAL Invalid sysevent event attribute list.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

ATTRIBUTE TYPE | ATTRIBUTE VALUE
--- | ---
Interface Stability | Evolving
MT-Level | MT-Safe

SEE ALSO

syseventd(1M), nvlist_alloc(3NVPAIR), nvlist_lookup_boolean(3NVPAIR), attributes(5)
NAME

sysevent_get_class_name, sysevent_get_subclass_name, sysevent_get_event_id,
sysevent_get_size – get class name, subclass name, ID or buffer size of event

SYNOPSIS

cc [flag ...] file ... -lsysevent [library ...]
#include <libsysevent.h>

char *sysevent_get_class_name(sysevent_t *ev);
char *sysevent_get_subclass_name(sysevent_t *ev);
void sysevent_get_event_id(sysevent_t *ev, sysevent_id_t *eid);
int sysevent_get_size(sysevent_t *ev);

PARAMETERS

eid pointer to sysevent_id_t structure
ev handle to event

DESCRIPTION

The sysevent_get_class_name() and sysevent_get_subclass_name() functions return, respectively, the class and subclass names for the provided event \( ev \).

The sysevent_get_event_id() function returns the unique event identifier associated with the sysevent handle, \( ev \). The identifier is composed of a relative timestamp issued at the time the event was generated and a sequence number to ensure uniqueness.

typedef struct sysevent_id {
    uint64_t eid_seq;
    hrtime_t eid_ts;
} sysevent_id_t;

The sysevent_get_size() function returns the size of the event buffer, \( ev \).

EXAMPLES

EXAMPLE 1 Parse sysevent header information.

The following example parses sysevent header information from an application’s event handler.

```c
hrtime_t last_ev_time;
unit64_t last_ev_seq;

void
event_handler(sysevent_t *ev)
{
    sysevent_t *new_ev;
    sysevent_id_t eid;

    /* Filter on class and subclass */
    if (strcmp(EC_PRIV, sysevent_get_class_name(ev)) != 0) {
        return;
    } else if (strcmp("ESC_MYSUBCLASS, sysevent_get_subclass_name(ev)) != 0) {
        return;
    }
```
EXAMPLE 1 Parse sysevent header information. (Continued)

    /* Check for replayed sysevent, time must
     * be greater than previously recorded.
     */
    sysevent_get_event_id(ev, &eid);
    if (eid.eid_ts < last_ev_time ||
        (eid.eid_ts == last_ev_time && eid.eid_seq <=
         last_ev_seq)) {
        return;
    }
    last_ev_time = eid.eid_ts;
    last_ev_seq = eid.eid_seq;

    /* Store event for later processing */
    ev_sz = sysevent_get_size(ev);
    new_ev = (sysevent_t *)malloc(ev_sz);
    bcopy(ev, new_ev, ev_sz);
    queue_event(new_ev);
}

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO attributes(5)
NAME

sysevent_get_vendor_name, sysevent_get_pub_name, sysevent_get_pid – get vendor name, publisher name or processor ID of event

SYNOPSIS

cc [flag...] file ... -lsysevent [library ...]

#include <libsysevent.h>

char *sysevent_get_vendor_name(sysevent_t *ev);
char *sysevent_get_pub_name(sysevent_t *ev);

pid_t sysevent_get_pid(sysevent_t *ev);

PARAMETERS

*ev handle to a system event object

DESCRIPTION

The sysevent_get_pub_name() function returns the publisher name for the sysevent handle, *ev. The publisher name identifies the name of the publishing application or kernel subsystem of the sysevent.

The sysevent_get_pid() function returns the process ID for the publishing application or SE_KERN_PID for sysevents originating in the kernel. The publisher name and PID are useful for implementing event acknowledgement.

The sysevent_get_vendor_name() function returns the vendor string for the publishing application or kernel subsystem. A vendor string is the company's stock symbol that provided the application or kernel subsystem that generated the system event. This information is useful for filtering sysevents for one or more vendors.

The interface manages the allocation of the vendor and publisher name strings, but it is up to the caller to free the strings when they are no longer needed with a call to free(). See malloc(3MALLOC).

EXAMPLES

EXAMPLE 1 Parse sysevent header information.

The following example parses sysevent header information from an application’s event handler.

```c
char *vendor;
char *pub;

void
event_handler(sysevent_t *ev)
{
    if (strcmp(EC_PRIV, sysevent_get_class_name(ev)) != 0) { return; }

    vendor = sysevent_get_vendor_name(ev);
    if (strcmp("SUNW", vendor) != 0) { free(vendor); return; }

    pub = sysevent_get_pub_name(ev);
    if (strcmp("test_daemon", pub) != 0) { free(vendor); free(pub); };
```
EXAMPLE 1 Parse sysevent header information.  (Continued)

    return;
  }
  (void) kill(sysevent_get_pid(ev), SIGUSR1);
  free(vendor);
  free(pub);
}

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  malloc(3MALLOC), attributes(5)
NAME  sysevent_post_event – post system event for applications

SYNOPSIS  cc [flag...] file ...-lsysevent -lnvpair [library...]
#include <libsysevent.h>
#include <libnvpair.h>

int sysevent_post_event(char *class, char *subclass, char *vendor, char
    *publisher, nvlist_t *attr_list, sysevent_id_t *eid);

PARAMETERS  attr_list      pointer to an nvlist_t, listing the name-value attributes
                 associated with the event, or NULL if there are no such attributes
                 for this event

class            pointer to a string defining the event class

eid               pointer to a system unique identifier

publisher        pointer to a string defining the event’s publisher name

subclass         pointer to a string defining the event subclass

vendor           pointer to a string defining the vendor

DESCRIPTION The sysevent_post_event() function causes a system event of the specified class,
subclass, vendor, and publisher to be generated on behalf of the caller and queued for
delivery to the sysevent daemon syseventd(1M).

The vendor must be the company stock symbol of the event posting application. The
publisher should be the name of the application generating the event.

For example, all events posted by Sun applications begin with the company’s stock
symbol, “SUNW”. The publisher is usually the name of the application generating the
system event. A system event generated by devfsadm(1M) has a publisher string of
devfsadm.

The publisher information is used by sysevent consumers to filter unwanted event
publishers.

Upon successful queuing of the system event, a unique identifier is assigned to eid.

RETURN VALUES The sysevent_post_event() function returns 0 if the system event has been
queued successfully for delivery. Otherwise it returns -1 and sets errno to indicate
the error.

ERRORS The sysevent_post_event() function will fail if:

ENOMEM           Insufficient resources to queue the system event.
EIO              The syseventd daemon is not responding and events cannot be
                 queued or delivered at this time.
EINVAL           Invalid argument.
EPERM            Permission denied.
 EXAMPLES

EXAMPLE 1  Post a system event event with no attributes.

The following example posts a system event event with no attributes.

if (sysevent_post_event(EC_PRIV, "ESC_MYSUBCLASS", "SUNW", argv[0],
                       NULL) != 0) {
    fprintf(stdout, "error logging system event\n");
}

EXAMPLE 2  Post a system event event with two name-value pair attributes.

The following example posts a system event event with two name-value pair attributes, an integer value and a string.

    nvlist_t *attr_list;
    uint32_t    uint32_val  = 0xFFFFFFFF;
    char *string_val = "string value data";

    if (nvlist_alloc(&attr_list, 0, 0) == 0) {
        err = nvlist_add_uint32(attr_list, "uint32 data", uint32_val);
        if (err == 0)
            err = nvlist_add_string(attr_list, "str data", str_value);
        if (err == 0)
            err = sysevent_post_event("EC_PRIV", "ESC_MYSUBCLASS", "SUNW", argv[0], attr_list);
        if (err != 0)
            fprintf(stdout, "error logging system event\n");
        nvlist_free(attr_list);
    }

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

+---------------------------------+------------------+
| ATTRIBUTE TYPE | ATTRIBUTE VALUE  |
+----------------+------------------+
| Interface Stability | Evolving         |
| MT-Level        | MT-Safe          |

SEE ALSO  devfsadm(1M), syseventd(1M), nvlist_add_boolean(3NVPAIR),
nvlist_alloc(3NVPAIR), attributes(5)
NAME
  tan – tangent function

SYNOPSIS
  cc [ flag ... ] file ... -lm [ library ... ]
  #include <math.h>
  double tan(double x);

DESCRIPTION
  The tan() function computes the tangent of its argument x, measured in radians.

RETURN VALUES
  Upon successful completion, tan() returns the tangent of x.
  If x is NaN or ±Inf, NaN is returned.

ERRORS
  No errors will occur.

ATTRIBUTES
  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
  atan(3M), isnan(3M), attributes(5)
NAME    tanh – hyperbolic tangent function

SYNOPSIS  
cc [ flag ... ] file ... -lm [ library ... ]
#include <math.h>
double tanh(double x);

DESCRIPTION  The tanh() function computes the hyperbolic tangent of x.

RETURN VALUES Upon successful completion, tanh() returns the hyperbolic tangent of x.

If x is NaN, NaN is returned.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO  atanh(3M), isnan(3M), tan(3M), attributes(5)
### NAME
tnfctl_buffer_alloc, tnfctl_buffer_dealloc – allocate or deallocate a buffer for trace data

### SYNOPSIS
```c
#include <tnf/tnfctl.h>

tnfctl_errorcode_t tnfctl_buffer_alloc(tnfctl_handle_t *hndl, const char *trace_file_name, size_t trace_buffer_size);

tnfctl_buffer_dealloc(tnfctl_handle_t *hndl);
```

### DESCRIPTION
`tnfctl_buffer_alloc()` allocates a buffer to which trace events are logged. When tracing a process using a tnfctl handle returned by `tnfctl_pid_open(3TNF)`, `tnfctl_exec_open(3TNF)`, `tnfctl_indirect_open(3TNF)`, and `tnfctl_internal_open(3TNF)`, `trace_file_name` is the name of the trace file to which trace events should be logged. It can be an absolute path specification or a relative path specification. If it is relative, the current working directory of the process that is calling `tnfctl_buffer_alloc()` is prefixed to `trace_file_name`. If the named trace file already exists, it is overwritten. For kernel tracing, that is, for a tnfctl handle returned by `tnfctl_kernel_open(3TNF)`, trace events are logged to a trace buffer in memory; therefore, `trace_file_name` is ignored. Use `tnfxtract(1)` to extract a kernel buffer into a file.

`trace_buffer_size` is the size in bytes of the trace buffer that should be allocated. An error is returned if an attempt is made to allocate a buffer when one already exists. `tnfctl_buffer_alloc()` affects the trace attributes; use `tnfctl_trace_attrs_get(3TNF)` to get the latest trace attributes after a buffer is allocated.

`tnfctl_buffer_dealloc()` is used to deallocate a kernel trace buffer that is no longer needed. `hndl` must be a kernel handle, returned by `tnfctl_kernel_open(3TNF)`. A process’s trace file cannot be deallocated using `tnfctl_buffer_dealloc()`. Instead, once the trace file is no longer needed for analysis and after the process being traced exits, use `rm(1)` to remove the trace file. Do not remove the trace file while the process being traced is still alive. `tnfctl_buffer_dealloc()` affects the trace attributes; use `tnfctl_trace_attrs_get(3TNF)` to get the latest trace attributes after a buffer is deallocated.

For a complete discussion of tnf tracing, see `tracing(3TNF)`.

### RETURN VALUES
`tnfctl_buffer_alloc()` and `tnfctl_buffer_dealloc()` return `TNFCTL_ERR_NONE` upon success.

### ERRORS
The following error codes apply to `tnfctl_buffer_alloc()`:

- **TNFCTL_ERR_BUFEXISTS**: A buffer already exists.
- **TNFCTL_ERR_ACCES**: Permission denied; could not create a trace file.
- **TNFCTL_ERR_SIZETOOSMALL**: The `trace_buffer_size` requested is smaller than the minimum trace buffer size needed.
Use `trace_min_size` of trace attributes in `tnfctl_trace_attrs_get(3TNF)` to determine the minimum size of the buffer.

- **TNFCTL_ERR_SIZETOOBIG**: The requested trace file size is too big.
- **TNFCTL_ERR_BADARG**: `trace_file_name` is NULL or the absolute path name is longer than MAXPATHLEN.
- **TNFCTL_ERR_ALLOCFAIL**: A memory allocation failure occurred.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

The following error codes apply to `tnfctl_buffer_dealloc()`:

- **TNFCTL_ERR_BADARG**: `hndl` is not a kernel handle.
- **TNFCTL_ERR_NOBUF**: No buffer exists to deallocate.
- **TNFCTL_ERR_BADDEALLOC**: Cannot deallocate a trace buffer unless tracing is stopped. Use `tnfctl_trace_state_set(3TNF)` to stop tracing.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

**ATTRIBUTES**

See `attributes(5)` for descriptions of the following attributes:

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<tr>
<td>Availability</td>
<td>SUNWtnfc</td>
</tr>
<tr>
<td>MT Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

prex(1), rm(1), tnfextract(1), TNF_PROBE(3TNF), libtnfctl(3TNF),
tnfctl_exec_open(3TNF), tnfctl_indirect_open(3TNF),
tnfctl_internal_open(3TNF), tnfctl_kernel_open(3TNF),
tnfctl_pid_open(3TNF), tnfctl_trace_attrs_get(3TNF), tracing(3TNF),
attributes(5)
tnfctl_close(3TNF)

NAME
tnfctl_close – close a tnfctl handle

SYNOPSIS
ec [ flag ... ] file ... -ltnfctl [ library ... ]
#include <tnf/tnfctl.h>
tnfctl_errcode_t tnfctl_close(tnfctl_handle_t *hndl,
          tnfctl_targ_op_t action);

DESCRIPTION
tnfctl_close() is used to close a tnfctl handle and to free up the memory
associated with the handle. When the handle is closed, the tracing state and the states
of the probes are not changed. tnfctl_close() can be used to close handles in any
mode, that is, whether they were created by tnfctl_internal_open(3TNF),
tnfctl_pid_open(3TNF), tnfctl_exec_open(3TNF),
tnfctl_indirect_open(3TNF), or tnfctl_kernel_open(3TNF).

The action argument is only used in direct mode, that is, if hndl was created by
tnfctl_exec_open(3TNF) or tnfctl_pid_open(3TNF). In direct mode, action
specifies whether the process will proceed, be killed, or remain suspended. action may
have the following values:

| TNFCTL_TARG_DEFAULT | Kills the target process if hndl was created
|                     | with tnfctl_exec_open(3TNF), but lets
|                     | it continue if it was created with
|                     | tnfctl_pid_open(3TNF). |

| TNFCTL_TARG_KILL    | Kills the target process. |
| TNFCTL_TARG_RESUME  | Allows the target process to continue. |
| TNFCTL_TARG_SUSPEND | Leaves the target process suspended. This is
|                     | not a job control suspend. It is possible to
|                     | attach to the process again with a debugger
|                     | or with the tnfctl_pid_open(3TNF)
|                     | interface. The target process can also be
|                     | continued with prun(1). |

RETURN VALUES
tnfctl_close() returns TNFCTL_ERR_NONE upon success.

ERRORS
The following error codes apply to tnfctl_close():

| TNFCTL_ERR_BADARG | A bad argument was sent in action. |
| TNFCTL_ERR_INTERNAL | An internal error occurred. |

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO prex(1), prun(1), TNF_PROBE(3TNF), libtnfctl(3TNF),
        tnfctl_exec_open(3TNF), tnfctl_indirect_open(3TNF),
        tnfctl_kernel_open(3TNF), tnfctl_pid_open(3TNF), tracing(3TNF),
        attributes(5)
The interfaces `tnfctl_indirect_open()` and `tnfctl_check_libs()` are used to control probes in another process where the `libtnfctl`(3TNF) client has already opened `/proc(4)` on the target process. An example of this is when the client is a debugger. Since these clients already use `/proc` on the target, `libtnfctl`(3TNF) cannot use `/proc` directly. Therefore, these clients must provide callback functions that can be used to inspect and to update the target process. The target process must load `libtnfprobe.so.1` (defined in `<tnf/tnfctl.h>` as macro `TNFCTL_LIBTNFPROBE`).

The first argument `prochandle` is a pointer to an opaque structure that is used in the callback functions that inspect and update the target process. This structure should encapsulate the state that the caller needs to use `/proc` on the target process (the `/proc file descriptor`). The second argument, `config`, is a pointer to

```c
typedef
struct tnfctl_ind_config {
    int (*p_read)(void *prochandle, paddr_t addr, char *buf, size_t size);
    int (*p_write)(void *prochandle, paddr_t addr, char *buf, size_t size);
    pid_t (*p_getpid)(void *prochandle);
    int (*p_obj_iter)(void *prochandle, tnfctl_ind_obj_f *func,
                     void *client_data);
} tnfctl_ind_config_t;
```

The first field `p_read` is the address of a function that can read `size` bytes at address `addr` in the target image into the buffer `buf`. The function should return 0 upon success. The second field `p_write` is the address of a function that can write `size` bytes at address `addr` in the target image from the buffer `buf`. The function should return 0 upon success. The third field `p_getpid` is the address of a function that should return the process id of the target process (`prochandle`). The fourth field `p_obj_iter` is the address of a function that iterates over all load objects and the executable by calling the callback function `func` with `client_data`. If `func` returns 0, `p_obj_iter` should continue processing link objects. If `func` returns any other value, `p_obj_iter` should stop calling the callback function and return that value. `p_obj_iter` should return 0 if it iterates over all load objects.

If a failure is returned by any of the functions in `config`, the error is propagated back as `PREX_ERR_INTERNAL` by the `libtnfctl` interface that called it.

The definition of `tnfctl_ind_obj_f` is:
typedef int
  tnfctl_ind_obj_f(void *prochandle,
    const struct tnfctl_ind_obj_info *obj
    void *client_data);

typedef struct tnfctl_ind_obj_info {
  int objfd;       /* -1 indicates fd not available */
  paddr_t text_base; /* virtual addr of text segment */
  paddr_t data_base; /* virtual addr of data segment */
  const char *objname; /* null-term. pathname to loadobj */
} tnfctl_ind_obj_info_t;

objfd should be the file descriptor of the load object or executable. If it is -1, then
objname should be an absolute pathname to the load object or executable. If objfd is not
closed by libtnfctl, it should be closed by the load object iterator function. text_base
and data_base are the addresses where the text and data segments of the load object are
mapped in the target process.

Whenever the target process opens or closes a dynamic object, the set of available
probes may change. See dlopen(3DL) and dlclose(3DL). In indirect mode, call
tnfctl_check_libs() when such events occur to make libtnfctl aware of any
changes. In other modes this is unnecessary but harmless. It is also harmless to call
tnfctl_check_libs() when no such events have occurred.

RETURN VALUES
  tnfctl_indirect_open() and tnfctl_check_libs() return
  TNFCTL_ERR_NONE upon success.

ERRORS
  The following error codes apply to tnfctl_indirect_open():

  TNFCTL_ERR_ALLOCFAIL          A memory allocation failure occurred.
  TNFCTL_ERR_BUSY               Internal tracing is being used.
  TNFCTL_ERR_NOLIBTFNPROBE      libtnfprobe.so.1 is not loaded in the
target process.
  TNFCTL_ERR_INTERNAL           An internal error occurred.

  The following error codes apply to tnfctl_check_libs():

  TNFCTL_ERR_ALLOCFAIL          A memory allocation failure occurred.
  TNFCTL_ERR_INTERNAL           An internal error occurred.

ATTRIBUTES
  See attributes(5) for descriptions of the following attributes:

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<thead>
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<th>ATTRIBUTE TYPE</th>
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<tr>
<td>MT Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO
  prex(1), TNF_PROBE(3TNF), dlclose(3DL), dlopen(3DL), libtnfctl(3TNF),
  tnfctl_probe_enable(3TNF), tnfctl_probe_trace(3TNF), tracing(3TNF),
  proc(4), attributes(5)
Linker and Libraries Guide

tnfc_tl_indirect_open() should only be called after the dynamic linker has mapped in all the libraries (rtld sync point) and called only after the process is stopped. Indirect process probe control assumes the target process is stopped whenever any libtnfctl interface is used on it. For example, when used for indirect process probe control, tnfctl_probe_enable(3TNF) and tnfctl_probe_trace(3TNF) should be called only for a process that is stopped.
tnfctl_internal_open(3TNF)

NAME
tnfctl_internal_open – create handle for internal process probe control

SYNOPSIS
cce [ flag ... ] file ... -lt nfctl [ library ... ]
#include <tnf/tnfctl.h>

tnfctl_errcode_t tnfctl_internal_open(tnfctl_handle_t **ret_val);

DESCRIPTION
tnfctl_internal_open() returns in ret_val a pointer to an opaque handle that can
be used to control probes in the same process as the caller (internal process probe
control). The process must have libtnfprobe.so.1 loaded. Probes in libraries that
are brought in by dlopen(3DL) will be visible after the library has been opened.
Probes in libraries closed by a dlclose(3DL) will not be visible after the library has
been disassociated. See the NOTES section for more details.

RETURN VALUES
tnfctl_internal_open() returns T NFCTL_ERR_NONE upon success.

ERRORS
TNFCTL_ERR_ALLOCFAIL A memory allocation failure occurred.
TNFCTL_ERR_BUSY Another client is already tracing this
program (internally or externally).
TNFCTL_ERR_NOLIBTNFPROBE libtnfprobe.so.1 is not linked in the
target process.
TNFCTL_ERR_INTERNAL An internal error occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

SEE ALSO
ld(1), prex(1), T NF_PROBE(3TNF), dlopen(3DL), dlclose(3DL),
libtnfctl(3TNF), tracing(3TNF), attributes(5)

Linker and Libraries Guide

NOTES
libtnfctl interposes on dlopen(3DL) and dlclose(3DL) in order to be notified of
libraries being dynamically opened and closed. This interposition is necessary for
internal process probe control to update its list of probes. In these interposition
functions, a lock is acquired to synchronize on traversal of the library list maintained
by the runtime linker. To avoid deadlocking on this lock, tnfctl_internal_open
() should not be called from within the init section of a library that can be opened by
dlopen(3DL).
Since interposition does not work as expected when a library is opened dynamically, `tnfctl_internal_open()` should not be used if the client opened `libtnfctl` through `dlopen(3DL)`. In this case, the client program should be built with a static dependency on `libtnfctl`. Also, if the client program is explicitly linking in `-ldl`, it should link `-ltnfctl` before `-ldl`.

Probes in filtered libraries (see `ld(1)`) will not be seen because the filtee (backing library) is loaded lazily on the first symbol reference and not at process startup or `dlopen(3DL)` time. A workaround is to call `tnfctl_check_libs(3TNF)` once the caller is sure that the filtee has been loaded.
tnfctl_kernel_open(3TNF)

NAME
tnfctl_kernel_open – create handle for kernel probe control

SYNOPSIS
cc [ flag ... ] file ... -ltnfctl [ library ... ]
#include <tnf/tnfctl.h>

tnfctl_errcode_t tnfctl_kernel_open(tnfctl_handle_t **ret_val);

DESCRIPTION
tnfctl_kernel_open() starts a kernel tracing session and returns in ret_val an
opaque handle that can be used to control tracing and probes in the kernel. Only one
kernel tracing session is possible at a time on a given machine. An error code of
TNFCTL_ERR_BUSY is returned if there is another process using kernel tracing. Use
the command

fuser -f /dev/tnfctl

to print the process id of the process currently using kernel
tracing. Only a superuser may use tnfctl_kernel_open(). An error code of
TNFCTL_ERR_ACCESS is returned if the caller does not have the necessary privileges.

RETURN VALUES
tnfctl_kernel_open returns TNFCTL_ERR_NONE upon success.

ERRORS

TNFCTL_ERR_ACCESS Permission denied. Superuser privileges are
needed for kernel tracing.

TNFCTL_ERR_BUSY Another client is currently using kernel
tracing.

TNFCTL_ERR_ALLOCFAIL Memory allocation failed.

TNFCTL_ERR_FILENOTFOUND /dev/tnfctl not found.

TNFCTL_ERR_INTERNAL Some other failure occurred.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
prex(1), fuser(1M), TNF_PROBE(3TNF), libtnfctl(3TNF), tracing(3TNF),
tnf_kernel_probes (4), attributes(5)
tnfctl_pid_open(3TNF)

NAME

tnfctl_pid_open, tnfctl_exec_open, tnfctl_continue – interfaces for direct probe and
process control for another process

SYNOPSIS

cc [ flag ... ] file ... -ltnfctl [ library ... ]
#include <tnf/tnfctl.h>

tnfctl_errcode_t tnfctl_pid_open(pid_t pid, tnfctl_handle_t **ret_val);

tnfctl_errcode_t tnfctl_exec_open(const char *pgm_name, char *const *argv, char *const *envp,
libnfprobe_path, const char *ld_preload, tnfctl_handle_t **ret_val);

tnfctl_errcode_t tnfctl_continue(tnfctl_handle_t *hndl,
  tnfctl_event_t *evt, tnfctl_handle_t **child_hndl);

DESCRIPTION

tnfctl_pid_open(), tnfctl_exec_open(), and tnfctl_continue() are the
interfaces used to create handles to control probes in another process (direct process
probe control). Either tnfctl_pid_open() or tnfctl_exec_open() will return a
handle in ret_val that can be used for probe control. On return of these calls, the
process is stopped. tnfctl_continue() allows the process specified by hndl to
continue execution.

tnfctl_pid_open() attaches to a running process with process id of pid. The
process is stopped on return of this call. tnfctl_pid_open() returns an error
message if pid is the same as the calling process. See tnfctl_internal_open(3TNF)
for information on internal process probe control. A pointer to an opaque handle is
returned in ret_val that can be used for probe control. On return of these calls, the
process must have libtnfprobe.so.1 (defined in <tnf/tnfctl.h> as macro TNFCTL_LIBTNFPROBE) linked in for probe control to
work.

tnfctl_exec_open() is used to exec(2) a program and obtain a probe control
handle. For probe control to work, the process image to be exec’ed must load
libtnfprobe.so.1. The interface tnfctl_exec_open() makes it simple for the
library to be loaded at process start up time. pgm_name is the command to exec. If
pgm_name is not an absolute path, then the $PATH environment variable is used to find
the pgm_name. argv is a null-terminated argument pointer, that is, it is a
null-terminated array of pointers to null-terminated strings. These strings constitute
the argument list available to the new process image. argv must have at least one
member, and it should point to a string that is the same as pgm_name. See execve(2).

libnfprobe_path is an optional argument, and if set, it should be the path to the directory
that contains libtnfprobe.so.1. There is no need for a trailing "/" in this
argument. This argument is useful if libtnfprobe.so.1 is not installed in
/usr/lib. ld_preload is a space-separated list of libraries to preload into the target
program. This string should follow the syntax guidelines of the LD_PRELOAD
environment variable. See ld.so.1(1). The following illustrates how strings are
concatenated to form the LD_PRELOAD environment variable in the new process
image:
This option is useful for preloading interposition libraries that have probes in them.

`envp` is an optional argument, and if set, it is used for the environment of the target program. It is a null-terminated array of pointers to null-terminated strings. These strings constitute the environment of the new process image. See `execve(2)`. If `envp` is set, it overrides `ld_preload`. In this case, it is the caller’s responsibility to ensure that `libtnfprobe.so.1` is loaded into the target program. If `envp` is not set, the new process image inherits the environment of the calling process, except for `LD_PRELOAD`.

`ret_val` is the return argument which is the handle that can be used to control the process and the probes within the process. Upon return, the process is stopped before any user code, including `.init` sections, has been executed.

`tnfctl_continue()` is a blocking call and lets the target process referenced by `hndl` continue running. It can only be used on handles returned by `tnfctl_pid_open()` and `tnfctl_exec_open()` (direct process probe control). It returns when the target stops; the reason that the process stopped is returned in `evt`. This call is interruptible by signals. If it is interrupted, the process is stopped, and `TNFCTL_EVENT_EINTR` is returned in `evt`. The client of this library will have to decide which signal implies a stop to the target and catch that signal. Since a signal interrupts `tnfctl_continue()`, it will return, and the caller can decide whether or not to call `tnfctl_continue()` again.

`tnfctl_continue()` returns with an event of `TNFCTL_EVENT_DLOPEN`, `TNFCTL_EVENT_DLCLOSE`, `TNFCTL_EVENT_EXEC`, `TNFCTL_EVENT_FORK`, `TNFCTL_EVENT_EXIT`, or `TNFCTL_EVENT_TARGGONE`, respectively, when the target program does a `dlopen(3DL)`, `dlclose(3DL)`, any flavor of `exec(2)`, `fork(2)` (or `fork1(2)`), `exit(2)`, or terminates unexpectedly. If the target program did an `exec(2)`, then the client needs to call `tnfctl_close(3TNF)` on the current handle leaving the target resumed, suspended, or killed (second argument to `tnfctl_close(3TNF)`). No other `libtnfctl` interface call can be used on the existing handle. If the client wants to control the exec’ed image, it should leave the old handle suspended, and use `tnfctl_pid_open()` to reattach to the same process. This new handle can then be used to control the exec’ed image. See EXAMPLES below for sample code. If the target process did a `fork(2)` or `fork1(2)`, and if control of the child process is not needed, then `child_hndl` should be `NULL`. If control of the child process is needed, then `child_hndl` should be set. If it is set, a pointer to a handle that can be used to control the child process is returned in `child_hndl`. The child process is stopped at the end of the `fork()` system call. See EXAMPLES for an example of this event.

**RETURN VALUES**

`tnfctl_pid_open()`, `tnfctl_exec_open()`, and `tnfctl_continue()` return `TNFCTL_ERR_NONE` upon success.

**ERRORS**

The following error codes apply to `tnfctl_pid_open()`:

```
<current value of $LD_PRELOAD> + <space> +
libtnfprobe_path + */libtnfprobe.so.1" +<space> +
ld_preload
```
tnfctl_pid_open(3TNF)

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNFCTL_ERR_BADARG</td>
<td>The pid specified is the same process. Use tnfctl_internal_open(3TNF) instead.</td>
</tr>
<tr>
<td>TNFCTL_ERR_ACCES</td>
<td>Permission denied. No privilege to connect to a setuid process.</td>
</tr>
<tr>
<td>TNFCTL_ERR_ALLOCFAIL</td>
<td>A memory allocation failure occurred.</td>
</tr>
<tr>
<td>TNFCTL_ERR_BUSY</td>
<td>Another client is already using /proc to control this process or internal tracing is being used.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOTDYNAMIC</td>
<td>The process is not a dynamic executable.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOPROCESS</td>
<td>No such target process exists.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOLIBTNFPROBE</td>
<td>libtnfprobe.so.1 is not linked in the target process.</td>
</tr>
<tr>
<td>TNFCTL_ERR_INTERNAL</td>
<td>An internal error occurred.</td>
</tr>
</tbody>
</table>

The following error codes apply to tnfctl_exec_open():

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNFCTL_ERR_ACCES</td>
<td>Permission denied.</td>
</tr>
<tr>
<td>TNFCTL_ERR_ALLOCFAIL</td>
<td>A memory allocation failure occurred.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOTDYNAMIC</td>
<td>The target is not a dynamic executable.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOLIBTNFPROBE</td>
<td>libtnfprobe.so.1 is not linked in the target process.</td>
</tr>
<tr>
<td>TNFCTL_ERR_FILENOTFOUND</td>
<td>The program is not found.</td>
</tr>
<tr>
<td>TNFCTL_ERR_INTERNAL</td>
<td>An internal error occurred.</td>
</tr>
</tbody>
</table>

The following error codes apply to tnfctl_continue():

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNFCTL_ERR_BADARG</td>
<td>Bad input argument. hndl is not a direct process probe control handle.</td>
</tr>
<tr>
<td>TNFCTL_ERR_INTERNAL</td>
<td>An internal error occurred.</td>
</tr>
<tr>
<td>TNFCTL_ERR_NOPROCESS</td>
<td>No such target process exists.</td>
</tr>
</tbody>
</table>

**EXAMPLES**

**EXAMPLE 1 Using tnfctl_pid_open()**

These examples do not include any error-handling code. Only the initial example includes the declaration of the variables that are used in all of the examples.

The following example shows how to preload libtnfprobe.so.1 from the normal location and inherit the parent’s environment.

```c
const char *pgm;
char * const *argv;
tnfctl_handle_t *hndl, *new_hndl, *child_hndl;
tnfctl_errcode_t err;
```
EXAMPLE 1 Using tnfctl_pid_open()  (Continued)

```c
char * const *envptr;
extern char **environ;
tnfctl_event_t evt;
int pid;

/* assuming argv has been allocated */
argv[0] = pgm;
/* set up rest of argument vector here */
err = tnfctl_exec_open(pgm, argv, NULL, NULL, NULL, &hndl);

This example shows how to preload two user-supplied libraries libc_probe.so.1 and libthread_probe.so.1. They interpose on the corresponding libc.so and libthread.so interfaces and have probes for function entry and exit.
libtnfprobe.so.1 is preloaded from the normal location and the parent’s environment is inherited.

/* assuming argv has been allocated */
argv[0] = pgm;
/* set up rest of argument vector here */
err = tnfctl_exec_open(pgm, argv, NULL, NULL, "libc_probe.so.1 libthread_probe.so.1", &hndl);

This example preloads an interposition library libc_probe.so.1, and specifies a different location from which to preload libtnfprobe.so.1.

/* assuming argv has been allocated */
argv[0] = pgm;
/* set up rest of argument vector here */
err = tnfctl_exec_open(pgm, argv, NULL, "/opt/SUNWXXX/lib", "libc_probe.so.1", &hndl);

To set up the environment explicitly for probe control to work, the target process must link libtnfprobe.so.1. If using envp, it is the caller’s responsibility to do so.

/* assuming argv has been allocated */
argv[0] = pgm;
/* set up rest of argument vector here */
/* envptr set up to caller’s needs */
err = tnfctl_exec_open(pgm, argv, envptr, NULL, NULL, &hndl);

Use this example to resume a process that does an exec(2) without controlling it.

err = tnfctl_continue(hndl, &evt, NULL);
switch (evt) {
  case TNFCTL_EVENT_EXEC:
    /* let target process continue without control */
    err = tnfctl_close(hndl, TNFCTL_TARG_RESUME);
    ... 
    break;
  }
```

Alternatively, use the next example to control a process that does an exec(2).

```c
```
EXAMPLE 1 Using tnfctl_pid_open()  (Continued)

/*
 * assume the pid variable has been set by calling
 * tnfctl_trace_attrs_get()
 */
err = tnfctl_continue(hndl, &evt, NULL);
switch (evt) {
    case TNFCTL_EVENT_EXEC:
        /* suspend the target process */
        err = tnfctl_close(hndl, TNFCTL_TARG_SUSPEND);
        /* re-open the exec’ed image */
        err = tnfctl_pid_open(pid, &new_hndl);
        /* new_hndl now controls the exec’ed image */
        ...
        break;
}

To let fork’ed children continue without control, use NULL as the last argument to
tnfctl_continue().
err = tnfctl_continue(hndl, &evt, NULL);

The next example is how to control child processes that fork(2) or fork1(2) create.
err = tnfctl_continue(hndl, &evt, &child_hndl);
switch (evt) {
    case TNFCTL_EVENT_FORK:
        /* spawn a new thread or process to control child_hndl */
        ...
        break;
}

ATTRIBUTES
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SEE ALSO
ld(1), prex(1), proc(1), exec(2), execve(2), exit(2), fork(2), TNF_PROBE(3TNF),
dlclose(3DL), dlopen(3DL), libtnfctl(3TNF), tnfctl_close(3TNF),
tnfctl_internal_open(3TNF), tracing(3TNF) attributes(5)

Linker and Libraries Guide

NOTES
After a tnfctl_continue() returns, a client should use
tnfctl_trace_attrs_get(3TNF) to check the trace_buf_state member of the
trace attributes and make sure that there is no internal error in the target.
tnfctl_probe_apply(3TNF)

NAME  tnfctl_probe_apply, tnfctl_probe_apply_ids – iterate over probes

SYNOPSIS  
```
cc [ flag ... ] file ... -ltnfctl [ library ... ]
#include <tnf/tnfctl.h>
```

```c
#include <tnfctl.h>

tnfctl_errcode_t tnfctl_probe_apply(tnfctl_handle_t *hndl, 
    tnfctl_probe_op_t probe_op, void *clientdata);
```

```c
#include <tnfctl.h>

tnfctl_errcode_t tnfctl_probe_apply_ids(tnfctl_handle_t *hndl, 
    ulong_t probe_count, ulong_t *probe_ids, tnfctl_probe_op_t probe_op, 
    void *clientdata);
```

DESCRIPTION  

`tnfctl_probe_apply()` is used to iterate over the probes controlled by `hndl`. For every probe, the `probe_op` function is called:

```c
typedef tnfctl_errcode_t (*tnfctl_probe_op_t)(
    tnfctl_handle_t *hndl, 
    tnfctl_probe_t *probe_hndl, 
    void *clientdata);
```

Several predefined functions are available for use as `probe_op`. These functions are described in `tnfctl_probe_state_get(3TNF)`. The `clientdata` supplied in `tnfctl_probe_apply()` is passed in as the last argument of `probe_op`. The `probe_hndl` in the probe operation function can be used to query or change the state of the probe. See `tnfctl_probe_state_get(3TNF)`. The `probe_op` function should return `TNFCTL_ERR_NONE` upon success. It can also return an error code, which will cause `tnfctl_probe_apply()` to stop processing the rest of the probes and return with the same error code. Note that there are five (5) error codes reserved that the client can use for its own semantics. See `ERRORS`.

The lifetime of `probe_hndl` is the same as the lifetime of `hndl`. It is good until `hndl` is closed by `tnfctl_close(3TNF)`. Do not confuse a `probe_hndl` with `hndl`. The `probe_hndl` refers to a particular probe, while `hndl` refers to a process or the kernel. If `probe_hndl` is used in another `libtnfctl(3TNF)` interface, and it references a probe in a library that has been dynamically closed (see `dlclose(3DL)`), then the error code `TNFCTL_ERR_INVALIDPROBE` will be returned by that interface.

`tnfctl_probe_apply_ids()` is very similar to `tnfctl_probe_apply()`. The difference is that `probe_op` is called only for probes that match a probe id specified in the array of integers referenced by `probe_ids`. The number of probe ids in the array should be specified in `probe_count`. Use `tnfctl_probe_state_get()` to get the `probe_id` that corresponds to the `probe_hndl`.

RETURN VALUES  
`tnfctl_probe_apply()` and `tnfctl_probe_apply_ids()` return `TNFCTL_ERR_NONE` upon success.

ERRORS  
The following errors apply to both `tnfctl_probe_apply()` and `tnfctl_probe_apply_ids()`:

- `TNFCTL_ERR_INTERNAL`  
  An internal error occurred.
- `TNFCTL_ERR_USR1`  
  Error code reserved for user.
tnfctl_probe_apply(3TNF)

<table>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNFCTL_ERR_USR2</td>
<td>Error code reserved for user.</td>
</tr>
<tr>
<td>TNFCTL_ERR_USR3</td>
<td>Error code reserved for user.</td>
</tr>
<tr>
<td>TNFCTL_ERR_USR4</td>
<td>Error code reserved for user.</td>
</tr>
<tr>
<td>TNFCTL_ERR_USR5</td>
<td>Error code reserved for user.</td>
</tr>
</tbody>
</table>

tnfctl_probe_apply() and tnfctl_probe_apply_ids() also return any error returned by the callback function probe_op.

The following errors apply only to tnfctlProbe_apply_ids():

- **TNFCTL_ERR_INVALIDPROBE**
  - The probe handle is no longer valid. For example, the probe is in a library that has been closed by dlclose(3DL).

**EXAMPLES**

**EXAMPLE 1** Enabling Probes

To enable all probes:

```c
tnfctl_probe_apply(hndl, tnfctl_probe_enable, NULL);
```

**EXAMPLE 2** Disabling Probes

To disable the probes that match a certain pattern in the probe attribute string:

```c
/* To disable all probes that contain the string "vm" */
tnfctl_probe_apply(hndl, select_disable, "vm");
static tnfctl_errcode_t
select_disable(tnfctl_handle_t *hndl, tnfctl_probe_t *probe_hndl, void *client_data)
{
    char *pattern = client_data;
    tnfctl_probe_state_t probe_state;
    tnfctl_probe_state_get(hndl, probe_hndl, &probe_state);
    if (strstr(probe_state.attr_string, pattern)) {
        tnfctl_probe_disable(hndl, probe_hndl, NULL);
    }
}
```

Note that these examples do not have any error handling code.

**ATTRIBUTES**

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</table>
tnfctl_probe_apply(3TNF)

SEE ALSO  prex(1), TNF_PROBE(3TNF), dlclose(3DL), dlopen(3DL), libtnfctl(3TNF), 
          tnfctl_close(3TNF), tnfctl_probe_state_get(3TNF), tracing(3TNF), 
          tnf_kernel_probes(4), attributes(5)

Linker and Libraries Guide
tnfctl_probe_state_get(3TNF)

NAME  tnfctl_probe_state_get, tnfctl_probe_enable, tnfctl_probe_disable, tnfctl_probe_trace,
      tnfctl_probe_untrace, tnfctl_probe_connect, tnfctl_probe_disconnect_all – interfaces to
      query and to change the state of a probe

SYNOPSIS  ce [flag ...]file ... -lt nfctl [library ...]
#include <tnf/tnfctl.h>

tnfctl_errcode_t tnfctl_probe_state_get(tnfctl_handle_t *hndl,
                                          tnfctl_probe_t *probe_hndl, tnfctl_probe_state_t *state);

tnfctl_errcode_t tnfctl_probe_enable(tnfctl_handle_t *hndl,
                                     tnfctl_probe_t *probe_hndl, void *ignored);

tnfctl_errcode_t tnfctl_probe_disable(tnfctl_handle_t *hndl,
                                       tnfctl_probe_t *probe_hndl, void *ignored);

tnfctl_errcode_t tnfctl_probe_trace(tnfctl_handle_t *hndl,
                                     tnfctl_probe_t *probe_hndl, void *ignored);

tnfctl_errcode_t tnfctl_probe_untrace(tnfctl_handle_t *hndl,
                                      tnfctl_probe_t *probe_hndl, void *ignored);

tnfctl_errcode_t tnfctl_probe_disconnect_all(tnfctl_handle_t *hndl,
                                             tnfctl_probe_t *probe_hndl, void *ignored);

tnfctl_errcode_t tnfctl_probe_connect(tnfctl_handle_t *hndl,
                                      tnfctl_probe_t *probe_hndl, const char *lib_base_name, const char
                                      *func_name);

DESCRIPTION  tnfctl_probe_state_get() returns the state of the probe specified by probe_hndl
      in the process or kernel specified by hndl. The user will pass these in to an apply
      iterator. The caller must also allocate state and pass in a pointer to it. The semantics
      of the individual members of state are:

      id
      The unique integer assigned to this probe. This number
does not change over the lifetime of this probe. A
      probe_hndl can be obtained by using the calls
      tnfctl_apply(), tnfctl_apply_ids(), or
      tnfctl_register_funcs().

      attr_string
      A string that consists of attribute value pairs separated
      by semicolons. For the syntax of this string, see the
      syntax of the detail argument of the
      TNF_PROBE(3TNF) macro. The attributes name, slots,
      keys, file, and line are defined for every probe.
      Additional user-defined attributes can be added by
      using the detail argument of the TNF_PROBE(3TNF)
      macro. An example of attr_string follows:

      "name pageout;slots vnode pages_pageout;
       keys vm pageio io;file vm.c;line 25;"

      enabled
      B_TRUE if the probe is enabled, or B_FALSE if the
      probe is disabled. Probes are disabled by default. Use
tnfctl_probe_state_get(3TNF)

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnfctl_probe_enable() or tnfctl_probe_disable()</td>
<td>Changes the state of the probe.</td>
</tr>
<tr>
<td>traced</td>
<td>B_TRUE if the probe is traced, B_FALSE if not. Probes in user processes are traced by default. Kernel probes are untraced by default. Use tnfctl_probe_trace() or tnfctl_probe_untrace() to change this state.</td>
</tr>
<tr>
<td>new_probe</td>
<td>B_TRUE if this is a new probe brought in since the last change in libraries. Use tnfctl_probe_trace() or tnfctl_probe_untrace() to change this state.</td>
</tr>
<tr>
<td>obj_name</td>
<td>The name of the shared object or executable in which the probe is located. This string can be freed, so the client should make a copy of the string if it needs to be saved for use by other libtnfctl interfaces. In kernel mode, this string is always NULL.</td>
</tr>
<tr>
<td>func_names</td>
<td>A null-terminated array of pointers to strings that contain the names of functions connected to this probe. Whenever an enabled probe is encountered at runtime, these functions are executed. This array also will be freed by the library when the state of the probe changes. Use tnfctl_probe_connect() or tnfctl_probe_disconnect_all() to change this state.</td>
</tr>
<tr>
<td>func_addrs</td>
<td>A null-terminated array of pointers to addresses of functions in the target image connected to this probe. This array also will be freed by the library when the state of the probe changes.</td>
</tr>
<tr>
<td>client_registered_data</td>
<td>Data that was registered by the client for this probe by the creator function in tnfctl_register_funcs(3TNF).</td>
</tr>
</tbody>
</table>

tnfctl_probe_enable( ), tnfctl_probe_disable( ), tnfctl_probe_trace( ), tnfctl_probe_untrace( ), and tnfctl_probe_disconnect_all() ignore the last argument. This convenient feature permits these functions to be used in the probe_op field of tnfctl_probe_apply(3TNF) and tnfctl_probe_apply_ids(3TNF). tnfctl_probe_enable() enables the probe specified by probe_hndl. This is the master switch on a probe. A probe does not perform any action until it is enabled.

tnfctl_probe_disable() disables the probe specified by probe_hndl.
tnfctl_probe_state_get(3TNF)

<table>
<thead>
<tr>
<th>tnfctl_probe_trace() turns on tracing for the probe specified by probe_hndl. Probes emit a trace record only if the probe is traced.</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnfctl_probe_untrace() turns off tracing for the probe specified by probe_hndl. This is useful if you want to connect probe functions to a probe without tracing it.</td>
</tr>
<tr>
<td>tnfctl_probe_connect() connects the function func_name which exists in the library lib_base_name, to the probe specified by probe_hndl. tnfctl_probe_connect() returns an error code if used on a kernel tnfctl handle. lib_base_name is the base name (not a path) of the library. If it is NULL, and multiple functions in the target process match func_name, one of the matching functions is chosen arbitrarily. A probe function is a function that is in the target’s address space and is written to a certain specification. The specification is not currently published.</td>
</tr>
<tr>
<td>tnf_probe_debug() is one function exported by libtnfprobe.so.1 and is the debug function that prex(1) uses. When the debug function is executed, it prints out the probe arguments and the value of the sunw%debug attribute of the probe to stderr.</td>
</tr>
<tr>
<td>tnfctl_probe_disconnect_all() disconnects all probe functions from the probe specified by probe_hndl.</td>
</tr>
</tbody>
</table>

Note that no libtnfctl call returns a probe handle (tnfctl_probe_t), yet each of the routines described here takes a probe_hndl as an argument. These routines may be used by passing them to one of the tnfctl_probe_apply(3TNF) iterators as the "op" argument. Alternatively, probe handles may be obtained and saved by a user’s "op" function, and they can be passed later as the probe_hndl argument when using any of the functions described here.

RETURN VALUES

The following error codes apply to tnfctl_probe_state_get():

TNFCTL_ERR_INVALIDPROBE probe_hndl is no longer valid. The library that the probe was in could have been dynamically closed by dlclose(3DL).

The following error codes apply to tnfctl_probe_enable(), tnfctl_probe_disable(), tnfctl_probe_trace(), tnfctl_probe_untrace(), and tnfctl_probe_disconnect_all():

TNFCTL_ERR_INVALIDPROBE probe_hndl is no longer valid. The library that the probe was in could have been dynamically closed by dlclose(3DL).

TNFCTL_ERR_BUF BROKEN Cannot do probe operations because tracing is broken in the target.
Cannot do probe operations until a buffer is allocated. See tnfctl_buffer_alloc(3TNF). This error code does not apply to kernel probe control.

The following error codes apply to tnfctl_probe_connect():

- **TNFCTL_ERR_INVALIDPROBE**
  - `probe_hndl` is no longer valid. The library that the probe was in could have been dynamically closed by `dlclose(3DL)`.

- **TNFCTL_ERR_BADARG**
  - The handle is a kernel handle, or `func_name` could not be found.

- **TNFCTL_ERR_BUFBROKEN**
  - Cannot do probe operations because tracing is broken in the target.

- **TNFCTL_ERR_NOBUF**
  - Cannot do probe operations until a buffer is allocated. See tnfctl_buffer_alloc(3TNF).

**ATTRIBUTES**

See attributes(5) for description of the following attributes:

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<tr>
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<td>Availability</td>
<td>SUNWtnfc</td>
</tr>
<tr>
<td>MT Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

**SEE ALSO**

prex(1), TNF_PROBE(3TNF), libtnfctl(3TNF), tnfctl_check_libs(3TNF), tnfctl_continue(3TNF), tnfctl_probe_apply(3TNF), tnfctl_probe_apply_ids(3TNF), tracing(3TNF), tnf_kernel_probes(4), attributes(5)
The function `tnfctl_register_funcs()` is used to store client-specific data on a per-probe basis. It registers a creator and a destructor function with `hndl`, either of which can be NULL. The creator function is called for every probe that currently exists in `hndl`. Every time a new probe is discovered, that is brought in by `dlopen(3DL)`, `create_func` is called.

The return value of the creator function is stored as part of the probe state and can be retrieved by `tnfctl_probe_state_get(3TNF)` in the member field `client_registered_data`.

`destroy_func` is called for every probe handle that is freed. This does not necessarily happen at the time `dlclose(3DL)` frees the shared object. The probe handles are freed only when `hndl` is closed by `tnfctl_close(3TNF)`. If `tnfctl_register_funcs()` is called a second time for the same `hndl`, then the previously registered destructor function is called first for all of the probes.

`tnfctl_register_funcs()` returns `TNFCTL_ERR_NONE` upon success.

**ERRORS**

- `TNFCTL_ERR_INTERNAL` An internal error occurred.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

**SEE ALSO**

- `prex(1)`, `TNF_PROBE(3TNF)`, `dlclose(3DL)`, `dlopen(3DL)`, `libtnfctl(3TNF)`, `tnfctl_close(3TNF)`, `tnfctl_probe_state_get(3TNF)`, `tracing(3TNF)`, `tnf_kernel_probes(4)`, attributes(5)

*Linker and Libraries Guide*
tnfctl_strerror - map a tnfctl error code to a string

**SYNOPSIS**

c++ [ flag ... ] file ... -ltnfctl [ library ... ]
#include <tnf/tnfctl.h>

    const char * tnfctl_strerror(tnfctl_errcode_t errcode);

**DESCRIPTION**

`tnfctl_strerror()` maps the error number in `errcode` to an error message string, and it returns a pointer to that string. The returned string should not be overwritten or freed.

**ERRORS**

`tnfctl_strerror()` returns the string "unknown libtnfctl.so error code" if the error number is not within the legal range.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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</tbody>
</table>

**SEE ALSO**

`prex(1), TNF_PROBE(3TNF), libtnfctl(3TNF), tracing(3TNF), attributes(5)`
tnfctl_trace_attrs_get(3TNF)

NAME
  tnfctl_trace_attrs_get — get the trace attributes from a tnfctl handle

SYNOPSIS
  
  #include <tnf/tnfctl.h>

  tnfctl_errcode_t tnfctl_trace_attrs_get(tnfctl_handle_t *hndl,
                                          tnfctl_trace_attrs_t *attrs);

DESCRIPTION

  tnfctl_trace_attrs_get() returns the trace attributes associated with
  hndl in attrs. The trace attributes can be changed by some of the other
  interfaces in libtnfctl(3TNF). It is the client’s responsibility to use
  tnfctl_trace_attrs_get() to get the new trace attributes after use of
  interfaces that change them. Typically, a client will use
  tnfctl_trace_attrs_get() after a call to
  tnfctl_continue(3TNF) in order to make sure that tracing is still
  working. See the discussion of trace_buf_state that follows.

  Trace attributes are represented by the struct tnfctl_trace_attrs
  structure defined in <tnf/tnfctl.h>:

  struct tnfctl_trace_attrs {
    pid_t targ_pid; /* not kernel mode */
    const char *trace_file_name; /* not kernel mode */
    size_t trace_buf_size;
    size_t trace_min_size;
    tnfctl_bufstate_t trace_buf_state;
    boolean_t trace_state; /* kernel mode only */
    boolean_t filter_state; /* kernel mode only */
    long pad;
  };

  The semantics of the individual members of attrs are:

  targ_pid          The process id of the target process. This is not valid
                    for kernel tracing.

  trace_file_name   The name of the trace file to which the target writes.
                    trace_file_name will be NULL if no trace file exists
                    or if kernel tracing is implemented. This pointer
                    should not be used after calling other libtnfctl
                    interfaces. The client should copy this string if it
                    should be saved for the use of other libtnfctl
                    interfaces.

  trace_buf_size    The size of the trace buffer or file in bytes.

  trace_min_size    The minimum size in bytes of the trace buffer that can
                    be allocated by using the
                    tnfctl_buffer_alloc(3TNF) interface.

  trace_buf_state   The state of the trace buffer. Tnfctl_BUF_OK indicates
                    that a trace buffer has been allocated.
                    Tnfctl_BUF_NONE indicates that no buffer has been
                    allocated. Tnfctl_BUF_BROKEN indicates that there is
an internal error in the target for tracing. The target
will continue to run correctly, but no trace records will
be written. To fix tracing, restart the process. For kernel
tracing, deallocate the existing buffer with
tnfctl_buffer_dealloc(3TNF) and allocate a new
one with tnfctl_buffer_alloc(3TNF).

trace_state
The global tracing state of the target. Probes that are
enabled will not write out data unless this state is on.
This state is off by default for the kernel and can be
changed by tnfctl_trace_state_set(3TNF). For a
process, this state is on by default and can only be
changed by tnf_process_disable(3TNF) and
tnf_process_enable(3TNF).

filter_state
The state of process filtering. For kernel probe control,
it is possible to select a set of processes for which
probes are enabled. See
tnfctl_filter_list_get(3TNF),
tnfctl_filter_list_add(3TNF), and
tnfctl_filter_list_delete(3TNF). No trace
output will be written when other processes traverse
these probe points. By default process filtering is off,
and all processes cause the generation of trace records
when they hit an enabled probe. Use
tnfctl_filter_state_set(3TNF) to change the
filter state.

RETURN VALUES
tnfctl_trace_attrs_get() returns TNFCTL_ERR_NONE upon success.

ERRORS
The following error codes apply to tnfctl_trace_attrs_get()

TNFCTL_ERR_INTERNAL An internal error occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
prex(1), TNF_PROBE(3TNF), libtnfctl(3TNF), tnfctl_buffer_alloc(3TNF),
tnfctl_continue(3TNF), tnfctl_filter_list_get (3TNF),
tnf_process_disable(3TNF), tracing(3TNF), attributes(5)
The interfaces to control kernel tracing and process filtering are used only with kernel handles, handles created by `tnfctl_kernel_open(3TNF)`. These interfaces are used to change the tracing and filter states for kernel tracing.

`tnfctl_trace_state_set()` sets the kernel global tracing state to "on" if `trace_state` is `B_TRUE`, or to "off" if `trace_state` is `B_FALSE`. For the kernel, `trace_state` is off by default. Probes that are enabled will not write out data unless this state is on. Use `tnfctl_trace_attrs_get(3TNF)` to retrieve the current tracing state.

`tnfctl_filter_state_set()` sets the kernel process filtering state to "on" if `filter_state` is `B_TRUE`, or to "off" if `filter_state` is `B_FALSE`. `filter_state` is off by default. If it is on, only probe points encountered by processes in the process filter set by `tnfctl_filter_list_add()` will generate trace points. Use `tnfctl_trace_attrs_get(3TNF)` to retrieve the current process filtering state.

`tnfctl_filter_list_get()` returns the process filter list as an array in `pid_list`. The count of elements in the process filter list is returned in `pid_count`. The caller should use `free(3C)` to free memory allocated for the array `pid_list`.

`tnfctl_filter_list_add()` adds `pid_to_add` to the process filter list. The process filter list is maintained even when the process filtering state is off, but it has no effect unless the process filtering state is on.

`tnfctl_filter_list_delete()` deletes `pid_to_delete` from the process filter list. It returns an error if the process does not exist or is not in the filter list.

The interfaces `tnfctl_trace_state_set()`, `tnfctl_filter_state_set()`, `tnfctl_filter_list_add()`, `tnfctl_filter_list_delete()`, and `tnfctl_filter_list_get()` return `TNFCTL_ERR_NONE` upon success.

The following error codes apply to `tnfctl_trace_state_set`: 

538  man pages section 3: Extended Library Functions  •  Last Revised 4 Mar 1997
The following error codes apply to tnfctl_filter_state_set:

- **TNFCTL_ERR_BADARG**: The handle is not a kernel handle.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

The following error codes apply to tnfctl_filter_list_add:

- **TNFCTL_ERR_BADARG**: The handle is not a kernel handle.
- **TNFCTL_ERR_NOPROCESS**: No such process exists.
- **TNFCTL_ERR_ALLOCFAIL**: A memory allocation failure occurred.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

The following error codes apply to tnfctl_filter_list_delete:

- **TNFCTL_ERR_BADARG**: The handle is not a kernel handle.
- **TNFCTL_ERR_NOPROCESS**: No such process exists.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

The following error codes apply to tnfctl_filter_list_get:

- **TNFCTL_ERR_BADARG**: The handle is not a kernel handle.
- **TNFCTL_ERR_ALLOCFAIL**: A memory allocation failure occurred.
- **TNFCTL_ERR_INTERNAL**: An internal error occurred.

**ATTRIBUTES**

See attributes(5) for descriptions of the following attributes:

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<td>MT-Safe</td>
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</tbody>
</table>

**SEE ALSO**

prex(1), TNF_PROBE(3TNF), free(3C), libtnfctl(3TNF),
tnfctl_kernel_open(3TNF), tnfctl_trace_attrs_get (3TNF),
tracing(3TNF), tnf_kernel_probes(4), attributes(5)
TNF_DECLARE_RECORD(3TNF)

NAME

TNF_DECLARE_RECORD, TNF_DEFINE_RECORD_1, TNF_DEFINE_RECORD_2,
TNF_DEFINE_RECORD_3, TNF_DEFINE_RECORD_4, TNF_DEFINE_RECORD_5 –
TNF type extension interface for probes

SYNOPSIS

cc [ flag ... ] file ... [ -ltnfprobe ] [ library ... ]
#include <tnf/probe.h>

TNF_DECLARE_RECORD (c_type, tnf_type);

TNF_DEFINE_RECORD_1 (c_type, tnf_type, tnf_member_type_1, c_member_name_1);

TNF_DEFINE_RECORD_2 (c_type, tnf_type, tnf_member_type_1, c_member_name_1,
                      tnf_member_type_2, c_member_name_2);

TNF_DEFINE_RECORD_3 (c_type, tnf_type, tnf_member_type_1, c_member_name_1,
                      tnf_member_type_2, c_member_name_2, tnf_member_type_3,
                      c_member_name_3);

TNF_DEFINE_RECORD_4 (c_type, tnf_type, tnf_member_type_1, c_member_name_1,
                      tnf_member_type_2, c_member_name_2, tnf_member_type_3, c_member_name_3,
                      tnf_member_type_4, c_member_name_4);

TNF_DEFINE_RECORD_5 (c_type, tnf_type, tnf_member_type_1, c_member_name_1,
                      tnf_member_type_2, c_member_name_2, tnf_member_type_3, c_member_name_3,
                      tnf_member_type_4, c_member_name_4, tnf_member_type_5,
                      c_member_name_5);

DESCRIPTION

This macro interface is used to extend the TNF (Trace Normal Form) types that can be
used in TNF_PROBE(3TNF).

There should be only one TNF_DECLARE_RECORD and one TNF_DEFINE_RECORD per
new type being defined. The TNF_DECLARE_RECORD should precede the
TNF_DEFINE_RECORD. It can be in a header file that multiple source files share if
those source files need to use the tnf_type being defined. The TNF_DEFINE_RECORD
should only appear in one of the source files.

The TNF_DEFINE_RECORD macro interface defines a function as well as a couple of
data structures. Hence, this interface has to be used in a source file (.c or .cc file) at file
scope and not inside a function.

Note that there is no semicolon after the TNF_DEFINE_RECORD interface. Having one
will generate a compiler warning.

Compiling with the preprocessor option -DNPROBE (see cc(1B)), or with the
preprocessor control statement #define NPROBE ahead of the #include
<tnf/probe.h> statement, will stop the TNF type extension code from being
compiled into the program.

c_type

c_type must be a C struct type. It is the template from which the new tnf_type is being
created. Not all elements of the C struct need be provided in the TNF type being
defined.
tnf_type

*tnf_type* is the name being given to the newly created type. Use of this interface uses the name space prefixed by *tnf_type*. So, if a new type called "xxx_type" is defined by a library, then the library should not use "xxx_type" as a prefix in any other symbols it defines. The policy on managing the type name space is the same as managing any other name space in a library i.e., prefix any new TNF types by the unique prefix that the rest of the symbols in the library use. This would prevent name space collisions when linking multiple libraries that define new TNF types. For example, if a library libpalloc.so uses the prefix "pal" for all symbols it defines, then it should also use the prefix "pal" for all new TNF types being defined.

/*
* Note: name space prefixed by pal_tnf_header should not be used by this
* client anymore.
*/

EXAMPLE 1 Defining and using a TNF type.

This example shows how a new TNF type is defined and used in a probe. This code is assumed to be part of a fictitious library called "libpalloc.so" which uses the prefix "pal" for all it’s symbols.

```c
#include <tnf/probe.h>
typedef struct pal_header {
    long size;
    char * descriptor;
    struct pal_header *next;
} pal_header_t;
TNF_DECLARE_RECORD(pal_header_t, pal_tnf_header);
TNF_DEFINE_RECORD_2(pal_header_t, pal_tnf_header,
    tnf_long, size,
    tnf_string, descriptor)

void pal_free(pal_header_t *header_p)
{
    int state;
    TNF_PROBE_2(pal_free_start, "palloc pal_free",
        "sunw%debug entering pal_free",
        tnf_long, state_var, state,
        pal_tnf_header, header_var, header_p);
    ...
}
```

EXAMPLES

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

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<td>SUNWtnfd</td>
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</table>
TNF_DECLARE_RECORD(3TNF)

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<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  prex(1), tnfdump(1), TNF_PROBE(3TNF), tnf_process_disable(3TNF), attributes(5)

NOTES  It is possible to make a tnf_type definition be recursive or mutually recursive e.g. a structure that uses the "next" field to point to itself (a linked list). If such a structure is sent in to a TNF_PROBE(3TNF), then the entire linked list will be logged to the trace file (until the "next" field is NULL). But, if the list is circular, it will result in an infinite loop. To break the recursion, either don’t include the "next" field in the tnf_type, or define the type of the "next" member as tnf_opaque.
TNF_PROBE(3TNF)

NAME
TNF_PROBE, TNF_PROBE_0, TNF_PROBE_1, TNF_PROBE_2, TNF_PROBE_3, TNF_PROBE_4, TNF_PROBE_5, TNF_PROBE_0_DEBUG, TNF_PROBE_1_DEBUG, TNF_PROBE_2_DEBUG, TNF_PROBE_3_DEBUG, TNF_PROBE_4_DEBUG, TNF_PROBE_5_DEBUG, TNF_DEBUG

SYNOPSIS

This macro interface is used to insert probes into C or C++ code for tracing. See tracing(3TNF) for a discussion of the Solaris tracing architecture, including example source code that uses it.

You can place probes anywhere in C and C++ programs including .init sections, .fini sections, multi-threaded code, shared objects, and shared objects opened by dlopen(3DL). Use probes to generate trace data for performance analysis or to write debugging output to stderr. Probes are controlled at runtime by prex(1).
The trace data is logged to a trace file in Trace Normal Form (TNF). The interface for the user to specify the name and size of the trace file is described in prex(1). Think of the trace file as the least recently used circular buffer. Once the file has been filled, newer events will overwrite the older ones.

Use TNF_PROBE_0 through TNF_PROBE_5 to create production probes. These probes are compiled in by default. Developers are encouraged to embed such probes strategically, and to leave them compiled within production software. Such probes facilitate on-site analysis of the software.

Use TNF_PROBE_0_DEBUG through TNF_PROBE_5_DEBUG to create debug probes. These probes are compiled out by default. If you compile the program with the preprocessor option -DTNF_DEBUG (see cc(1B)), or with the preprocessor control statement #define TNF_DEBUG ahead of the #include <tnf/probe.h> statement, the debug probes will be compiled into the program. When compiled in, debug probes differ in only one way from the equivalent production probes. They contain an additional "debug" attribute which may be used to distinguish them from production probes at runtime, for example, when using prex(). Developers are encouraged to embed any number of probes for debugging purposes. Disabled probes have such a small runtime overhead that even large numbers of them do not make a significant impact.

If you compile with the preprocessor option -DNPROBE (see cc(1B)), or place the preprocessor control statement #define NPROBE ahead of the #include <tnf/probe.h> statement, no probes will be compiled into the program.

name The name of the probe should follow the syntax guidelines for identifiers in ANSI C. The use of name declares it, hence no separate declaration is necessary. This is a block scope declaration, so it does not affect the name space of the program.

keys keys is a string of space-separated keywords that specify the groups that the probe belongs to. Semicolons, single quotation marks, and the equal character (=) are not allowed in this string. If any of the groups are enabled, the probe is enabled. keys cannot be a variable. It must be a string constant.

detail detail is a string that consists of <attribute> <value> pairs that are each separated by a semicolon. The first word (up to the space) is considered to be the attribute and the rest of the string (up to the semicolon) is considered the value. Single quotation marks are used to denote a string value. Besides quotation marks, spaces separate multiple values. The value is optional. Although semicolons or single quotation marks generally are not allowed within either the attribute or the value, when text with embedded spaces is meant to denote a single value, use single quotes surrounding this text.

Use detail for one of two reasons. First, use detail to supply an attribute that a user can type into prex(1) to select probes. For example, if a user defines an attribute called color, then prex(1) can select probes based on the value of color. Second, use detail to
annotate a probe with a string that is written out to a trace file only once. prex(1) uses spaces to tokenize the value when searching for a match. Spaces around the semicolon delimiter are allowed. detail cannot be a variable; it must be a string constant. For example, the detail string:

```
"XYZ%debug 'entering function A'; XYZ%exception 'no file';
XYZ%func_entry; XYZ%color red blue"
```

consists of 4 units:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
<th>Values that prex matches on</th>
</tr>
</thead>
<tbody>
<tr>
<td>XYZ%debug</td>
<td>'entering function A'</td>
<td>'entering function A'</td>
</tr>
<tr>
<td>XYZ%exception</td>
<td>'no file'</td>
<td>'no file'</td>
</tr>
<tr>
<td>XYZ%func_entry</td>
<td>/.*/</td>
<td>(regular expression)</td>
</tr>
<tr>
<td>XYZ%color</td>
<td>red blue</td>
<td>red &lt;or&gt; blue</td>
</tr>
</tbody>
</table>

Attribute names must be prefixed by the vendor stock symbol followed by the ‘%’ character. This avoids conflicts in the attribute name space. All attributes that do not have a ‘%’ character are reserved. The following attributes are predefined:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Semantics</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>name of probe</td>
</tr>
<tr>
<td>keys</td>
<td>keys of the probe (value is space-separated tokens)</td>
</tr>
<tr>
<td>file</td>
<td>file name of the probe</td>
</tr>
<tr>
<td>line</td>
<td>line number of the probe</td>
</tr>
<tr>
<td>slots</td>
<td>slot names of the probe event (arg_name_n)</td>
</tr>
<tr>
<td>object</td>
<td>the executable or shared object that this probe is in.</td>
</tr>
<tr>
<td>debug</td>
<td>distinguishes debug probes from production probes</td>
</tr>
</tbody>
</table>

arg_type_n
This is the type of the nth argument. The following are predefined TNF types:

<table>
<thead>
<tr>
<th>tnf Type</th>
<th>Associated C type (and semantics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnf_int</td>
<td>int</td>
</tr>
</tbody>
</table>
TNF_PROBE(3TNF)

<table>
<thead>
<tr>
<th>tnf Type</th>
<th>Associated C type (and semantics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnf_uint</td>
<td>unsigned int</td>
</tr>
<tr>
<td>tnf_long</td>
<td>long</td>
</tr>
<tr>
<td>tnf_ulong</td>
<td>unsigned long</td>
</tr>
<tr>
<td>tnf_longlong</td>
<td>long long (if implemented in compilation system)</td>
</tr>
<tr>
<td>tnf_ulonglong</td>
<td>unsigned long long (if implemented in compilation system)</td>
</tr>
<tr>
<td>tnf_float</td>
<td>float</td>
</tr>
<tr>
<td>tnf_double</td>
<td>double</td>
</tr>
<tr>
<td>tnf_string</td>
<td>char *</td>
</tr>
<tr>
<td>tnfOpaque</td>
<td>void *</td>
</tr>
</tbody>
</table>

To define new TNF types that are records consisting of the predefined TNF types or references to other user defined types, use the interface specified in TNF_DECLARE_RECORD(3TNF).

arg_name_n
arg_name_n is the name that the user associates with the n
th argument. Do not place quotation marks around arg_name_n. Follow the syntax guidelines for identifiers in ANSI C. The string version of arg_name_n is stored for every probe and can be accessed as the attribute "slots".

arg_value_n
arg_value_n is evaluated to yield a value to be included in the trace file. A read access is done on any variables that are in mentioned in arg_value_n. In a multi-threaded program, it is the user’s responsibility to place locks around the TNF_PROBE macro if arg_value_n contains a variable that should be read protected.

EXAMPLES
EXAMPLE 1 tracing(3TNF).
See tracing(3TNF) for complete examples showing debug and production probes in source code.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</thead>
<tbody>
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<td>SUNWtnfd</td>
</tr>
<tr>
<td>MT Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>
SEE ALSO cc(1B), ld(1), prex(1), tnfdump(1), libthread(3THR), libtnfctl(3TNF),
TNF_DECLARE_RECORD(3TNF), dlopen(3DL), libtnfctl(3TNF),
tnf_process_disable(3TNF), tracing(3TNF), attributes(5)

NOTES If attaching to a running program with prex(1) to control the probes, compile the
program with -ltnfprobe or start the program with the environment variable
LD_PRELOAD set to libtnfprobe.so.1. See ld(1). If libtnfprobe is explicitly
linked into the program, it must be before libthread on the link line.
tnf_process_disable(3TNF)

NAME

tnf_process_disable, tnf_process_enable, tnf_thread_disable, tnf_thread_enable – probe control internal interface

SYNOPSIS

cc [ flag ... ] file ... -ltnfprobe [ library ... ]
#include <tnf/probe.h>

void tnf_process_disable(void);
void tnf_process_enable(void);
void tnf_thread_disable(void);
void tnf_thread_enable(void);

DESCRIPTION

There are three levels of granularity for controlling tracing and probe functions (called probing from here on) — probing for the entire process, a particular thread, and the probe itself can be disabled/enabled. The first two (process and thread) are controlled by this interface. The probe is controlled via the application prex(1).

tnf_process_disable() turns off probing for the process. The default process state is to have probing enabled. tnf_process_enable() turns on probing for the process.

tnf_thread_disable() turns off probing for the currently running thread. Threads are "born" or created with this state enabled. tnf_thread_enable() turns on probing for the currently running thread. If the program is a non-threaded program, these two thread interfaces disable or enable probing for the process.

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
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</tr>
<tr>
<td>MT-Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO

prex(1), tnfdump(1), TNF_DECLARE_RECORD(3TNF), TNF_PROBE(3TNF), attributes(5)

NOTES

A probe is considered enabled only if:

- prex(1) has enabled the probe AND
- the process has probing enabled — which is the default or could be set via tnf_process_enable() AND
- the thread that hits the probe has probing enabled — which is every thread’s default or could be set via tnf_thread_enable().
There is a run time cost associated with determining that the probe is disabled. To reduce the performance effect of probes, this cost should be minimized. The quickest way that a probe can be determined to be disabled is by the enable control that `prex(1)` uses. Therefore, to disable all the probes in a process use the `disable` command in `prex(1)` rather than `tnf_process_disable()`.

`tnf_process_disable()` and `tnf_process_enable()` should only be used to toggle probing based on some internal program condition. `tnf_thread_disable()` should be used to turn off probing for threads that are uninteresting.
tracing – overview of tnf tracing system

<table>
<thead>
<tr>
<th>NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>tnf tracing is a set of programs and API’s that can be used to present a high-level view of the performance of an executable, a library, or part of the kernel. tracing is used to analyze a program’s performance and identify the conditions that produced a bug.</td>
<td></td>
</tr>
</tbody>
</table>

The core elements of tracing are:

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNF_PROBE_*()</td>
<td>The TNF_PROBE_<em>() macros define &quot;probes&quot; to be placed in code which, when enabled and executed, cause information to be added to a trace file. See TNF_PROBE(3TNF). If there are insufficient TNF_PROBE_</em> macros to store all the data of interest for a probe, data may be grouped into records. See TNF_DECLARE_RECORD(3TNF).</td>
</tr>
<tr>
<td>prex</td>
<td>Displays and controls probes in running software. See prex(1).</td>
</tr>
<tr>
<td>kernel probes</td>
<td>A set of probes built into the Solaris kernel which capture information about system calls, multithreading, page faults, swapping, memory management, and I/O. You can use these probes to obtain detailed traces of kernel activity under your application workloads. See tnf_kernel_probes(4).</td>
</tr>
<tr>
<td>tnfextract</td>
<td>A program that extracts the trace data from the kernel’s in-memory buffer into a file. See tnfextract(1).</td>
</tr>
<tr>
<td>tnfdump</td>
<td>A program that displays the information from a trace file. See tnfdump(1).</td>
</tr>
<tr>
<td>libtnfctl</td>
<td>A library of interfaces that controls probes in a process. See libtnfctl(3TNF). prex(1) also utilizes this library. Other tools and processes use the libtnfctl interfaces to exercise fine control over their own probes.</td>
</tr>
<tr>
<td>tnf_process_enable()</td>
<td>A routine called by a process to turn on tracing and probe functions for the current process. See tnf_process_enable(3TNF).</td>
</tr>
<tr>
<td>tnf_process_disable()</td>
<td>A routine called by a process to turn off tracing and probe functions for the current process. See tnf_process_disable(3TNF).</td>
</tr>
<tr>
<td>tnf_thread_enable()</td>
<td>A routine called by a process to turn on tracing and probe functions for the currently running thread. See tnf_thread_enable(3TNF).</td>
</tr>
</tbody>
</table>
tnf_thread_disable()  A routine called by a process to turn off tracing and probe functions for the currently running thread. See tnf_thread_disable(3TNF).

EXAMPLES

EXAMPLE 1 Tracing a Process

The following function in some daemon process accepts job requests of various types, queueing them for later execution. There are two “debug probes” and one “production probe.” Note that probes which are intended for debugging will not be compiled into the final version of the code; however, production probes are compiled into the final product.

```c
#include <tnf/probe.h>

void work(long, char *);
enum work_request_type { READ, WRITE, ERASE, UPDATE };
static char *work_request_name[] = {"read", "write", "erase", "update"};
main( ) {
    long i;
    for (i = READ; i <= UPDATE; i++)
        work(i, work_request_name[i]);
}
void work(long request_type, char *request_name) {
    static long q_length;
    TNF_PROBE_2_DEBUG(work_start, "work",
        "XYZ%debug 'in function work'",
        tnf_long, request_type_arg, request_type,
        tnf_string, request_name_arg, request_name);
    /* assume work request is queued for later processing */
    q_length++;
    TNF_PROBE_1(work_queue, "work queue",
        "XYZ%work_load heavy",
        tnf_long, queue_length, q_length);
    TNF_PROBE_0_DEBUG(work_end, "work", "");
}
```

The production probe “work_queue,” which remains compiled in the code, will, when enabled, log the length of the work queue each time a request is received.

The debug probes “work_start” and “work_end,” which are compiled only during the development phase, track entry to and exit from the `work()` function and measure how much time is spent executing it. Additionally, the debug probe “work_start” logs
the value of the two incoming arguments request_type and request_name. The runtime overhead for disabled probes is low enough that one can liberally embed them in the code with little impact on performance.

For debugging, the developer would compile with -DTNF_DEBUG, run the program under control of prex(1), enable the probes of interest (in this case, all probes), continue the program until exit, and dump the trace file:

```
% cc
-DTNF_DEBUG -o daemon daemon.c # compile in all probes
% prex daemon # run program under prex control
Target process stopped
Type "continue" to resume the target, "help" for help ...
prex> list probes $all # list all probes in program
<probe list output here>
prex> enable $all # enable all probes
prex> continue # let target process execute
<program output here>
prex: target process finished
% ls /tmp/trace-* # trace output is in trace-<pid>
/tmp/trace-4194
% tnfdump /tmp/trace-4194 # get ascii output of trace file
<trace records output here>
```

For the production version of the system, the developer simply compiles without -DTNF_DEBUG.

**EXAMPLE 2 Tracing the Kernel**

Kernel tracing is similar to tracing a process; however, there are some differences. For instance, to trace the kernel, you need superuser privileges. The following example uses prex(1) and traces the probes in the kernel that capture system call information.

```
Allocate kernel
trace buffer and capture trace data:
root# prex -k
Type "help" for help ...
prex> buffer alloc 2m # allocate kernel trace buffer
Buffer of size 2097152 bytes allocated
prex> list probes $all # list all kernel probes
<probe list output here>
prex> list probes syscall # list syscall probes
# (keys=syscall)
<syscall probes list output here>
prex> enable syscall # enable only syscall probes
prex> ktrace on # turn on kernel tracing
<Run your application in another window at this point>
prex> ktrace off # turn off kernel tracing
prex> quit # exit prex
Extract the kernel's trace buffer into a file:
root# tnfxtract /tmp/ktrace # extract kernel trace buffer
Reset kernel tracing:
```
EXAMPLE 2 Tracing the Kernel  (Continued)

root# prex -k
prex> disable $all   # disable all probes
prex> untrace $all   # untrace all probes
prex> buffer dealloc  # deallocate kernel trace buffer
prex> quit

CAUTION: Do not deallocate the trace buffer until you have extracted it into a trace file. Otherwise, you will lose the trace data that you collected from your experiment!

Examine the kernel trace file:

root# tnfdump /tmp/ktrace  # get ascii dump of trace file
<trace records output here>

prex can also attach to a running process, list probes, and perform a variety of other tasks.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>SUNWtnfd</td>
</tr>
<tr>
<td>MT Level</td>
<td>MT-Safe</td>
</tr>
</tbody>
</table>

SEE ALSO  prex(1), tnfdump(1), tnfxtract(1), TNF_DECLARE_RECORD(3TNF),
           TNF_PROBE(3TNF), libtnfctl(3TNF), tnf_process_disable(3TNF),
           tnf_kernel_probes(4), attributes(5)
volmgt_acquire(3VOLMGT)

NAME
volmgt_acquire – reserve removable media device

SYNOPSIS
c [ flag ... ] file ... -lvolmgt [ library ... ]
#include <sys/types.h>
#include <volmgt.h>

int volmgt_acquire(char *dev, char *id, int ovr, char **err, pid_t *pidp);

DESCRIPTION
The volmgt_acquire() routine reserves the removable media device specified as dev. volmgt_acquire() operates in two different modes, depending on whether or not Volume Management is running. See vold(1M).

If Volume Management is running, volmgt_acquire() attempts to reserve the removable media device specified as dev. Specify dev as either a symbolic device name (for example, floppy0) or a physical device pathname (for example, /vol/dsk/unnamed_floppy).

If Volume Management is not running, volmgt_acquire() requires callers to specify a physical device pathname for dev. Specifying dev as a symbolic device name is not acceptable. In this mode, volmgt_acquire() relies entirely on the major and minor numbers of the device to determine whether or not the device is reserved.

If dev is free, volmgt_acquire() updates the internal device reservation database with the caller’s process id (pid) and the specified id string.

If dev is reserved by another process, the reservation attempt fails and volmgt_acquire():

- sets errno to EBUSY
- fills the caller’s id value in the array pointed to by err
- fills in the pid to which the pointer pidp points with the pid of the process which holds the reservation, if the supplied pidp is non-zero

If the override ovr is non-zero, the call overrides the device reservation.

RETURN VALUES
Upon successful completion, volmgt_acquire() returns a non-zero value.

Upon failure, volmgt_acquire() returns 0. If the return value is 0, and errno is set to EBUSY, the address pointed to by err contains the string that was specified as id (when the device was reserved by the process holding the reservation).

ERRORS
The volmgt_acquire() routine fails if one or more of the following are true:

EINVAL
One of the specified arguments is invalid or missing.

EBUSY
dev is already reserved by another process (and ovr was not set to a non-zero value)
EXAMPLE 1 Using volmgt_acquire()

In the following example, Volume Management is running and the first floppy drive is reserved, accessed and released.

```c
#include <volmgt.h>
char *errp;
if (!volmgt_acquire("floppy0", "FileMgr", 0, NULL, &errp, NULL)) {
    /* handle error case */
    ...
}
/* floppy acquired - now access it */
if (!volmgt_release("floppy0")) {
    /* handle error case */
    ...
}
```

EXAMPLE 2 Using volmgt_acquire() To Override A Lock On Another Process

The following example shows how callers can override a lock on another process using volmgt_acquire().

```c
char *errp, buf[20];
int override = 0;
pid_t pid;
if (!volmgt_acquire("floppy0", "FileMgr", 0, &errp, &pid)) {
    if (errno == EBUSY) {
        (void) printf("override %s (pid=%ld)?\n", errp, pid);
        (void) fgets(buf, 20, stdin);
        if (buf[0] == 'y') {
            override++;
        }
    } else {
        /* handle other errors */
    }
}
if (override) {
    if (!volmgt_acquire("floppy0", "FileMgr", 1, kerrp, NULL)) {
        /* really give up this time! */
    }
}
```

ATTRIBUTES

See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
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</tr>
</tbody>
</table>
volmgt_acquire(3VOLMGT)

SEE ALSO void(1M), free(3C), malloc(3C), volmgt_release(3VOLMGT), attributes(5)

NOTES When returning a string through err, volmgt_acquire() allocates a memory area using malloc(3C). Use free(3C) to release the memory area when no longer needed.

The ovr argument is intended to allow callers to override the current device reservation. It is assumed that the calling application has determined that the current reservation can safely be cleared. See EXAMPLES.
This routine asks Volume Management to check the specified `pathname` and determine if new media has been inserted in that drive.

If a null pointer is passed in, then Volume Management will check each device it is managing that can be checked.

If new media is found, `volmgt_check()` tells Volume Management to initiate any "actions" specified in `/etc/vold.conf` (see `vold.conf(4)`).

This routine returns 0 if no media was found, and a non-zero value if any media was found.

### Errors

This routine can fail, returning 0, if a `stat(2)` or `open(2)` of the supplied `pathname` fails, or if any of the following is true:

- **ENXIO** Volume Management is not running.
- **EINVAL** An interrupt signal was detected while checking for media.

### Examples

**Example 1 Checking If Any New Media Is Inserted**

To check if any drive managed by Volume Management has any new media inserted in it:

```c
#include <volmgt.h>

int volmgt_check(char *pathname);

if (volmgt_check(NULL)) {
    (void) printf("Volume Management found media\n");
}
```

This would also request Volume Management to take whatever action was specified in `/etc/vold.conf` for any media found.

### Attributes

See `attributes(5)` for descriptions of the following attributes:

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<thead>
<tr>
<th>ATTRIBUTE TYPE</th>
<th>ATTRIBUTE VALUE</th>
</tr>
</thead>
<tbody>
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<td>MT-Safe</td>
</tr>
</tbody>
</table>

### See Also

`cc(1B), volcheck(1), vold(1M), open(2), stat(2), volmgt_inuse(3VOLMGT), volmgt_running(3VOLMGT), vold.conf(4), attributes(5), volfs(7FS)`

### Notes

Volume Management must be running for this routine to work.
Since `volmgt_check()` returns 0 for two different cases (both when no media is found, and when an error occurs), it is up to the user to check `errno` to differentiate the two, and to ensure that Volume Management is running.
The `volmgt_feature_enabled()` routine checks whether specific Volume Management features are enabled. `volmgt_feature_enabled()` checks for the Volume Management features passed in to it by the `feat_str` parameter.

Currently, the only supported feature string that `volmgt_feature_enabled()` checks for is `floppy-summit-interfaces`. The `floppy-summit-interfaces` feature string checks for the presence of the `libvolmgt` routines `volmgt_acquire()` and `volmgt_release()`.

The list of features that `volmgt_feature_enabled()` checks for is expected to expand in the future.

0 is returned if the specified feature is not currently available. A non-zero value indicates that the specified feature is currently available.

**EXAMPLE 1** A sample of the `volmgt_feature_enabled()` function.

In the following example, `volmgt_feature_enabled()` checks whether the `floppy-summit-interfaces` feature is enabled.

```c
if (volmgt_feature_enabled("floppy-summit-interfaces")) {
    (void) printf("Media Sharing Routines ARE present\n");
} else {
    (void) printf("Media Sharing Routines are NOT present\n");
}
```

**ATTRIBUTES** See `attributes(5)` for descriptions of the following attributes:

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</table>

**SEE ALSO** `volmgt_acquire(3VOLMGT), volmgt_release(3VOLMGT), attributes(5)`
volmgt_inuse(3VOLMGT)

NAME
volmgt_inuse – check whether or not Volume Management is managing a pathname

SYNOPSIS
cc [ flag ... ] file ... -lvolmgt [ library ... ]
#include <volmgt.h>

int volmgt_inuse(char *pathname);

DESCRIPTION
volmgt_inuse() checks whether Volume Management is managing the specified pathname.

RETURN VALUES
A non-zero value is returned if Volume Management is managing the specified pathname, otherwise 0 is returned.

ERRORS
This routine can fail, returning 0, if a stat(2) of the supplied pathname or an open(2) of /dev/volctl fails, or if any of the following is true:

- ENXIO Volume Management is not running.
- EINTR An interrupt signal was detected while checking for the supplied pathname for use.

EXAMPLES
EXAMPLE 1 Using volmgt_inuse()

To see if Volume Management is managing the first floppy disk:

if (volmgt_inuse("/dev/rdiskette0") != 0) {
    (void) printf("volmgt is managing diskette 0\n");
} else {
    (void) printf("volmgt is NOT managing diskette 0\n");
}

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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<tr>
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<td>MT-Safe</td>
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</tbody>
</table>

SEE ALSO
cc(1B), vold(1M), open(2), stat(2), errno(3C), volmgt_check(3VOLMGT), volmgt_running(3VOLMGT), attributes(5), volfs(7FS)

NOTES
This routine requires Volume Management to be running.

Since volmgt_inuse() returns 0 for two different cases (both when a volume is not in use, and when an error occurs), it is up to the user to to check errno to differentiate the two, and to ensure that Volume Management is running.
NAME
volmgmt_ownspath – check Volume Management name space for path

SYNOPSIS
cc [flag ...] file ...-lvolgmt [library ...]

#include <volmgt.h>

int volmgmt_ownspath(char *path);

DESCRIPTION
volmgmt_ownspath() checks to see if a given path is contained in the Volume Management name space. This is achieved by comparing the beginning of the supplied path name with the output from volmgmt_root(3VOLMGT).

PARAMETERS path
A string containing the path.

RETURN VALUES
non-zero
The path is owned by Volume Management.

0
volmgmt() does not have path in its name space, or Volume Management is not running.

EXAMPLES
EXAMPLE 1 Using volmgmt_ownspath()

The following example first checks if volmgmt() is running, then checks the Volume Management name space for path, and then returns the id for the piece of media.

char *path;
...
if (volmgmt_running()) {
    if (volmgmt_ownspath(path)) {
        (void) printf("id of %s is %lld\n", path, media_getid(path));
    }
}

ATTRIBUTES
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<td>Safe</td>
</tr>
<tr>
<td>Commitment Level</td>
<td>Public</td>
</tr>
</tbody>
</table>

SEE ALSO
volmgmt_root(3VOLMGT), volmgmt_running(3VOLMGT) attributes(5)
volmgt_release(3VOLMGT)

NAME
volmgt_release – release removable media device reservation

SYNOPSIS
c [ flag ... ] file ... -l volmgt [ library ... ]
#include <volmgt.h>
int volmgt_release (char *dev);

DESCRIPTION
The volmgt_release() routine releases the removable media device reservation
specified as dev. See volmgt_acquire(3VOLMGT) for a description of dev.

If dev is reserved by the caller, volmgt_release() updates the internal device
reservation database to indicate that the device is no longer reserved. If the requested
device is reserved by another process, the release attempt fails and errno is set to 0.

RETURN VALUES
Upon successful completion, volmgt_release returns a non-zero value. Upon
failure, 0 is returned.

ERRORS
On failure, volmgt_release() returns 0, and sets errno for one of the following
conditions:
EINVAL        dev was invalid or missing.
EBUSY          dev was not reserved by the caller.

EXAMPLES
EXAMPLE 1 Using volmgt_release()

In the following example, Volume Management is running, and the first floppy drive
is reserved, accessed and released.

#include <volmgt.h>
char *errp;
if (!volmgt_acquire("floppy0", "FileMgr", 0, &errp,
        NULL)) { /* handle error case */
        ...}
/* floppy acquired - now access it */
if (!volmgt_release("floppy0")) { /* handle error case */
        ...}

ATTRIBUTES
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<td>MT-Safe</td>
</tr>
<tr>
<td>Interface Stability</td>
<td>Stable</td>
</tr>
</tbody>
</table>

SEE ALSO
vold(1M), volmgt_acquire(3VOLMGT), attributes(5)
volmgt_root — return the Volume Management root directory

SYNOPSIS

```c
#include <volmgt.h>

const char *volmgt_root(void);
```

DESCRIPTION

The `volmgt_root()` function returns the current Volume Management root directory, which by default is `/vol` but can be configured to be in a different location.

RETURN VALUES

The `volmgt_root()` function returns pointer to a static string containing the root directory for Volume Management.

ERRORS

This function may fail if an `open()` of `/dev/volctl` fails. If this occurs a pointer to the default Volume Management root directory is returned.

EXAMPLES

**EXAMPLE 1** Finding the Volume Management root directory.

To find out where the Volume Management root directory is:

```c
if ((path = volmgt_root()) != NULL) {
    (void) printf("Volume Management root dir=%s\n", path);
} else {
    (void) printf("can’t find Volume Management root dir\n");
}
```

FILES

`/vol` default location for the Volume Management root directory

ATTRIBUTES

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SEE ALSO

`cc(1B), vold(1M), open(2), volmgt_check(3VOLMGT), volmgt_inuse(3VOLMGT), volmgt_running(3VOLMGT), attributes(5), volfs(7FS)`

NOTES

This function returns the default root directory location even when Volume Management is not running.
volmgt_running(3VOLMGT)

NAME  volmgt_running - return whether or not Volume Management is running

SYNOPSIS  cc [ flag ... ] file ... -Ivolmgt [ library ... ]
#include <volmgt.h>

int volmgt_running(void);

DESCRIPTION  volmgt_running() tells whether or not Volume Management is running.

RETURN VALUES  A non-zero value is returned if Volume Management is running, else 0 is returned.

ERRORS  volmgt_running() will fail, returning 0, if a stat(2) or open(2) of /dev/volctl
fails, or if any of the following is true:

ENXIO    Volume Management is not running.
EINTR    An interrupt signal was detected while checking to see if Volume
         Management was running.

EXAMPLES  EXAMPLE 1 Using volmgt_running()
To see if Volume Management is running:

if (volmgt_running() != 0) {
    (void) printf("Volume Management is running\n");
} else {
    (void) printf("Volume Management is NOT running\n");
}

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  cc(1B), vold(1M), open(2), stat(2), volmgt_check(3VOLMGT),
           volmgt_inuse (3VOLMGT), attributes(5), volfs(7FS)

NOTES  Volume Management must be running for many of the Volume Management library
routines to work.
volmgt_symname, volmgt_symdev – convert between Volume Management symbolic names, and the devices that correspond to them

SYNOPSIS

```c
#include <volmgt.h>

char *volmgt_symname(char *pathname);
char *volmgt_symdev(char *symname);
```

DESCRIPTION

These two routines compliment each other, translating between Volume Management’s symbolic name for a device, called a symname, and the /dev pathname for that same device.

`volmgt_symname()` converts a supplied /dev pathname to a symname, Volume Management’s idea of that device’s symbolic name (see `volfs(7FS)` for a description of Volume Management symbolic names).

`volmgt_symdev()` does the opposite conversion, converting between a symname, Volume Management’s idea of a device’s symbolic name for a volume, to the /dev pathname for that device.

RETURN VALUES

`volmgt_symname()` returns the symbolic name for the device pathname supplied, and `volmgt_symdev()` returns the device pathname for the supplied symbolic name.

These strings are allocated upon success, and therefore must be freed by the caller when they are no longer needed (see `free(3C)`).

ERRORS

`volmgt_symname()` can fail, returning a null string pointer, if a `stat(2)` of the supplied pathname fails, or if an `open(2)` of /dev/volctl fails, or if any of the following is true:

- **ENXIO**: Volume Management is not running.
- **EINTR**: An interrupt signal was detected while trying to convert the supplied pathname to a symname.

`volmgt_symdev()` can fail if an `open(2)` of /dev/volctl fails, or if any of the following is true:

- **ENXIO**: Volume Management is not running.
- **EINTR**: An interrupt signal was detected while trying to convert the supplied symname to a /dev pathname.

EXAMPLES

**EXAMPLE 1** Testing Floppies

The following tests how many floppies Volume Management currently sees in floppy drives (up to 10):

```c
for (i=0; i < 10; i++) {
    (void) sprintf(path, "floppy%d", i);
    if (volmgt_symdev(path) != NULL) {
        (void) printf("volume %s is in drive %d
",...
```

Extended Library Functions  565
EXAMPLE 1 Testing Floppies (Continued)

    path, i);
    }
  }

EXAMPLE 2 Finding The Symbolic Name

This code finds out what symbolic name (if any) Volume Management has for /dev/rdsk/c0t6d0s2:

  if ((nm = volmgt_symname("/dev/rdsk/c0t6d0s2*)) == NULL) {
      (void) printf("path not managed
");
  } else {
      (void) printf("path managed as %s
", nm);
  }

ATTRIBUTES

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SEE ALSO

cc(1B), vold(1M), open(2), stat(2), free(3C), malloc(3C),
volmgt_check(3VOLMGT), volmgt_inuse(3VOLMGT),
volmgt_running(3VOLMGT), attributes(5), volfs(7FS)

NOTES

These routines only work when Volume Management is running.

BUGS

There should be a straightforward way to query Volume Management for a list of all media types it’s managing, and how many of each type are being managed.
wsreg_add_child_component(3WSREG)

NAME
wsreg_add_child_component, wsreg_remove_child_component,
wsreg_get_child_components – add or remove a child component

SYNOPSIS
cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_add_child_component(Wsreg_component *comp, const
Wsreg_component *childComp);

int wsreg_remove_child_component(Wsreg_component *comp, const
Wsreg_component *childComp);

Wsreg_component **wsreg_get_child_components(const
Wsreg_component *comp);

DESCRIPTION
The wsreg_add_child_component() function adds the component specified by
childComp to the list of child components contained in the component specified by
comp.

The wsreg_remove_child_component() function removes the component
specified by childComp from the list of child components contained in the component
specified by comp.

The wsreg_get_child_components() function returns the list of child
components contained in the component specified by comp.

RETURN VALUES
The wsreg_add_child_component() function returns a non-zero value if the
specified child component was successfully added; otherwise, 0 is returned.

The wsreg_remove_child_component() function returns a non-zero value if the
specified child component was successfully removed; otherwise, 0 is returned.

The wsreg_get_child_components() function returns a null-terminated array of
Wsreg_component pointers that represents the specified component’s list of child
components. If the specified component has no child components, NULL is returned.
The resulting array must be released by the caller through a call to
wsreg_free_component_array(). See wsreg_create_component(3WSREG).

USAGE
The parent-child relationship between components in the product install registry is
used to record a product’s structure. Product structure is the arrangement of features
and components that make up a product. The structure of installed products can be
displayed with the prodreg GUI.

The child component must be installed and registered before the parent component
can be. The registration of a parent component that has child components results in
each of the child components being updated to reflect their parent component.

Read access to the product install registry is required in order to use these functions
because these relationships are held with lightweight component references that can
only be fully resolved using the registry contents.
wsreg_add_child_component(3WSREG)

**ATTRIBUTES**  See attributes(5) for descriptions of the following attributes:

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**SEE ALSO**  prodreg(1M), wsreg_can_access_registry(3WSREG),
               wsreg_create_component(3WSREG), wsreg_initialize(3WSREG),
               wsreg_register(3WSREG), wsreg_set_parent(3WSREG), attributes(5)
wsreg_add_compatible_version(3WSREG)

NAME

wsreg_add_compatible_version, wsreg_remove_compatible_version,
wsreg_get_compatible_versions – add or remove a backward-compatible version

SYNOPSIS

cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_add_compatible_version(Wsreg_component *comp, const
char *version);

int wsreg_remove_compatible_version(Wsreg_component *comp, const
char *version);

char **wsreg_get_compatible_versions(const Wsreg_component
*comp);

DESCRIPTION

The wsreg_add_compatible_version() function adds the version string
specified by version to the list of backward-compatible versions contained in the
component specified by comp.

The wsreg_remove_compatible_version() function removes the version string
specified by version from the list of backward-compatible versions contained in the
component specified by comp.

The wsreg_get_compatible_versions() function returns the list of
backward-compatible versions contained in the component specified by comp.

RETURN VALUES

The wsreg_add_compatible_version() function returns a non-zero value if the
specified backward-compatible version was successfully added; otherwise, 0 is
returned.

The wsreg_remove_compatible_version() function returns a non-zero value if
the specified backward-compatible version was successfully removed; otherwise, 0 is
returned.

The wsreg_get_compatible_versions() function returns a null-terminated
array of char pointers that represents the specified component’s list of
backward-compatible versions. If the specified component has no such versions, NULL
is returned. The resulting array and its contents must be released by the caller.

USAGE

The list of backward compatible versions is used to allow components that are used by
multiple products to upgrade successfully without compromising any of its dependent
products. The installer that installs such an update can check the list of
backward-compatible versions and look at what versions are required by all of the
dependent components to ensure that the upgrade will not result in a broken product.

ATTRIBUTES

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</table>
wsreg_add_compatible_version(3WSREG)

SEE ALSO prodreg(1M), wsreg_initialize(3WSREG), wsreg_register(3WSREG),
wsreg_set_version(3WSREG), attributes(5)
The `wsreg_add_dependent_component()` function adds the component specified by `dependentComp` to the list of dependent components contained in the component specified by `comp`.

The `wsreg_remove_dependent_component()` function removes the component specified by `dependentComp` from the list of dependent components contained in the component specified by `comp`.

The `wsreg_get_dependent_components()` function returns the list of dependent components contained in the component specified by `comp`.

The `wsreg_add_dependent_component()` function returns a non-zero value if the specified dependent component was successfully added; otherwise, 0 is returned.

The `wsreg_remove_dependent_component()` function returns a non-zero value if the specified dependent component was successfully removed; otherwise, 0 is returned.

The `wsreg_get_dependent_components()` function returns a null-terminated array of `Wsreg_component` pointers that represents the specified component’s list of dependent components. If the specified component has no dependent components, `NULL` is returned. The resulting array must be released by the caller through a call to `wsreg_free_component_array()`. See `wsreg_create_component(3WSREG)`.

The relationship between two components in which one must be installed for the other to be complete is a dependent/required relationship. The component that is required by the other component is the required component. The component that requires the other is the dependent component.

The required component must be installed and registered before the dependent component can be. Uninstaller applications should check the registry before uninstalling and unregistering components so a successful uninstallation of one product will not result in another product being compromised.

Read access to the product install registry is required to use these functions because these relationships are held with lightweight component references that can only be fully resolved using the registry contents.
wsreg_add_dependent_component(3WSREG)

The act of registering a component having required components results in the converse dependent relationships being established automatically.

ATTRIBUTES

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SEE ALSO

wsreg_add_required_component(3WSREG),
wsreg_can_access_registry(3WSREG), wsreg_create_component(3WSREG),
wsreg_initialize(3WSREG), wsreg_register(3WSREG), attributes(5)
NAME
wsreg_add_display_name, wsreg_remove_display_name, wsreg_get_display_name,
wsreg_get_display_languages – add, remove, or return a localized display name

SYNOPSIS
cc [flag ...] file ... -lwsreg [library ...]
#include <wsreg.h>

int wsreg_add_display_name(Wsreg_component *comp, const char
  *language, const char *display_name);

int wsreg_remove_display_name(Wsreg_component *comp, const char
  *language);

char *wsreg_get_display_name(const Wsreg_component *comp, const
  char *language);

char **wsreg_get_display_languages(const Wsreg_component *comp);

DESCRIPTION
For each of these functions, the comp argument specifies the component on which
these functions operate. The language argument is the ISO 639 language code
identifying a particular display name associated with the specified component.

The wsreg_add_display_name() function adds the display name specified by
display_name to the component specified by comp.

The wsreg_remove_display_name() function removes a display name from the
component specified by comp.

The wsreg_get_display_name() function returns a display name from the
component specified by comp.

The wsreg_get_display_languages() returns the ISO 639 language codes for
which display names are available from the component specified by comp.

RETURN VALUES
The wsreg_add_display_name() function returns a non-zero value if the display
name was set correctly; otherwise 0 is returned.

The wsreg_remove_display_name() function returns a non-zero value if the
display name was removed; otherwise 0 is returned.

The wsreg_get_display_name() function returns the display name from the
specified component if the component has a display name for the specified language
code. Otherwise, NULL is returned. The caller must not free the resulting display
name.

The wsreg_get_display_languages() function returns a null-terminated array of
ISO 639 language codes for which display names have been set into the specified
component. If no display names have been set, NULL is returned. It is the caller’s
responsibility to release the resulting array, but not the contents of the array.
wsreg_add_display_name(3WSREG)

ATTRIBUTES
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SEE ALSO
wsreg_initialize(3WSREG), attributes(5)
The `wsreg_add_required_component()` function adds the component specified by `requiredComp` to the list of required components contained in the component specified by `comp`.

The `wsreg_remove_required_component()` function removes the component specified by `requiredComp` from the list of required components contained in the component specified by `comp`.

The `wsreg_get_required_components()` function returns the list of required components contained in the component specified by `comp`.

The `wsreg_add_required_component()` function returns a non-zero value if the specified required component was successfully added. Otherwise, 0 is returned.

The `wsreg_remove_required_component()` function returns a non-zero value if the specified required component was successfully removed. Otherwise, 0 is returned.

The `wsreg_get_required_components()` function returns a null-terminated array of `Wsreg_component` pointers that represents the specified component's list of required components. If the specified component has no required components, NULL is returned. The resulting array must be released by the caller through a call to `wsreg_free_component_array()`. See `wsreg_create_component(3WSREG)`.

The relationship between two components in which one must be installed for the other to be complete is a dependent/required relationship. The component that is required by the other component is the required component. The component that requires the other is the dependent component.

The required component must be installed and registered before the dependent component can be. Uninstaller applications should check the registry before uninstalling and unregistering components so a successful uninstallation of one product will not result in another product being compromised.

Read access to the product install registry is required in order to use these functions because these relationships are held with lightweight component references that can only be fully resolved using the registry contents.
wsreg_add_required_component(3WSREG)

ATTRIBUTES
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SEE ALSO
wsreg_add_dependent_component(3WSREG),
wsreg_can_access_registry(3WSREG), wsreg_create_component(3WSREG),
wsreg_initialize(3WSREG), wsreg_register(3WSREG), attributes(5)
The `wsreg_can_access_registry()` function is used to determine what access, if any, an application has to the product install registry.

The `access_flag` argument can be one of the following:

- `O_RDONLY` Inquire about read only access to the registry.
- `O_RDWR` Inquire about modify (read and write) access to the registry.

The `wsreg_can_access_registry()` function returns non-zero if the specified access level is permitted. A return value of 0 indicates the specified access level is not permitted.

**EXAMPLE 1** Initialize the registry and determine if access to the registry is permitted.

```c
#include <fcntl.h>
#include <wsreg.h>

int main(int argc, char **argv)
{
    int result;
    if (wsreg_initialize(WSREG_INIT_NORMAL, NULL)) {
        printf("conversion recommended, sufficient access denied\n");
    }

    if (wsreg_can_access_registry(O_RDONLY)) {
        printf("registry read access granted\n");
    } else {
        printf("registry read access denied\n");
    }

    if (wsreg_can_access_registry(O_RDWR)) {
        printf("registry read/write access granted\n");
    } else {
        printf("registry read/write access denied\n");
    }
}
```

**USAGE** The `wsreg_initialize(3WSREG)` function must be called before calls to `wsreg_can_access_registry()` can be made.

**ATTRIBUTES** See attributes(5) for descriptions of the following attributes:
wsreg_can_access_registry(3WSREG)

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SEE ALSO

wsreg_initialize(3WSREG), attributes(5)
wsreg_clone_component(3WSREG)

NAME
wsreg_clone_component – clone a component

SYNOPSIS
cc [flag...] file ...-lwsreg [library...]
#include <wsreg.h>

Wsreg_component *wsreg_clone_component(const Wsreg_component *comp);

DESCRIPTION
The wsreg_clone_component() function clones the component specified by comp.

RETURN VALUES
The wsreg_clone_component() returns a pointer to a component that is configured exactly the same as the component specified by comp.

USAGE
The resulting component must be released through a call to wsreg_free_component() by the caller. See wsreg_create_component(3WSREG).

ATTRIBUTES
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SEE ALSO
wsreg_create_component(3WSREG), wsreg_initialize(3WSREG), wsreg_get(3WSREG), attributes(5)
wsreg_components_equal(3WSREG)

NAME  
wsreg_components_equal – determine equality of two components

SYNOPSIS  
cc [flag ...]  file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_components_equal(const Wsreg_component *comp1, const
Wsreg_component *comp2);

DESCRIPTION  
The wsreg_components_equal() function determines if the component specified
by the comp1 argument is equal to the component specified by the comp2 argument.
Equality is evaluated based only on the content of the two components, not the order
in which data was set into the components.

RETURN VALUES  
The wsreg_components_equal() function returns a non-zero value if the
component specified by the comp1 argument is equal to the component specified by
the comp2 argument. Otherwise, 0 is returned.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

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SEE ALSO  
wsreg_clone_component(3WSREG), wsreg_create_component(3WSREG),
wsreg_initialize(3WSREG), attributes(5)
NAME
wsreg_create_component, wsreg_free_component, wsreg_free_component_array – create or release a component

SYNOPSIS
cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>
Wsreg_component *wsreg_create_component(const char *uuid);
void wsreg_free_component(Wsreg_component *comp);
int wsreg_free_component_array(Wsreg_component **complist);

DESCRIPTION
The wsreg_create_component() function allocates a new component and assigns the uuid (universal unique identifier) specified by uuid to the resulting component.

The wsreg_free_component() function releases the memory associated with the component specified by comp.

The wsreg_free_component_array() function frees the null-terminated array of component pointers specified by complist. This function can be used to free the results of a call to wsreg_get_all(). See wsreg_get(3WSREG).

RETURN VALUES
The wsreg_create_component() function returns a pointer to the newly allocated Wsreg_component structure.

The wsreg_free_component_array() function returns a non-zero value if the specified Wsreg_component array was freed successfully. Otherwise, 0 is returned.

USAGE
A minimal registerable Wsreg_component configuration must include a version, unique name, display name, and an install location.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>MT-Level</td>
<td>Unsafe</td>
</tr>
</tbody>
</table>

SEE ALSO
wsreg_add_display_name(3WSREG), wsreg_get(3WSREG),
wsreg_initialize(3WSREG), wsreg_register(3WSREG),
wsreg_set_id(3WSREG), wsreg_set_location(3WSREG),
wsreg_set_unique_name(3WSREG), wsreg_set_version(3WSREG),
attributes(5)
wsreg_get(3WSREG)

NAME
wsreg_get, wsreg_get_all – query product install registry

SYNOPSIS
cc [flag...] file ... -lwsreg [library ...]
#include <wsreg.h>
Wsreg_component *wsreg_get(const Wsreg_query *query);
Wsreg_component **wsreg_get_all(void);

DESCRIPTION
The wsreg_get() function queries the product install registry for a component that
matches the query specified by query.

The wsreg_get_all() function returns all components currently registered in the
product install registry.

RETURN VALUES
The wsreg_get() function returns a pointer to a Wsreg_component structure
representing the registered component. If no component matching the specified query
is currently registered, wsreg_get() returns NULL.

The wsreg_get_all() function returns a null-terminated array of
Wsreg_component pointers. Each element in the resulting array represents one
registered component.

USAGE
The wsreg library must be initialized by a call to wsreg_initialize(3WSREG)
before any call to wsreg_get() or wsreg_get_all().

The Wsreg_component pointer returned from wsreg_get() should be released
through a call to wsreg_free_component(). See
wsreg_create_component(3WSREG).

The Wsreg_component pointer array returned from wsreg_get_all() should be
released through a call to wsreg_free_component_array(). See
wsreg_create_component(3WSREG).

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO
wsreg_create_component(3WSREG), wsreg_initialize(3WSREG),
wsreg_register(3WSREG), attributes(5)
The `wsreg_initialize()` function initializes the `wsreg` library.

The `level` argument can be one of the following:

- `WSREG_INIT_NORMAL`: If an old registry file is present, attempt to perform a conversion.
- `WSREG_INIT_NO_CONVERSION`: If an old conversion file is present, do not perform the conversion, but indicate that the conversion is recommended.

The `alternate_root` argument can be used to specify a root prefix. If `NULL` is specified, no root prefix is used.

The `wsreg_initialize()` function can return one of the following:

- `WSREG_SUCCESS`: The initialization was successful and no registry conversion is necessary.
- `WSREG_CONVERSION_RECOMMENDED`: An old registry file exists and should be converted.

A conversion is attempted if the `init_level` argument is `WSREG_INIT_NORMAL` and a registry file from a previous version of the product install registry exists. If the `wsreg_initialize()` function returns `WSREG_CONVERSION_RECOMMENDED`, the user either does not have permission to update the product install registry or does not have read/write access to the previous registry file.

The `wsreg_initialize()` function must be called before any other `wsreg` library functions.

The registry conversion can take some time to complete. The registry conversion can also be performed using the graphical registry viewer `/usr/bin/prodreg` or by the registry converter `/usr/bin/regconvert`.

See `attributes(5)` for descriptions of the following attributes:

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**See also**

`prodreg(1M), wsreg_can_access_registry(3WSREG), attributes(5)`
wsreg_query_create(3WSREG)

NAME
    wsreg_query_create, wsreg_query_free – create a new query

SYNOPSIS
    cc [flag...] file ...-lwsreg [library...]
    #include <wsreg.h>

    Wsreg_query *wsreg_query_create(void);
    void wsreg_query_free(Wsreg_query *query);

DESCRIPTION
    The wsreg_query_create() function allocates a new query that can retrieve
    components from the product install registry.

    The wsreg_query_free() function releases the memory associated with the query
    specified by query.

RETURN VALUES
    The wsreg_query_create() function returns a pointer to the newly allocated
    query. The resulting query is completely empty and must be filled in to describe the
    desired component.

USAGE
    The query identifies fields used to search for a specific component in the product
    install registry. The query must be configured and then passed to the
    wsreg_get(3WSREG) function to perform the registry query.

ATTRIBUTES
    See attributes(5) for descriptions of the following attributes:

    +---------------------------------+-----------------
    | ATTRIBUTE TYPE | ATTRIBUTE VALUE |
    |----------------|-----------------|
    | MT-Level       | Unsafe          |

SEE ALSO
    wsreg_get(3WSREG), wsreg_initialize(3WSREG),
    wsreg_query_set_id(3WSREG), wsreg_query_set_instance(3WSREG),
    wsreg_query_set_location(3WSREG),
    wsreg_query_set_unique_name(3WSREG),
    wsreg_query_set_version(3WSREG), wsreg_unregister(3WSREG),
    attributes(5)
wsreg_query_set_id(3WSREG)

NAME  wsreg_query_set_id, wsreg_query_get_id – set or get the uuid of a query

SYNOPSIS  cc [flag ...] file ...-lwsreg [library ...]
            #include <wsreg.h>

            int wsreg_query_set_id(Wsreg_query *query, const char *uuid);
            char *wsreg_query_get_id(const Wsreg_query *query);

DESCRIPTION  The wsreg_query_set_id() function sets the uuid (universal unique identifier) specified by uuid in the query specified by query. If a uuid has already been set in the specified query, the resources associated with the previously set uuid are released.

            The wsreg_query_get_id() function returns the uuid associated with the query specified by query. The resulting string is not a copy and must not be released by the caller.

RETURN VALUES  The wsreg_query_set_id() function returns non-zero if the uuid was set correctly; otherwise 0 is returned.

            The wsreg_query_get_id() function returns the uuid associated with the specified query.

USAGE  The query identifies fields used to search for a specific component in the product install registry. By specifying the uuid, the component search is narrowed to all components in the product install registry that have the specified uuid.

            Other fields can be specified in the same query to further narrow the search.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  wsreg_get(3WSREG), wsreg_initialize(3WSREG),
towsreg_query_create(3WSREG), attributes(5)
wsreg_query_set_instance(3WSREG)

NAME  wsreg_query_set_instance, wsreg_query_get_instance – set or get the instance of a query

SYNOPSIS  
cc [flag...] file ...-lwsreg [library...]
#include <wsreg.h>

int wsreg_query_set_instance(Wsreg_query *query, int instance);
int wsreg_query_get_instance(Wsreg_query *comp);

DESCRIPTION  The wsreg_query_set_instance() function sets the instance number specified by instance in the query specified by query.

The wsreg_query_get_instance() function retrieves the instance from the query specified by query.

RETURN VALUES  The wsreg_query_set_instance() function returns a non-zero value if the instance was set correctly; otherwise 0 is returned.

The wsreg_query_get_instance() function returns the instance number from the specified query. It returns 0 if the instance number has not been set.

USAGE  The query identifies fields used to search for a specific component in the product install registry. By specifying the instance, the component search is narrowed to all components in the product install registry that have the specified instance.

Other fields can be specified in the same query to further narrow down the search.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  wsreg_get(3WSREG), wsreg_initialize(3WSREG), wsreg_query_create(3WSREG), attributes(5)
NAME

wsreg_query_set_location, wsreg_query_get_location – set or get the location of a query

SYNOPSIS

cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_query_set_location(Wsreg_query *query, const char *location);

char *wsreg_query_get_location(Wsreg_query *query);

DESCRIPTION

The wsreg_query_set_location() function sets the location specified by location in the query specified by query. If a location has already been set in the specified query, the resources associated with the previously set location are released.

The wsreg_query_get_location() function gets the location string from the query specified by query.

RETURN VALUES

The wsreg_query_set_location() function returns a non-zero value if the location was set correctly; otherwise 0 is returned.

The wsreg_query_get_location() function returns the location from the specified query structure. The resulting location string is not a copy, so it must not be released by the caller.

USAGE

The query identifies fields used to search for a specific component in the product install registry. By specifying the install location, the component search is narrowed to all components in the product install registry that are installed in the same location.

Other fields can be specified in the same query to further narrow the search.

ATTRIBUTES

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SEE ALSO

wsreg_get(3WSREG), wsreg_initialize(3WSREG), wsreg_query_create(3WSREG), attributes(5)
wsreg_query_set_unique_name(3WSREG)

NAME
wsreg_query_set_unique_name, wsreg_query_get_unique_name – set or get the unique name of a query

SYNOPSIS
cc [flag...] file ...-1wsreg [library...]
#include <wsreg.h>

int wsreg_query_set_unique_name(Wsreg_query *query, const char *unique_name);

char *wsreg_query_get_unique_name(const Wsreg_query *query);

DESCRIPTION
The wsreg_query_set_unique_name() function sets the unique name specified by unique_name in the query specified by query. If a unique name has already been set in the specified query, the resources associated with the previously set unique name are released.

The wsreg_query_get_unique_name() function gets the unique name string from the query specified by query. The resulting string is not a copy and must not be released by the caller.

RETURN VALUES
The wsreg_query_set_unique_name() function returns a non-zero value if the unique_name was set correctly; otherwise 0 is returned.

The wsreg_query_get_unique_name() function returns a copy of the unique_name from the specified query.

USAGE
The query identifies fields used to search for a specific component in the product install registry. By specifying the unique name, the component search is narrowed to all components in the product install registry that have the specified unique name.

Other fields can be specified in the same query to further narrow the search.

ATTRIBUTES
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SEE ALSO
wsreg_get(3WSREG), wsreg_initialize(3WSREG), wsreg_query_create(3WSREG), attributes(5)
NAME
wsreg_query_set_version, wsreg_query_get_version – set or get the version of a query

SYNOPSIS
cc [flag ...] file ... -lwsreg [library ...]
#include <wsreg.h>

int wsreg_query_set_version(Wsreg_query *query, const char *version);

char *wsreg_query_get_version(const Wsreg_query *query);

DESCRIPTION
The wsreg_query_set_version() function sets the version specified by version in the query specified by query. If a version has already been set in the specified query, the resources associated with the previously set version are released.

The wsreg_query_get_version() function gets the version string from the query specified by query. The resulting string is not a copy and must not be released by the caller.

RETURN VALUES
The wsreg_query_set_version() function returns a non-zero value if the version was set correctly; otherwise 0 is returned.

The wsreg_query_get_version() function returns the version from the specified query. If no version has been set, NULL is returned. The resulting version string is not a copy and must not be released by the caller.

USAGE
The query identifies fields used to search for a specific component in the product install registry. By specifying the version, the component search is narrowed to all components in the product install registry that have the specified version.

Other fields can be specified in the same query to further narrow the search.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
wsreg_get(3WSREG), wsreg_initialize(3WSREG),
wreg_query_create(3WSREG), attributes(5)
wsreg_register() Function

NAME
wsreg_register – register a component in the product install registry

SYNOPSIS
cc [flag ...] file ...-lwsreg [library...]
#include <wsreg.h>

int wsreg_register(Wsreg_component *comp);

DESCRIPTION
The wsreg_register() function updates a component in the product install registry.

If comp is already in the product install registry, the call to wsreg_register() results in the currently registered component being updated. Otherwise, comp is added to the product install registry.

An instance is assigned to the component upon registration. Subsequent component updates retain the same component instance.

If comp has required components, each required component is updated to reflect the required component relationship.

If comp has child components, each child component that does not already have a parent is updated to reflect specified component as its parent.

RETURN VALUES
Upon successful completion, a non-zero value is returned. If the component could not be updated in the product install registry, 0 is returned.

EXAMPLES
EXAMPLE 1 Create and register a component.

The following example creates and registers a component.

#include <wsreg.h>

int main (int argc, char **argv)
{
    char *uuid = "d6cf2869-1dd1-11b2-9fcb-080020b69971";
    Wsreg_component *comp = NULL;
    /* Initialize the registry */
    wsreg_initialize(WSREG_INIT_NORMAL, NULL);
    /* Create the component */
    comp = wsreg_create_component(uuid);
    wsreg_set_unique_name(comp, "wsreg_example_1");
    wsreg_set_version(comp, "1.0");
    wsreg_add_display_name(comp, "en", "Example 1 component");
    wsreg_set_type(comp, WSREG_COMPONENT);
    wsreg_set_location(comp, "/usr/local/example1_component");
    /* Register the component */
    wsreg_register(comp);
    wsreg_free_component(comp);
    return 0;
}
A product’s structure can be recorded in the product install registry by registering a component for each element and container in the product definition. The product and each of its features would be registered in the same way as a package that represents installed files.

Components should be registered only after they are successfully installed. If an entire product is being registered, the product should be registered after all components and features are installed and registered.

In order to register correctly, the component must be given a uuid, unique name, version, display name, and a location. The location assigned to product structure components should generally be the location in which the user chose to install the product.

**ATTRIBUTES**  
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**SEE ALSO**  
wsreg_get(3WSREG), wsreg_init(3WSREG),  
wsreg_create_component(3WSREG), wsreg_unregister(3WSREG), attributes(5)
wsreg_set_data(3WSREG)

NAME  wsreg_set_data, wsreg_get_data, wsreg_get_data_pairs – add or retrieve a key-value pair

SYNOPSIS  cc [flag...] file ...-lwsreg [library...]
#include <wsreg.h>

int wsreg_set_data(Wsreg_component *comp, const char *key, const char *value);
char *wsreg_get_data(const Wsreg_component *comp, const char *key);
char *wsreg_get_data_pairs(const Wsreg_component *comp);

DESCRIPTION  The wsreg_set_data() function adds the key-value pair specified by key and value to the component specified by comp. If value is NULL, the key and current value is removed from the specified component.

The wsreg_get_data() function retrieves the value associated with the key specified by key from the component specified by comp.

The wsreg_get_data_pairs() function returns the list of key-value pairs from the component specified by comp.

RETURN VALUES  The wsreg_set_data() function returns a non-zero value if the specified key-value pair was successfully added. It returns 0 if the addition failed. If NULL is passed as the value, the current key-value pair are removed from the specified component.

The wsreg_get_data() function returns the value associated with the specified key. It returns NULL if there is no value associated with the specified key. The char pointer that is returned is not a clone, so it must not be freed by the caller.

The wsreg_get_data_pairs() function returns a null-terminated array of char pointers that represents the specified component’s list of data pairs. The even indexes of the resulting array represent the key names. The odd indexes of the array represent the values. If the specified component has no data pairs, NULL is returned. The resulting array (not its contents) must be released by the caller.

USAGE  Any string data can be associated with a component. Because this information can be viewed in the prodreg registry viewer, it is a good place to store support contact information.

After the data pairs are added or removed, the component must be updated with a call to wsreg_register(3WSREG) for the modifications to be persistent.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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592  man pages section 3: Extended Library Functions • Last Revised 22 Sep 2000
SEE ALSO prodreg(1M), wsreg_initialize(3WSREG), wsreg_register(3WSREG), attributes(5)
wsreg_set_id(3WSREG)

NAME  
wsreg_set_id, wsreg_get_id – set or get the uuid of a component

SYNOPSIS  
cc [flag...] file ...-lwsreg [library...]
#include <wsreg.h>

int wsreg_set_id(Wsreg_component *comp, const char *uuid);
char *wsreg_get_id(const Wsreg_component *comp);

DESCRIPTION  
The wsreg_set_id() function sets the uuid (universal unique identifier) specified by uuid into the component specified by comp. If a uuid has already been set into the specified component, the resources associated with the previously set uuid are released.

The wsreg_set_id() function returns non-zero if the uuid was set correctly; otherwise 0 is returned.

The wsreg_get_id() function returns a copy of the uuid of the component specified by comp. The resulting string must be released by the caller.

RETURN VALUES  
The wsreg_set_id() function returns non-zero if the uuid was set correctly; otherwise 0 is returned.

The wsreg_get_id() function returns a copy of the specified component’s uuid.

USAGE  
Generally, the uuid will be set into a component by the wsreg_create_component(3WSREG) function, so a call to the wsreg_set_id() is not necessary.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

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SEE ALSO  
wsreg_create_component(3WSREG), wsreg_initialize(3WSREG), attributes(5)
wsreg_set_instance(3WSREG)

NAME
wsreg_set_instance, wsreg_get_instance – set or get the instance of a component

SYNOPSIS
cc [flag ...] file ...-lwreg [library ...]
#include <wsreg.h>

int wsreg_set_instance(Wsreg_component *comp, int instance);
int wsreg_get_instance(Wsreg_component *comp);

DESCRIPTION
The wsreg_set_instance() function sets the instance number specified by instance of the component specified by comp. The instance number and uuid are used to uniquely identify any component in the product install registry.

The wsreg_get_instance() function determines the instance number associated with the component specified by comp.

RETURN VALUES
The wsreg_set_instance() function returns a non-zero value if the instance was set correctly; otherwise 0 is returned.

The wsreg_get_instance() function returns the instance number associated with the specified component.

EXAMPLES
EXAMPLE 1 Get the instance value of a registered component.

The following example demonstrates how to get the instance value of a registered component.

#include <fcntl.h>
#include <wsreg.h>

int main (int argc, char **argv)
{
    char *uuid = "d6cf2869-1dd1-11b2-9fcb-080020b69971";
    Wsreg_component *comp = NULL;

    /* Initialize the registry */
    wsreg_initialize(WSREG_INIT_NORMAL, NULL);
    if (!wsreg_can_access_registry(O_RDWR)) {
        printf("No permission to modify the registry.\n");
        return 1;
    }

    /* Create a component */
    comp = wsreg_create_component(uuid);
    wsreg_set_unique_name(comp, "wsreg_example_1");
    wsreg_set_version(comp, "1.0");
    wsreg_add_display_name(comp, "en", "Example 1 component");
    wsreg_set_type(comp, WSREG_COMPONENT);
    wsreg_set_location(comp, "/usr/local/example1_component");

    /* Register */
    wsreg_register(comp);

    printf("Instance %d was assigned\n", wsreg_get_instance(comp));
}
wsreg_set_instance(3WSREG)

EXAMPLE 1 Get the instance value of a registered component.  

    wsreg_free_component(comp);
    return 0;

Upon component registration with the wsreg_register(3WSREG) function, the 
instance number is set automatically. The instance number of 0 (the default) indicates 
to the wsreg_register() function that an instance number should be looked up 
and assigned during registration. If a component with the same uuid and location is 
already registered in the product install registry, that component’s instance number 
will be used during registration.

After registration of a component, the wsreg_get_instance() function can be used 
to determine what instance value was assigned.

ATTRIBUTES  See attributes(5) for descriptions of the following attributes:

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SEE ALSO  wsreg_create_component(3WSREG), wsreg_register(3WSREG), 
           attributes(5)
wsreg_set_location(3WSREG)

NAME
wsreg_set_location, wsreg_get_location – set or get the location of a component

SYNOPSIS
cc [flag ...] file ... -lwsreg [library ...]
#include <wsreg.h>

int wsreg_set_location(Wsreg_component *comp, const char *location);
char *wsreg_get_location(const Wsreg_component *comp);

DESCRIPTION
The wsreg_set_location() function sets the location specified by location into the component specified by comp. Every component must have a location before being registered. If a location has already been set into the specified component, the resources associated with the previously set location are released.

The wsreg_get_location() function gets the location string from the component specified by comp. The resulting string must be released by the caller.

RETURN VALUES
The wsreg_set_location() function returns a non-zero value if the location was set correctly; otherwise 0 is returned.

The wsreg_get_location() function returns a copy of the location from the specified component.

ATTRIBUTES
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SEE ALSO
wsreg_initialize(3WSREG), attributes(5)
The `wsreg_set_parent()` function sets the parent specified by `parent` of the component specified by `comp`.

The `wsreg_get_parent()` function gets the parent of the component specified by `comp`.

The `wsreg_get_parent()` function returns a pointer to a `Wsreg_component` structure that represents the parent of the specified component. If the specified component does not have a parent, `NULL` is returned. If a non-null value is returned, it the caller's responsibility to release the memory associated with the resulting `Wsreg_component` pointer with a call to `wsreg_free_component()`. See `wsreg_create_component(3WSREG)`.

The parent of a component is set as a result of registering the parent component. When a component that has children is registered, all of the child components are updated to reflect the newly registered component as their parent. This update only occurs if the child component does not already have a parent component set.

The specified parent component is reduced to a lightweight component reference that uniquely identifies the parent in the product install registry. This lightweight reference includes the parent's uuid and instance number.

The parent must be registered before a call to `wsreg_set_parent()` can be made, since the parent's instance number must be known at the time the `wsreg_set_parent()` function is called.

A process needing to call `wsreg_set_parent()` or `wsreg_get_parent()` must have read access to the product install registry.

See attributes(5) for descriptions of the following attributes:

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</tr>
</tbody>
</table>

**SEE ALSO**

- `wsreg_can_access_registry(3WSREG)`
- `wsreg_create_component(3WSREG)`
- `wsreg_initialize(3WSREG)`
- `wsreg_register(3WSREG)`
- `wsreg_set_instance(3WSREG)`, attributes(5)
**NAME**
wsreg_set_type, wsreg_get_type – set or get the type of a component

**SYNOPSIS**
```c
#include <wsreg.h>

int wsreg_set_type(Wsreg_component *comp, Wsreg_component_type type);
Wsreg_component_type wsreg_get_type(const Wsreg_component *comp);
```

**DESCRIPTION**
The `wsreg_set_type()` function sets the type specified by `type` in the component specified by `comp`.

The `wsreg_get_type()` function retrieves the type from the component specified by `comp`.

**RETURN VALUES**
The `wsreg_set_type()` function returns a non-zero value if the type is set successfully; otherwise 0 is returned.

The `wsreg_get_type()` function returns the type currently set in the component specified by `comp`.

**USAGE**
The component type is used to indicate whether a `Wsreg_component` structure represents a product, feature, or component. The `type` argument can be one of the following:

- **WSREG_PRODUCT**
  Indicates the `Wsreg_component` represents a product. A product is a collection of features and/or components.

- **WSREG_FEATURE**
  Indicates the `Wsreg_component` represents a feature. A feature is a collection of components.

- **WSREG_COMPONENT**
  Indicates the `Wsreg_component` represents a component. A component is a collection of files that may be installed.

**ATTRIBUTES**
See attributes(5) for descriptions of the following attributes:

<table>
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</table>

**SEE ALSO**
wsreg_create_component(3WSREG), wsreg_initialize(3WSREG),
wsreg_register(3WSREG), wsreg_set_instance(3WSREG), attributes(5)
The `wsreg_set_uninstaller()` function sets the uninstaller specified by `uninstaller` in the component specified by `comp`. If an uninstaller has already been set in the specified component, the resources associated with the previously set uninstaller are released.

The `wsreg_get_uninstaller()` function gets the uninstaller string from the component specified by `comp`. The resulting string must be released by the caller.

The `wsreg_set_uninstaller()` function returns a non-zero value if the uninstaller was set correctly; otherwise 0 is returned.

The `wsreg_get_uninstaller()` function returns a copy of the uninstaller from the specified component.

An uninstaller is usually only associated with a product, not with every component that comprises a product. The uninstaller string is a command that can be passed to the shell to launch the uninstaller.

If an uninstaller is set in a registered component, the `prodreg(1M)` registry viewer will provide an uninstall button that will invoke the uninstaller.

See `attributes(5)` for descriptions of the following attributes:

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</table>

**SEE ALSO** `prodreg(1M), wsreg_initialize(3WSREG), attributes(5)`
NAME | wsreg_set_unique_name, wsreg_get_unique_name – set or get the unique name of a component

SYNOPSIS | cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_set_unique_name(Wsreg_component *comp, const char *
*unique_name);

char *wsreg_get_unique_name(const Wsreg_component *comp);

DESCRIPTION | The wsreg_set_unique_name() function sets the unique name specified by
*unique_name in the component specified by *comp. Every component must have a
unique name before being registered. If a unique name has already been set in the
specified component, the resources associated with the previously set unique name are
released.

The wsreg_get_unique_name() function gets the unique name string from the
component specified by *comp. The resulting string must be released by the caller.

RETURN VALUES | The wsreg_set_unique_name() function returns a non-zero value if the unique
name was set correctly; otherwise it returns 0.

The wsreg_get_unique_name() function returns a copy of the unique name from
the specified component.

ATTRIBUTES | See attributes(5) for descriptions of the following attributes:

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</table>

SEE ALSO | wsreg_initialize(3WSREG), attributes(5)
wsreg_set_vendor(3WSREG)

NAME  
wsreg_set_vendor, wsreg_get_vendor – set or get the vendor of a component

SYNOPSIS  
cc [flag...]  file ...-lwreg [library...]
#include <wsreg.h>

int wsreg_set_vendor(Wsreg_component *comp, const char *vendor);
char *wsreg_get_vendor(const Wsreg_component *comp);

DESCRIPTION  
The wsreg_set_vendor() function sets the vendor specified by vendor in the
component specified by comp. The vendor argument is a string that identifies the
vendor of the component. If a vendor has already been set in the specified component,
the resources associated with the previously set vendor are released.

The wsreg_get_vendor() function gets the vendor string from the component
specified by comp. The resulting string must be released by the caller.

RETURN VALUES  
The wsreg_set_vendor() function returns a non-zero value if the vendor was set
correctly; otherwise it returns 0.

The wsreg_get_vendor() function returns a copy of the vendor from the specified
component.

ATTRIBUTES  
See attributes(5) for descriptions of the following attributes:

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SEE ALSO  
wreg_initialize(3WSREG), attributes(5)
### NAME
wsreg_set_version, wsreg_get_version – set or get the version of a component

### SYNOPSIS
```
cc [flag ...] file ...-lwsreg [library ...]
#include <wsreg.h>

int wsreg_set_version(Wareg_component *comp, const char *version);
char *wsreg_get_version(const Wareg_component *comp);
```

### DESCRIPTION
The `wsreg_set_version()` function sets the version specified by `version` in the component specified by `comp`. The `version` argument is a string that represents the version of the component. Every component must have a version before being registered. If a version has already been set in the specified component, the resources associated with the previously set version are released.

The `wsreg_get_version()` function gets the version string from the component specified by `comp`. The resulting string must be released by the caller.

### RETURN VALUES
The `wsreg_set_version()` function returns a non-zero value if the version was set correctly; otherwise it returns 0.

The `wsreg_get_version()` function returns a copy of the version from the specified component.

### ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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### SEE ALSO
wsreg_initialize(3WSREG), attributes(5)
The `wsreg_unregister()` function removes the component specified by `comp` from the product install registry. The component will only be removed if the `comp` argument has a matching uuid, instance, and version.

Usually, the component retrieved through a call to `wsreg_get()`, before being passed to the `wsreg_unregister()` function.

If the component has required components, the respective dependent components will be updated to reflect the change.

A component that has dependent components cannot be unregistered until the dependent components are uninstalled and unregistered.

Upon successful completion, a non-zero return value is returned. If the component could not be unregistered, 0 is returned.

### EXAMPLE

**Unregister a component.**

The following example demonstrates how to unregister a component.

```c
#include <stdio.h>
#include <wsreg.h>

int main(int argc, char **argv)
{
    char *uuid = "d6cf2869-1dd1-11b2-9fcb-080020b69971";
    char *location = "/usr/local/example1_component";
    Wsreg_query *query = NULL;
    Wsreg_component *comp = NULL;

    /* Initialize the registry */
    wsreg_initialize(WSREG_INIT_NORMAL, NULL);

    /* Query for the component */
    query = wsreg_query_create();
    wsreg_query_set_id(query, uuid);
    wsreg_query_set_location(query, location);
    comp = wsreg_get(query);

    if (comp != NULL) {
        /* The query succeeded. The component has been found. */
        Wsreg_component **dependent_comps;
        dependent_comps = wsreg_get_dependent_components(comp);
        if (dependent_comps != NULL) {
            /*
            * The component has dependent components. The
            * component cannot be unregistered.
            */
            wsreg_free_component_array(dependent_comps);
            /*
            * The component can be unregistered.
            */
            return wsreg_unregister(comp);
        }
    }
}
```
EXAMPLE 1 Unregister a component.  (Continued)

printf("The component cannot be uninstalled because 
  *it has dependent components\n");
} else {
  /*
   * The component does not have dependent components.
   * It can be unregistered.
   */
  if (wsreg_unregister(comp) != 0) {
    printf("wsreg_unregister succeeded\n");
  } else {
    printf("unregister failed\n");
  }
}
/* Be sure to free the component */
wsreg_free_component(comp);
} else {
  /* The component is not currently registered. */
  printf("The component was not found in the registry\n");
  wsreg_query_free(query);
}

USAGE Components should be unregistered before uninstallation. If the component cannot be unregistered, uninstallation should not be performed.

A component cannot be unregistered if other registered components require it. A call to wsreg_get_dependent_components() can be used to determine if this situation exists. See wsreg_add_dependent_component(3WSREG).

A successful unregistration of a component will result in all components required by the unregistered component being updated in the product install registry to remove the dependency. Also, child components will be updated so the unregistered component is no longer registered as their parent.

When unregistering a product, the product should first be unregistered, followed by the unregistration of its first feature and then the unregistration and uninstallation of the components that comprise that feature. Be sure to use this top-down approach to avoid removing a component that belongs to a product or feature that is required by a separate product.

ATTRIBUTES See attributes(5) for descriptions of the following attributes:

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SEE ALSO wsreg_add_dependent_component(3WSREG), wsreg_get(3WSREG), wsreg_initialize(3WSREG), wsreg_register(3WSREG), attributes(5)
NAME
y0, y1, yn – Bessel functions of the second kind

SYNOPSIS
c
c

c

c

double y0(double x);

double y1(double x);

double yn(int n, double x);

DESCRIPTION
The y0(), y1() and yn() functions compute Bessel functions of x of the second kind of orders 0, 1 and n respectively. The value of x must be positive.

RETURN VALUES
Upon successful completion, y0(), y1() and yn() will return the relevant Bessel value of x of the second kind.

If x is NaN, NaN is returned.

If the x argument to y0(), y1() or yn() is negative, -HUGE_VAL or NaN is returned, and errno may be set to EDOM.

If x is 0.0, -HUGE_VAL is returned and errno may be set to ERANGE or EDOM.

If the correct result would cause overflow, -HUGE_VAL is returned and errno may be set to ERANGE.

For exceptional cases, matherr(3M) tabulates the values to be returned as dictated by Standards other than XPG4.

ERRORS
The y0(), y1() and yn() functions may fail if:

EDOM The value of x is negative.

ERANGE The value of x is too large in magnitude, or x is 0.0, or the correct result would cause overflow.

USAGE
An application wishing to check for error situations should set errno to 0 before calling y0(), y1() or yn(). If errno is non-zero on return, or the return value is NaN, an error has occurred.

ATTRIBUTES
See attributes(5) for descriptions of the following attributes:

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SEE ALSO
isnan(3M), j0(3M), matherr(3M), attributes(5), standards(5)
Index

A
absolute value function — fabs, 190
access a table property —
  picl_get_next_by_col, 382
access a table property —
  picl_get_next_by_row, 382
access CPU performance counters in other
  processes — cpc_pctx_bind_event, 72
access CPU performance counters in other
  processes — cpc_pctx_invalidate, 72
access CPU performance counters in other
  processes — cpc_pctx_rele, 72
access CPU performance counters in other
  processes — cpc_pctx_take_sample, 72
aclcheck — check the validity of an ACL, 20
aclfrommode — convert an ACL to or from
  permission bits, 23
aclfromtext — convert internal representation to
  or from external representation, 24
aclsort — sort an ACL, 22
acltomode — convert an ACL to or from
  permission bits, 23
acltotext — convert internal representation to or
  from external representation, 24
acos — arc cosine function, 26
acosh — inverse hyperbolic functions, 27
add or delete node to or from tree —
  ptree_add_node, 398
add or delete node to or from tree —
  ptree_delete_node, 398
add or remove a backward compatible version
  — wsreg_add_compatible_version, 569
add or remove a backward compatible version
  — wsreg_get_compatible_versions, 569
add or remove a child component —
  wsreg_add_child_component, 567
add or remove a child component —
  wsreg_get_child_components, 567
add or remove a child component —
  wsreg_remove_child_component, 567
add or remove a dependent component —
  wsreg_add_dependent_component, 571
add or remove a dependent component —
  wsreg_get_dependent_components, 571
add or remove a dependent component —
  wsreg_remove_dependent_component, 571
add or remove a required component —
  wsreg_add_required_component, 575
add or remove a required component —
  wsreg_get_required_components, 575
add or remove a required component —
  wsreg_remove_required_component, 575
add or retrieve a key-value pair —
  wsreg_get_data, 592
add or retrieve a key-value pair —
  wsreg_get_data_pairs, 592
add or retrieve a key-value pair —
  wsreg_set_data, 592
add, remove, or return a localized display name
  — wsreg_add_display_name, 573
add, remove, or return a localized display name
  — wsreg_get_display_languages, 573
add, remove, or return a localized display name
— wsreg_get_display_name, 573
add, remove, or return a localized display name
— wsreg_remove_display_name, 573
advance — regular expression compile and
match routines, 413
allocate or deallocate a buffer for trace data
— tnctl_buffer_alloc, 512
— tnctl_buffer_dealloc, 512
allow or disallow a memory segment to be
imported by other nodes
— rsm_memseg_export_publish, 431
allow or disallow a memory segment to be
imported by other nodes
— rsm_memseg_export_republish, 431
allow or disallow a memory segment to be
imported by other nodes
— rsm_memseg_export_unpublish, 431
annotate source code with info for tools
— NOTE, 312
— _NOTE, 312
arc cosine function — acos, 26
arc sine function — asin, 28
arc tangent function — atan, 30
arc tangent function — atan2, 29
asin — arc sine function, 28
asinh — inverse hyperbolic functions, 27
associate callbacks with process events —
pctx_set_events, 374
atan — arc tangent function, 30
atan2 — arc tangent function, 29
atanh — inverse hyperbolic functions, 27
au_close — construct audit records, 31
au_open — construct audit records, 31
au_preselect — preselect an audit record, 32
au_to — create audit record tokens, 35
au_to_arg — create audit record tokens, 35
au_to_attr — create audit record tokens, 35
au_to_data — create audit record tokens, 35
au_to_groups — create audit record tokens, 35
au_to_in_addr — create audit record tokens, 35
au_to_ipc — create audit record tokens, 35
au_to_ipc_perm — create audit record
tokens, 35
au_to_iport — create audit record tokens, 35
au_to_me — create audit record tokens, 35
au_to_new_in_addr — create audit record
tokens, 35
au_to_new_process — create audit record
tokens, 35
au_to_new_socket — create audit record
tokens, 35
au_to_new_subject — create audit record
tokens, 35
au_to_opaque — create audit record tokens, 35
au_to_path — create audit record tokens, 35
au_to_process — create audit record tokens, 35
au_to_return — create audit record tokens, 35
au_to_socket — create audit record tokens, 35
au_to_subject — create audit record tokens, 35
au_to_text — create audit record tokens, 35
au_user_mask — get user’s binary preselection
mask, 37
au_write — write audit records, 31
audit control file information
— endac, 199
— getacdir, 199
— getacflag, 199
— getacinfo, 199
— getacmin, 199
— getacna, 199
— setac, 199
audit record tokens, manipulating
— au_close, 31
— au_open, 31
— au_preselect, 32
— au_write, 31
authentication information routines for PAM
— pam_get_item, 349
— pam_set_item, 349
authentication transaction routines for PAM
— pam_end, 366
— pam_start, 366
B
base 10 logarithm function — log10, 268
Basic Security Module functions
— au_close, 31
— au_open, 31
— au_preselect, 32
— au_write, 31
Bessel functions of the first kind
— j0, 228
Bessel functions of the first kind (Continued)
— j1, 228
— jn, 228
Bessel functions of the second kind
— y0, 606
— y1, 606
— yn, 606
bgets — read stream up to next delimiter, 38
buffer, split into fields — bufsplit, 39

cbrt — cube root function, 40
ceil — ceiling value function, 41
ceiling value function — ceil, 41
change or add a value to the PAM environment
— pam_putenv, 343
check the validity of an ACL — aclcheck, 20
check whether or not Volume Management is managing a pathname — volmgt_inuse, 560
check whether specific Volume Management features are enabled
— volmgt_feature_enabled, 559
chkauthattr — verify user authorization, 206
class-dependent data translation
— elf32_xlatetof, 147
— elf32_xlatetom, 147
— elf64_xlatetof, 147
— elf64_xlatetom, 147
close a smartcard session, terminal, or card — SCF_Session_close, 458
close a smartcard session, terminal, or card — SCF_Terminal_close, 458
close a tnfctl handle — tnfctl_close, 514
commands, open, close to and from a command — p2open, p2close, 327
compile — regular expression compile and match routines, 413
compute natural logarithm — log1p, 269
computes exponential functions — expm1, 189
config_admin — configuration administration interface, 43
config_ap_id_cmp — configuration administration interface, 43
config_change_state — configuration administration interface, 43
config_list — configuration administration interface, 43
config_list_ext — configuration administration interface, 43
config_private_func — configuration administration interface, 43
config_stat — configuration administration interface, 43
config_strerror — configuration administration interface, 43
config_test — configuration administration interface, 43
config_unload — configuration administration interface, 43
configuration administration interface — config_admin, 43
configuration administration interface — config_ap_id_cmp, 43
configuration administration interface — config_change_state, 43
configuration administration interface — config_list, 43
configuration administration interface — config_list_ext, 43
configuration administration interface — config_private_func, 43
configuration administration interface — config_stat, 43
configuration administration interface — config_strerror, 43
configuration administration interface — config_test, 43
configuration administration interface — config_unload, 43
connect to a DMI service provider
— ConnectToServer, 50, 106
construct, read, and write extended accounting records — ea_get_creator, 134
construct, read, and write extended accounting records — ea_get_hostname, 134
construct, read, and write extended accounting records — ea_get_object, 134
construct, read, and write extended accounting records — ea_next_object, 134
construct, read, and write extended accounting records — ea_pack_object, 134
construct, read, and write extended accounting records — ea_previous_object, 134
construct, read, and write extended accounting records — ea_unpack_object, 134
construct, read, and write extended accounting records — ea_write_object, 134
control kernel tracing and process filtering
— tnfctl_filter_list_add, 538
— tnfctl_filter_list_delete, 538
— tnfctl_filter_list_get, 538
— tnfctl_filter_state_set, 538
— tnfctl_trace_state_set, 538
control probes of another process where caller provides /proc functionality
— tnfctl_check_libs, 516
— tnfctl_indirect_open, 516
convert an ACL to or from permission bits
— aclfrommode, 23
— acltomode, 23
convert internal representation to or from external representation
— aclfromtext, 24
— acltotext, 24
convert a supplied name into an absolute pathname that can be used to access removable media — media_findname, 285
convert between Volume Management symbolic names, and the devices that correspond to them
— volmgt_symdev, 565
— volmgt_symname, 565
coordinate CPC library and application versions
— cpc_version, 81
copysign — return magnitude of first argument and sign of second argument, 52
cos — cosine function, 53
cosh — hyperbolic cosine function, 54
cosine function — cos, 53
cpc — hardware performance counters, 55
cpc_access — test access CPU performance counters, 57
cpc_bind_event — use CPU performance counters on lwps, 58
cpc_count_sys_events — enable and disable performance counters, 64
cpc_count_usr_events — enable and disable performance counters, 64
cpc_event — data structure to describe CPU performance counters, 66
cpc_event_accum — simple difference and accumulate operations, 68
cpc_event_diff — simple difference and accumulate operations, 68
cpc_eventtosstr — translate strings to and from events, 78
cpc_getcciname — determine CPU performance counter configuration, 70
cpc_getcpuelf — determine CPU performance counter configuration, 70
cpc_getcpuver — determine CPU performance counter configuration, 70
cpc_getcpustate — determine CPU performance counter configuration, 70
cpc_getname — determine CPU performance counter configuration, 70
cpc_getusage — determine CPU performance counter configuration, 70
cpc_pctx_bind_event — access CPU performance counters in other processes, 72
cpc_pctx_invalidate — access CPU performance counters in other processes, 72
cpc_pctx_rele — access CPU performance counters in other processes, 72
cpc_pctx_take_sample — access CPU performance counters in other processes, 72
cpc_rele — use CPU performance counters on lwps, 58
cpc_strtoevent — translate strings to and from events, 78
cpc_take_sample — use CPU performance counters on lwps, 58
cpc_version — coordinate CPC library and application versions, 81
cpc_walk_names — determine CPU performance counter configuration, 70
cplusplus_demangle — decode a C++ encoded symbol name, 82
create a new query — wsreg_query_create, 584
create a new query — wsreg_query_free, 584
create audit record tokens — au_to, 35
create audit record tokens — au_to_arg, 35
create audit record tokens — au_to_attr, 35
create audit record tokens — au_to_data, 35
create audit record tokens — au_to_groups, 35
create audit record tokens — au_to_in_addr, 35
create audit record tokens — au_to_ipc, 35
create audit record tokens —
  au_to_ipc_perm, 35
create audit record tokens — au_to_iport, 35
create audit record tokens — au_to_me, 35
create audit record tokens —
  au_to_new_in_addr, 35
create audit record tokens — au_to_new_socket, 35
create audit record tokens — au_to_new_subject, 35
create audit record tokens — au_to_opaque, 35
create audit record tokens — au_to_path, 35
create audit record tokens — au_to_process, 35
create audit record tokens — au_to_return, 35
create audit record tokens — au_to_socket, 35
create audit record tokens — au_to_subject, 35
cube root function — cbrrt, 40
create or break logical connection between import and export segments —
  rsm_memseg_import_connect, 435
data structure to describe CPU performance counters — cpc_event, 66
decode a C++ encoded symbol name — cplus_demangle, 82
decode a C++ encoded symbol name — demangle, 82
destroy a layout object —
  m_destroy_layout, 284
determine CPU performance counter configuration — cpc_getcciname, 70
determine CPU performance counter configuration — cpc_getcpuref, 70
determine CPU performance counter configuration — cpc_getcpuver, 70
determine CPU performance counter configuration — cpc_getnpic, 70
determine CPU performance counter configuration — cpc_getusage, 70
determine CPU performance counter configuration — cpc_walk_names, 70
determine access to product install registry —
  wsreg_can_access_registry, 577
determine equality of two components —
  wsreg_components_equal, 580
device ID interfaces for user applications —
  devid_compare, 83
device ID interfaces for user applications —
  devid_devicelid_to_nmlist, 83
device ID interfaces for user applications —
  devid_free, 83
device ID interfaces for user applications —
  devid_free_nmlist, 83
device ID interfaces for user applications —
  devid_get, 83
device ID interfaces for user applications —
  devid_get_minor_name, 83
device ID interfaces for user applications —
  devid_sizeof, 83
device ID interfaces for user applications —
  devid_compare, 83
device ID interfaces for user applications —
  devid_devicelid_to_nmlist, 83
devid_free — device ID interfaces for user applications, 83
deviid_free_nmlist — device ID interfaces for user applications, 83
deviid_get — device ID interfaces for user applications, 83
deviid_get_minor_name — device ID interfaces for user applications, 83
deviid_sizeof — device ID interfaces for user applications, 83
directories, create, remove them in a path — mkdirp, rmdirp, 292
dmi_error — print error in string form, 120
DmiAddComponent — Management Interface database administration functions, 111
DmiAddGroup — Management Interface database administration functions, 111
DmiAddLanguage — Management Interface database administration functions, 111
DmiAddRow — Management Interface operation functions, 115
DmiDeleteComponent — Management Interface database administration functions, 111
DmiDeleteGroup — Management Interface database administration functions, 111
DmiDeleteLanguage — Management Interface database administration functions, 111
DmiDeleteRow — Management Interface operation functions, 115
DmiGetAttribute — Management Interface operation functions, 115
DmiGetConfig — Management Interface initialization functions, 121
DmiGetMultiple — Management Interface operation functions, 115
DmiGetVersion — Management Interface initialization functions, 121
DmiListAttributes — Management Interface listing functions, 124
DmiListClassNames — Management Interface listing functions, 124
DmiListComponents — Management Interface listing functions, 124
DmiListComponentsByClass — Management Interface listing functions, 124
DmiListGroup — Management Interface listing functions, 124
DmiListLanguages — Management Interface listing functions, 124
DmiOriginateEvent — Service Provider functions for components, 129
DmiRegister — Management Interface initialization functions, 121
DmiRegisterCi — Service Provider functions for components, 129
DmiSetAttribute — Management Interface operation functions, 115
DmiSetConfig — Management Interface initialization functions, 121
DmiSetMultiple — Management Interface operation functions, 115
DmiUnregister — Management Interface initialization functions, 121
DmiUnRegisterCi — Service Provider functions for components, 129

E

ea_attach_to_group — open or close exact files, 138
ea_attach_to_object — open or close exact files, 138
ea_close — open or close exact files, 132
ea_error — error interface to extended accounting library, 131
ea_free_item — open or close exact files, 138
ea_free_object — open or close exact files, 138
ea_get_creator — construct, read, and write extended accounting records, 134
ea_get_hostname — construct, read, and write extended accounting records, 134
ea_get_object — construct, read, and write extended accounting records, 134
ea_match_object_catalog — open or close exact files, 138
ea_next_object — construct, read, and write extended accounting records, 134
ea_open — open or close exact files, 132
ea_pack_object — construct, read, and write extended accounting records, 134
ea_previous_object — construct, read, and write extended accounting records, 134
ea_set_group — open or close exact files, 138
ea_set_item — open or close exact files, 138
ea_unpack_object — construct, read, and write extended accounting records, 134

elf — object file access library, 149

e, get entries from name list — nlist, 311

e, process ELF object files, 155

e, error handling, 162

e, error handling, 162

e — set fill byte, 163

e — manipulate flags, 164

e — manipulate flags, 164

e — manipulate flags, 164

e — manipulate flags, 164

e — retrieve archive member header, 166

e — retrieve archive symbol table, 168

e — get base offset for an object file, 169

e — get section data, 170

e — get section identification data, 174

e — get section information, 176

e — compute hash value, 178

e — determine file type, 179

e — process ELF object files, 155

e — get section information, 176

e — get section data, 170

e — get section information, 176

e — process ELF object files, 155

e — get section information, 176

e — process ELF object files, 155

e — get section data, 170

e — retrieve uninterpreted file contents, 180

e — make a string pointer, 181

e — update an ELF descriptor, 182

e — coordinate ELF library and application versions, 186

e — return the checksum of an elf image, — elf32_checksum, 140

e — return the size of an object file type, 141

elf32_unpack_object — construct, read, and write extended accounting records, 134

elf32_write_object — construct, read, and write extended accounting records, 134

elf — object file access library, 149

elf, get entries from name list — nlist, 311

elf_begin — process ELF object files, 155

elf_cntl — control an elf file descriptor, 160

elf_ends — process ELF object files, 155

elf_errno — error handling, 162

elf_getarhdr — retrieve archive member header, 166

elf_getarsym — retrieve archive symbol table, 168

elf_getbase — get the base offset for an object file, 169

elf_getdata — get section data, 170

elf_getident — retrieve file identification data, 174

elf_getscn — get section information, 176

elf_hash — compute hash value, 178

elf_kind — determine file type, 179

elf_memory — process ELF object files, 155

elf_ndxscn — get section information, 176

elf_newdata — get section data, 170

elf_newscn — get section information, 176

elf_next — process ELF object files, 155

elf_nextscn — get section information, 176

elf_rand — process ELF object files, 155

elf_rawdata — get section data, 170

elf_rawfile — retrieve uninterpreted file contents, 180

e, make a string pointer, 181

e, update an ELF descriptor, 182

e, coordinate ELF library and application versions, 186

e — return the checksum of an elf image, — elf32_checksum, 140

e — return the size of an object file type, 141

elf32_getehdr — retrieve class-dependent object file header, 142

elf32_getphdr — retrieve class-dependent program header table, 144

elf32_getshdr — retrieve class-dependent section header, 146

elf32_newehdr — retrieve class-dependent object file header, 142

elf32_newphdr — retrieve class-dependent program header table, 144

elf32_xlatetof — class-dependent data translation, 147

elf32_xlatetom — class-dependent data translation, 147

elf64_checksum — return the checksum of an elf image, — elf32_checksum, 140

elf64_fsiz — return the size of an object file type, 141

elf64_getehdr — retrieve class-dependent object file header, 142

elf64_getphdr — retrieve class-dependent program header table, 144

elf64_getshdr — retrieve class-dependent section header, 146

elf64_newehdr — retrieve class-dependent object file header, 142

elf64_newphdr — retrieve class-dependent program header table, 144

elf64_xlatetof — class-dependent data translation, 147

elf64_xlatetom — class-dependent data translation, 147

enable and disable performance counters — cpc_count_sys_events, 64

enable and disable performance counters — cpc_count_usr_events, 64

encryption, determine whether a buffer of characters is encrypted — isencrypt, 226

endac — get audit control file information, 199

endauclass — close audit_class database file, 201

endauevent — close audit_event database file, 204

endauthattr — get authorization database entry, 206

endauuser — get audit_user database entry, 209
endexecattr — get execution attribute database entry, 211
endprofattr — get profile description database entry, 215
endprojent — project database entry functions, 217
enduserattr — get user_attr entry, 221
erf — error and complementary error functions, 187
erfc — error and complementary error functions, 187
error and complementary error functions
— erf, 187
— erfc, 187
error interface to extended accounting library —
ea_error, 131
establish a context with a smartcard —
SCF_Terminal_getCard, 478
establish a context with a smartcard terminal (reader) — SCF_Session_getTerminal, 468
establish a context with a system’s smartcard framework — SCF_Session_getSession, 466
Euclidean distance function — hypot, 224
Executable and Linking Format, See elf
exp — exponential function, 188
expm1 — computes exponential functions, 189
exponential function — exp, 188

F
fabs — absolute value function, 190
fgetprojent — project database entry functions, 217
files, search for named file in named directories — pathfind, 370
floating-point remainder value function —
  fmod, 192
floor — floor function, 191
floor function — floor, 191
fmod — floating-point remainder value function, 192
free_authattr — release memory, 206
free dynamic memory allocated for input DmiString structure, — freeDmiString, 193
free_execattr — release memory, 211
free memory for sysevent handle — sysevent_free, 502
free_profattr — get profile description database entry, 215
free_userattr — get user_attr entry, 221
freeDmiString — free dynamic memory allocated for input DmiString structure, 193
functions to manage lockfile structure for user’s mailbox
— maillock, 272
— mailunlock, 272
— touchlock, 272

G
gamma — log gamma function, 251
gamma_r — log gamma function, 251
get a property handle of a node —
  picl_get_first_prop, 380
get a property handle of a node —
  picl_get_next_prop, 380
get class name, subclass name, ID or buffer size of event — sysevent_get_class_name, 504
get class name, subclass name, ID or buffer size of event — sysevent_get_event_id, 504
get class name, subclass name, ID or buffer size of event — sysevent_get_size, 504
get class name, subclass name, ID or buffer size of event —
  sysevent_get_subclass_name, 504
get or free interconnect topology —
  rsm_free_interconnect_topology, 422
get or free interconnect topology —
  rsm_get_interconnect_topology, 422
get or release a controller handle —
  rsm_get_controller, 420
get or release a controller handle —
  rsm_get_controller_attr, 420
get or release a controller handle —
  rsm_release_controller, 420
get or release a poll descriptor —
  rsm_memseg_get_pollfd, 434
get or release a poll descriptor —
  rsm_memseg_release_pollfd, 434
get the value of a property —
  picl_get_propval, 385
get the value of a property —
  picl_get_propval_by_name, 385
get the value of a property —
  ptree_get_propval, 408
get the value of a property —
  ptree_get_propval_by_name, 408
get user_attr entry — enduserattr, 221
get user_attr entry — free_userattr, 221
get user_attr entry — getuserattr, 221
get user_attr entry — getuseruid, 221
get user_attr entry — setuserattr, 221
get vendor name, publisher name or processor
  ID of event — sysevent_get_pid, 506
get vendor name, publisher name or processor
  ID of event — sysevent_get_pub_name, 506
get vendor name, publisher name or processor
  ID of event — sysevent_get_vendor_name, 506
get a string describing a status code —
  SCF_strerror, 471
get and set media attributes
  — media_getattr, 288
  — media_setattr, 288
get attribute list pointer —
  sysevent_get_attr_list, 503
get error message string — picl_strerror, 392
get property information —
  ptree_get_propinfo, 407
get segment ID range —
  rsm_get_segmentid_range, 424
get the handle of the property by name —
  picl_get_prop_by_name, 383
get the information about a property —
  picl_get_propinfo, 384
get the root handle of the PICL tree —
  ptree_get_root, 387
get the root node handle — ptree_get_root, 409
get the trace attributes from a tnfctl handle —
  tnfctl_trace_attrs_get, 536
getacdir — get audit control file
  information, 199
getacdfg — get audit control file
  information, 199
getacinfo — get audit control file
  information, 199
getacmin — get audit control file
  information, 199
getacna — get audit control file
  information, 199
getprofnam — get profile description database entry, 215
getprojbvid — project database entry functions, 217
getprojbyname — project database entry functions, 217
getprojent — project database entry functions, 217
getuserattr — get user_attr entry, 221
getusernam — get user_attr entry, 221
getuseruid — get user_attr entry, 221
gmatch — shell global pattern matching, 223

H
hardware performance counters — cpc, 55
have Volume Management check for media — volmgt_check, 557
hyperbolic cosine function — cosh, 54
hyperbolic sine function — sinh, 491
hyperbolic tangent function — tanh, 511
hypot — Euclidean distance function, 224

I
ilogb — returns an unbiased exponent, 225
initialize a layout object —
    m_create_layout, 280
initialize kernel statistics facility
    — kstat_close, 239
    — kstat_open, 239
initialize wsreg library — wsreg_initialize, 583
initiate a session with the PICL daemon —
    picl_initialize, 388
inproj — project database entry functions, 217
interfaces for direct probe and process control for another process
    — tnfctl_continue, 522
    — tnfctl_exec_open, 522
    — tnfctl_pid_open, 522
interfaces to query and to change the state of a probe
    — tnfctl_probe_connect, 530
    — tnfctl_probe_disable, 530
    — tnfctl_probe_disconnect_all, 530
    — tnfctl_probe_enable, 530

interfaces to query and to change the state of a probe (Continued)
    — tnfctl_probe_state_get, 530
    — tnfctl_probe_trace, 530
    — tnfctl_probe_untrace, 530
inverse hyperbolic functions
    — acosh, 27
    — asinh, 27
    — atanh, 27
isencrypt — determine whether a buffer of characters is encrypted, 226
isnan — test for NaN, 227
iterate over probes
    — tnfctl_probe_apply, 527
    — tnfctl_probe_apply_ids, 527

J
j0 — Bessel functions of the first kind, 228
j1 — Bessel functions of the first kind, 228
jn — Bessel functions of the first kind, 228

K
kernel virtual memory functions
    copy data from kernel image or running system —
        kvm_read, kvm_kread,
        kvm_uread, 249
    copy data to kernel image or running system —
        kvm_write, kvm_kwritew,
        kvm_urewrite, 249
    get invocation argument for process —
        kvm_getcmd, 242
    get u-area for process —
        kvm_getu, 242
    get entries from kernel symbol table —
        kvm_nlist, 246
kstat — kernel statistics facility, 231
kstat_chain_update — update the kstat header chain, 237
kstat_close — initialize kernel statistics facility, 239
kstat_data_lookup — find a kstat by name, 238
kstat_lookup — find a kstat by name, 238
kstat_open — initialize kernel statistics facility, 239

616  man pages section 3: Extended Library Functions  •  February 2004
kernel virtual memory functions (Continued)
kstat_read — read or write kstat data, 240
kstat_write — read or write kstat data, 240
specify a kernel to examine — kvm_open, kvm_close, 247
kstat — kernel statistics facility, 231
kstat_chain_update — update the kstat header chain, 237
kstat_close — initialize kernel statistics facility, 239
kstat_data_lookup — find a kstat by name, 238
kstat_lookup — find a kstat by name, 238
kstat_open — initialize kernel statistics facility, 239
kstat_read — read or write kstat data, 240
kstat_write — read or write kstat data, 240
kva_match — look up a key in a key-value array, 241
kvm_close — specify kernel to examine, 247
kvm_getcmd — get invocation arguments for process, 242
kvm_getproc — read system process structures, 244
kvm_getu — get u-area for process, 242
kvm_kread — copy data from a kernel image or running system, 249
kvm_kwrite — copy data to a kernel image or running system, 249
kvm_nextproc — read system process structures, 244
kvm_nlist — get entries from kernel symbol table, 246
kvm_open — specify kernel to examine, 247
kvm_read — copy data from kernel image or running system, 249
kvm_setproc — read system process structures, 244
kvm_uread — copy data from a kernel image or running system, 249
kvm_uwrite — copy data to a kernel image or running system, 249
kvm_write — copy data to kernel image or running system, 249

L
layout transformation —
m_transform_layout, 297
layout transformation for wide character strings — m_wtransform_layout, 302
lgamma — log gamma function, 251
lgamma_r — log gamma function, 251
libdevinfo — library of device information functions, 253
libnvpair — library of name—value pair functions, 256
libpicl — PICL interface library, 257
libpicltree — PTree and Plug-in Registration interface library, 260
library for TNF probe control in a process or the kernel — libtnfctl, 263
library of device information functions — libdevinfo, 253
library of name—value pair functions — libnvpair, 256
libtnfctl — library for TNF probe control in a process or the kernel, 263
load exponent of a radix-independent floating-point number — scalb, 449
load exponent of a radix-independent floating-point number — scalbn, 450
log — natural logarithm function, 270
log gamma function — gamma, 251
— gamma_r, 251
— lgamma, 251
— lgamma_r, 251
log a message in system log — picld_log, 377
log10 — base 10 logarithm function, 268
log1p — compute natural logarithm, 269
logb — radix-independent exponent, 271

M
m_create_layout — initialize a layout object, 280
m_destroy_layout — destroy a layout object, 284
m_getvalues_layout — query layout values of a LayoutObject, 291
m_setvalues_layout — set layout values of a LayoutObject, 296

Index 617
m_transform_layout — layout transformation, 297
m_wtransform_layout — layout transformation for wide character strings, 302
maillock — functions to manage lockfile(s) for user’s mailbox, 272
mailunlock — functions to manage lockfile(s) for user’s mailbox, 272
Management Interface database administration functions
— DmiAddComponent, 111
— DmiAddGroup, 111
— DmiAddLanguage, 111
— DmiDeleteComponent, 111
— DmiDeleteGroup, 111
— DmiDeleteLanguage, 111
Management Interface initialization functions
— DmiGetConfig, 121
— DmiGetVersion, 121
— DmiRegister, 121
— DmiSetConfig, 121
— DmiUnregister, 121
Management Interface listing functions
— DmiListAttributes, 124
— DmiListClassNames, 124
— DmiListComponents, 124
— DmiListComponentsByClass, 124
— DmiListGroup, 124
— DmiListLanguages, 124
Management Interface operation functions
— DmiAddRow, 115
— DmiDeleteRow, 115
— DmiGetAttribute, 115
— DmiGetMultiple, 115
— DmiSetAttribute, 115
— DmiSetMultiple, 115
map or unmap imported segment —
  rsm_memseg_import_map, 440
map or unmap imported segment —
  rsm_memseg_import_unmap, 440
map a tnftcl error code to a string —
  tnftcl_strerror, 535
getexecuser — find one entry, 211
mathematical functions (Continued)
— lgamma, 251
— lgamma_r, 251
matherr — math library exception-handling, 274
md5 — MD5 hashing functions, 282
MD5 hashing functions — md5, 282
MD5 hashing functions — MD5Final, 282
MD5 hashing functions — MD5Init, 282
MD5 hashing functions — MD5Update, 282
MD5 hashing functions — md5_calc, 282
md5_calc — MD5 hashing functions, 282
MD5Final — MD5 hashing functions, 282
MD5Init — MD5 hashing functions, 282
MD5Update — MD5 hashing functions, 282
media_findname — convert a supplied name into an absolute pathname that can be used to access removable media, 285
media_getattr — get and set media attributes, 288
media_setattr — get and set media attributes, 288
memory management, copy a file into memory
— copylist, 51
mkdirp — create directories in a path, 292
modify/delete user credentials for an authentication service — pam_setcred, 345
mp — multiple precision integer arithmetic, 294
mp_gcd — multiple precision integer arithmetic, 294
mp_itom — multiple precision integer arithmetic, 294
mp_madd — multiple precision integer arithmetic, 294
mp_mcmp — multiple precision integer arithmetic, 294
mp_mdiv — multiple precision integer arithmetic, 294
mp_mfree — multiple precision integer arithmetic, 294
mp_msub — multiple precision integer arithmetic, 294
media_findname — convert a supplied name into an absolute pathname that can be used to access removable media, 285
media_getattr — get and set media attributes, 288
media_setattr — get and set media attributes, 288
memory management, copy a file into memory
— copylist, 51
mkdirp — create directories in a path, 292
modify/delete user credentials for an authentication service — pam_setcred, 345
mp — multiple precision integer arithmetic, 294
mp_gcd — multiple precision integer arithmetic, 294
mp_itom — multiple precision integer arithmetic, 294
mp_madd — multiple precision integer arithmetic, 294
mp_mcmp — multiple precision integer arithmetic, 294
mp_mdiv — multiple precision integer arithmetic, 294
mp_mfree — multiple precision integer arithmetic, 294
mp_msub — multiple precision integer arithmetic, 294
media_findname — convert a supplied name into an absolute pathname that can be used to access removable media, 285
media_getattr — get and set media attributes, 288
media_setattr — get and set media attributes, 288
memory management, copy a file into memory
— copylist, 51
mkdirp — create directories in a path, 292
modify/delete user credentials for an authentication service — pam_setcred, 345
mp — multiple precision integer arithmetic, 294
mp_gcd — multiple precision integer arithmetic, 294
mp_itom — multiple precision integer arithmetic, 294
mp_madd — multiple precision integer arithmetic, 294
mp_mcmp — multiple precision integer arithmetic, 294
mp_mdiv — multiple precision integer arithmetic, 294
mp_mfree — multiple precision integer arithmetic, 294
mp_msub — multiple precision integer arithmetic, 294
media_findname — convert a supplied name into an absolute pathname that can be used to access removable media, 285
media_getattr — get and set media attributes, 288
media_setattr — get and set media attributes, 288
memory management, copy a file into memory
— copylist, 51
mkdirp — create directories in a path, 292
modify/delete user credentials for an authentication service — pam_setcred, 345
mp — multiple precision integer arithmetic, 294
mp_gcd — multiple precision integer arithmetic, 294
mp_itom — multiple precision integer arithmetic, 294
mp_madd — multiple precision integer arithmetic, 294
mp_mcmp — multiple precision integer arithmetic, 294
mp_mdiv — multiple precision integer arithmetic, 294
mp_mfree — multiple precision integer arithmetic, 294
mp_msub — multiple precision integer arithmetic, 294
mp_mtox — multiple precision integer arithmetic, 294
mp_mult — multiple precision integer arithmetic, 294
mp_pow — multiple precision integer arithmetic, 294
mp_rpow — multiple precision integer arithmetic, 294
mp_xtom — multiple precision integer arithmetic, 294
multiple precision integer arithmetic
— mp, 294
— mp_gcd, 294
— mp_itom, 294
— mp_madd, 294
— mp_mcmp, 294
— mp_mdiv, 294
— mp_mfree, 294
— mp_min, 294
— mp_mout, 294
— mp_msub, 294
— mp_mtox, 294
— mp_mult, 294
— mp_pow, 294
— mp_rpow, 294
— mp_xtom, 294

O
open or close exact files —
ea_attach_to_group, 138
open or close exact files —
e_aattach_to_object, 138
open or close exact files — ea_close, 132
open or close exact files — ea_free_item, 138
open or close exact files — ea_free_object, 138
open or close exact files —
ea_match_object_catalog, 138
open or close exact files — ea_open, 132
open or close exact files — ea_set_group, 138
open or close exact files — ea_set_item, 138

P
p2close — close pipes to and from a
command, 327
p2open — open pipes to and from a
command, 327
PAM — PAM Service Module APIs, 351
PAM — Pluggable Authentication Module, 329
pam — Pluggable Authentication Module
Administrative Interface, 331
Interface Overview, 329
Stacking Multiple Schemes, 330
Stateful Interface, 330
pam_acct_mgmt — perform PAM account
validation procedures, 332
pam_authenticate — perform authentication
within the PAM framework, 333
pam_chauthtok — perform password related
functions within the PAM framework, 335
pam_close_session — perform PAM session
creation and termination operations, 341
pam_end — authentication transaction routines
for PAM, 366
PAM error messages, get string —
pam_strerror, 369
pam_get_data — PAM routines to maintain
module specific state, 347
pam_get_item — authentication information
routines for PAM, 349
pam_getenv — returns the value for a PAM
environment name, 337
pam_getenvlist — returns a list of all the PAM
environment variables, 338

N
natural logarithm function — log, 270
newDmiOctetString — create DmiOctetString in
dynamic memory, 308
newDmiString — create DmiString in dynamic
memory, 309
next representable double-precision
floating-point number — nextafter, 310
nextafter — next representable double-precision
floating-point number, 310
NOTE — annotate source code with info for
tools, 312
_NOTE — annotate source code with info for
tools, 312
NOTE — annotate source code with info for
tools
NOTE vs _NOTE, 313
NoteInfo Argument, 313
pam_open_session — perform PAM session creation and termination operations, 341
pam_putenv — change or add a value to the PAM environment, 343
PAM routines to maintain module specific state
— pam_get_data, 347
— pam_set_data, 347
PAM Service Module APIs — PAM, 351
pam_set_data — PAM routines to maintain module specific state, 347
pam_set_item — authentication information routines for PAM, 349
pam_setcred — modify/delete user credentials for an authentication service, 345
pam_sm — PAM Service Module APIs Interaction with the User, 352
Interface Overview, 351
Stateful Interface, 351
pam_sm_acct_mgmt — service provider implementation for pam_acct_mgmt, 355
pam_sm_authenticate — service provider implementation for pam_authenticate, 357
pam_sm_chauthtok — service provider implementation for pam_chauthtok, 359
pam_sm_close_session — Service provider implementation for pam_open_session and pam_close_session, 362
pam_sm_open_session — Service provider implementation for pam_open_session and pam_close_session, 362
pam_sm_setcred — service provider implementation for pam_setcred, 364
pam_start — authentication transaction routines for PAM, 366
pathfind — search for named file in named directories, 370
pctx_capture — process context library, 372
pctx_create — process context library, 372
pctx_release — process context library, 372
pctx_run — process context library, 372
pctx_set_events — associate callbacks with process events, 374
perform mutex locking on a card —
SCF_Card_lock, 453
perform mutex locking on a card — SCF_Card_unlock, 453
perform a reset of a smartcard —
SCF_Card_reset, 456
perform authentication within the PAM framework — pam_authenticate, 333
perform PAM account validation procedures —
pam_acct_mgmt, 332
perform PAM session creation and termination operations
— pam_close_session, 341
— pam_open_session, 341
perform password related functions within the PAM framework — pam_chauthtok, 335
picl_get_first_prop — get a property handle of a node, 380
picl_get_next_by_col — access a table property, 382
picl_get_next_by_row — access a table property, 382
picl_get_next_prop — get a property handle of a node, 380
picl_get_prop_by_name — get the handle of the property by name, 383
picl_get_propinfo — get the information about a property, 384
picl_get_propval — get the value of a property, 385
picl_get_propval_by_name — get the value of a property, 385
picl_get_root — get the root handle of the PICL tree, 387
picl_initialize — initiate a session with the PICL daemon, 388
PICL interface library — libpicl, 257
picl_set_propval — set the value of a property to the specified value, 389
picl_set_propval_by_name — set the value of a property to the specified value, 389
picl_shutdown — shutdown the session with the PICL daemon, 391
picl_strerror — get error message string, 392
picl_wait — wait for PICL tree to refresh, 393
picld_log — log a message in system log, 377
picld_plugin_register — register plug-in with the daemon, 378
pipes, open, close to and from a command —
p2open, p2close, 327
Pluggable Authentication Module, — PAM, 329
pow — power function, 394
power function — pow, 394
print a DmiString, — printDmiString, 397

print data in DmiAttributeValues list, — printDmiAttributeValues, 395
print data in input data union, — printDmiDataUnion, 396
print error in string form, — dmi_error, 120
printDmiAttributeValues — print data in DmiAttributeValues list, 395
printDmiDataUnion — print data in input data union, 396
printDmiString — print a DmiString, 397
probe insertion interface
— TNF_DEBUG, 543
— TNF_PROBE_0, 543
— TNF_PROBE_0_DEBUG, 543
— TNF_PROBE_1, 543
— TNF_PROBE_1_DEBUG, 543
— TNF_PROBE_2, 543
— TNF_PROBE_2_DEBUG, 543
— TNF_PROBE_3, 543
— TNF_PROBE_3_DEBUG, 543
— TNF_PROBE_4, 543
— TNF_PROBE_4_DEBUG, 543
— TNF_PROBE_5, 543
— TNF_PROBE_5_DEBUG, 543
process context library — pctx_capture, 372
process context library — pctx_create, 372
process context library — pctx_release, 372
process context library — pctx_run, 372
project database entry functions — endprojent, 217
project database entry functions — fgetprojent, 217
project database entry functions — getdefaultproj, 217
project database entry functions — getprojbyid, 217
project database entry functions — getprojbyname, 217
project database entry functions — getprojent, 217
project database entry functions — inproj, 217
project database entry functions — setprojent, 217
provide a transient program number, — reg_ci_callback, 412
ptree_add_node — add or delete node to or from tree, 398
PTree and Plug-in Registration interface library — libpicltree, 260
ptree_delete_node — add or delete node to or from tree, 398
ptree_get_propinfo — get property information, 407
ptree_get_propval — get the value of a property, 408
ptree_get_propval_by_name — get the value of a property, 408
ptree_get_root — get the root node handle, 409
ptree_update_propval — update a property value, 410
ptree_update_propval_by_name — update a property value, 410

Q
query layout values of a LayoutObject — m_getvalues_layout, 291

R
radix-independent exponent — logb, 271
read and write a disk’s VTOC — read_vtoc, 411
read from a segment —
— rsm_memseg_import_get16, 437
read from a segment —
— rsm_memseg_import_get32, 437
read from a segment —
— rsm_memseg_import_get64, 437
read from a segment —
— rsm_memseg_import_get8, 437
read from a segment —
— rsm_memseg_import_get, 437
read system process structures
— kvm_getproc, 244
— kvm_nextproc, 244
— kvm_setproc, 244
read and write a disk’s VTOC — read_vtoc, write_vtoc, 411
read or write kstat data
— kstat_read, 240
— kstat_write, 240
read_vtoc — read and write a disk’s VTOC, 411
receive asynchronous event notification —
  SCF_Terminal_addEventListener, 472
receive asynchronous event notification —
  SCF_Terminal_removeEventListener, 472
receive asynchronous event notification —
  SCF_Terminal_updateEventListener, 472
regexpr — regular expression compile and
  match routines, 413
register a component in the product install
  registry — wsreg_register, 590
register callbacks for probe creation and
destruction — tnfctl_register_funcs, 534
register plug-in with the daemon —
  picld_plugin_register, 378
regular expression compile and match routines
  — advance, 413
  — compile, 413
  — regexpr, 413
  — step, 413
release removable media device reservation —
  volmgt_release, 562
remainder — remainder function, 416
remainder function — remainder, 416
remote memory access error detection functions
  — rsm_memseg_import_close_barrier, 442
remote memory access error detection functions
  — rsm_memseg_import_open_barrier, 442
remote memory access error detection functions
  — rsm_memseg_import_order_barrier, 442
remove a component from the product install
  registry — wsreg_unregister, 604
reserve removable media device —
  volmgt_acquire, 554
resource allocation and management functions
  for export memory segments —
  rsm_memseg_export_create, 428
resource allocation and management functions
  for export memory segments —
  rsm_memseg_export_destroy, 428
resource allocation and management functions
  for export memory segments —
  rsm_memseg_export_rebind, 428
retrieve information about a session, terminal,
or card — SCF_Card_getInfo, 462
retrieve information about a session, terminal,
or card — SCF_Session_getInfo, 462
retrieve information about a session, terminal,
or card — SCF_Terminal_getInfo, 462
retrieve archive symbol table —
  elf_getarsym, 168
retrieve class-dependent object file header
  — elf32_getehdr, 142
  — elf32_newehdr, 142
  — elf64_getehdr, 142
  — elf64_newehdr, 142
retrieve class-dependent program header table
  — elf32_getphdr, 144
  — elf32_newphdr, 144
  — elf64_getphdr, 144
  — elf64_newphdr, 144
retrieve class-dependent section header
  — elf32_getshdr, 146
  — elf64_getshdr, 146
returns a list of all the PAM environment
  variables — pam_getenvlist, 338
return magnitude of first argument and sign of
  second argument — copysign, 52
return the size of an object file type
  — elf32_fsize, 141
  — elf64_fsize, 141
returns the value for a PAM environment name
  — pam_getenv, 337
return the Volume Management root directory
  — volmgt_root, 563
return whether or not Volume Management is
  running — volmgt_running, 564
returns an unbiased exponent — ilogb, 225
rint — round-to-nearest integral value, 417
rmdir — remove directories in a path, 292
round-to-nearest integral value — rint, 417
rsm_create_localmemory_handle — create or
  free local memory handle, 418
rsm_free_interconnect_topology — get or free
  interconnect topology, 422
rsm_free_localmemory_handle — create or free
  local memory handle, 418
rsm_get_controller — get or release a controller
  handle, 420
rsm_get_controller_attr — get or release a
  controller handle, 420
rsm_get_interconnect_topology — get or free
  interconnect topology, 422
rsm_get_segmentid_range — get segment ID
  range, 424
rsm_INTR_signal_post — signal or wait for an
event, 426
rsm_intr_signal_wait — signal or wait for an event, 426
rsm_memseg_export_create — resource allocation and management functions for export memory segments, 428
rsm_memseg_export_destroy — resource allocation and management functions for export memory segments, 428
rsm_memseg_export_publish — allow or disallow a memory segment to be imported by other nodes, 431
rsm_memseg_export_rebind — resource allocation and management functions for export memory segments, 428
rsm_memseg_export_republish — allow or disallow a memory segment to be imported by other nodes, 431
rsm_memseg_export_unpublish — allow or disallow a memory segment to be imported by other nodes, 431
rsm_memseg_get_pollfd — get or release a poll descriptor, 434
rsm_memseg_import_init_barrier — create or destroy barrier for imported segment, 439
rsm_memseg_import_map — map or unmap imported segment, 440
rsm_memseg_import_open_barrier — remote memory access error detection functions, 442
rsm_memseg_import_order_barrier — remote memory access error detection functions, 442
rsm_memseg_import_put — write to a segment, 444
rsm_memseg_import_put16 — write to a segment, 444
rsm_memseg_import_put32 — write to a segment, 444
rsm_memseg_import_put64 — write to a segment, 444
rsm_memseg_import_put8 — write to a segment, 444
rsm_memseg_import_putv — write to a segment using a list of I/O requests, 446
rsm_memseg_import_set_mode — set or get mode for barrier scoping, 448
rsm_memseg_import_unmap — map or unmap imported segment, 440
rsm_memseg_release_pollfd — get or release a poll descriptor, 434
rsm_release_controller — get or release a controller handle, 420

S
scalb — load exponent of a radix-independent floating-point number, 449
scalbn — load exponent of a radix-independent floating-point number, 450
SCF_Card_exchangeAPDU — send a command APDU to a card and read the card’s response, 451
SCF_Card_getInfo — retrieve information about a session, terminal, or card, 462
SCF_Card_lock — perform mutex locking on a card, 453
SCF_Card_reset — perform a reset of a smartcard, 456
SCF_Card_unlock — perform mutex locking on a card, 453
SCF_Card_waitForCardRemoved — wait for a card to be inserted or removed, 480
SCF_Session_close — close a smartcard session, terminal, or card, 458
SCF_Session_getInfo — retrieve information about a session, terminal, or card, 462
SCF_Session_getSession — establish a context with a system’s smartcard framework, 466
SCF_Session_getTerminal — establish a context with a smartcard terminal (reader), 468
SCF_strerror — get a string describing a status code, 471
SCF_Terminal_addEventListener — receive asynchronous event notification, 472
SCF_Terminal_close — close a smartcard session, terminal, or card, 458
SCF_Terminal_getCard — establish a context with a smartcard, 478
SCF_Terminal_getInfo — retrieve information about a session, terminal, or card, 462
SCF_Terminal_removeEventListener — receive asynchronous event notification, 472
SCF_Terminal_updateEventListener — receive asynchronous event notification, 472
SCF_Terminal_waitForCardAbsent — wait for a card to be inserted or removed, 480
SCF_Terminal_waitForCardPresent — wait for a card to be inserted or removed, 480
send a command APDU to a card and read the card’s response —
SCF_Card_exchangeAPDU, 451
send a file — sendfile, 486
send files over sockets or copy files to files — sendfile, 483
sendfile — send files over sockets or copy files to files, 483
sendfile — send a file, 486
Service Provider functions for components
— DmiOriginateEvent, 129
— DmiRegisterCi, 129
— DmiUnRegisterCi, 129
service provider implementation for
pam_acct_mgmt —
pam_sm_acct_mgmt, 355
service provider implementation for
pam_authenticate —
pam_sm_authenticate, 357
service provider implementation for
pam_chauthtok — pam_sm_chauthtok, 359
Service provider implementation for
pam_open_session and pam_close_session
— pam_sm_close_session, 362
— pam_sm_open_session, 362
service provider implementation for
pam_setcred — pam_sm_setcred, 364
set or get mode for barrier scoping —
rsms_memseg_import_get_mode, 448
set or get mode for barrier scoping —
rsms_memseg_import_set_mode, 448
set or get the instance of a component —
wsreg_get_instance, 595
set or get the instance of a component —
wsreg_set_instance, 595
set or get the instance of a query —
wsreg_query_get_instance, 586
set or get the instance of a query —
wsreg_query_set_instance, 586
set or get the location of a component —
wsreg_get_location, 597
set or get the location of a component —
wsreg_set_location, 597
set or get the location of a query —
wsreg_query_get_location, 587
set or get the location of a query —
wsreg_query_set_location, 587
set or get the parent of a component —
wsreg_get_parent, 598
set or get the parent of a component —
wsreg_set_parent, 598
set or get the type of a component —
wsreg_get_type, 599
set or get the type of a component —
wsreg_set_type, 599
set or get the uninstaller of a component —
wsreg_set_uninstaller, 600
set or get the uninstaller of a Wsreg_component —
wsreg_set_uninstaller, 600
set or get the unique name of a component —
wsreg_get_unique_name, 601
set or get the unique name of a component —
wsreg_set_unique_name, 601
set or get the unique name of a query — wsreg_query_get_unique_name, 588
set or get the unique name of a query — wsreg_query_set_unique_name, 588
set or get the uuid of a component — wsreg_get_id, 594
set or get the uuid of a component — wsreg_set_id, 594
set or get the uuid of a query — wsreg_query_get_id, 585
set or get the uuid of a query — wsreg_query_set_id, 585
set or get the vendor of a component — wsreg_get_vendor, 602
set or get the vendor of a component — wsreg_set_vendor, 602
set or get the version of a component — wsreg_get_version, 603
set or get the version of a component — wsreg_set_version, 603
set or get the version of a query — wsreg_query_get_version, 589
set or get the version of a query — wsreg_query_set_version, 589
set the value of a property to the specified value — picl_set_propval, 389
set the value of a property to the specified value — picl_set_propval_by_name, 389
set layout values of a LayoutObject — m_setvalues_layout, 296
setac — get audit control file information, 199
setauclass — rewind audit_class database file, 201
setauuser — rewind audit_event database file, 204
setauthattr — get authorization database entry, 206
setauuser — get audit_user database entry, 209
setexecattr — get execution attribute database entry, 211
setprofattr — get profile description database entry, 215
setprojent — project database entry functions, 217
setuserattr — get user_attr entry, 221
shell global pattern matching — gmatch, 223
shutdown the session with the PICL daemon — picl_shutdown, 391
signal or wait for an event — rsm_intr_signal_post, 426
signal or wait for an event — rsm_intr_signal_wait, 426
significand — significand function, 489
significand function — significand, 489
simple difference and accumulate operations — cpc_event_accum, 68
simple difference and accumulate operations — cpc_event_diff, 68
sin — sine function, 490
sine function — sin, 490
sinh — hyperbolic sine function, 491
sort an ACL — aclsort, 22
sqrt — square root function, 492
square root function — sqrt, 492
SSAAgentIsAlive — Sun Solstice Enterprise Agent registration and communication helper functions, 493
SSAGetTrapPort — Sun Solstice Enterprise Agent registration and communication helper functions, 493
SSAOidCmp — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidCpy — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidDup — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidFree — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidInit — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidNew — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidString — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidToStrOid — Sun Solstice Enterprise Agent OID helper functions, 496
SSAOidZero — Sun Solstice Enterprise Agent OID helper functions, 496
SSARegSubagent — Sun Solstice Enterprise Agent registration and communication helper functions, 493
SSARegSubtable — Sun Solstice Enterprise Agent registration and communication helper functions, 493
SSARegSubtree — Sun Solstice Enterprise
Agent registration and communication
helper functions, 493
SSASendTrap — Sun Solstice Enterprise Agent
registration and communication helper
functions, 493
SSAStringCpy — Sun Solstice Enterprise Agent
string helper functions, 498
SSAStringInit — Sun Solstice Enterprise Agent
string helper functions, 498
SSAStringToChar — Sun Solstice Enterprise
Agent string helper functions, 498
SSAStringZero — Sun Solstice Enterprise Agent
string helper functions, 498
SSASubagentOpen — Sun Solstice Enterprise
Agent registration and communication
helper functions, 493
step — regular expression compile and match
routines, 413
strcadd — copy strings, compressing or
expanding C language escape codes, 499
strncpy — copy strings, compressing or
expanding C language escape codes, 499
streadd — copy strings, compressing or
expanding C language escape codes, 499
STREAMS
  determine whether a buffer of characters is
  encrypted — isencrypt, 226
  read stream up to next delimiter — bgets, 38
  split buffer into fields — bufsplit, 39
strepy — copy strings, compressing or
expanding C language escape codes, 499
strfind — string manipulations, 501
string manipulations — strfind, 501
       strsnp, 501
       strtrns, 501
string manipulations
  — strfind, 501
  — strsnp, 501
  — strtrns, 501
string operation, get PAM error message string
  — pam_strerror, 369
strings, copy, compressing or expanding C
language escape codes, 499
Sun::Solaris::Kstat — tied hash interface to the
kstat facility, 229
Sun Solstice Enterprise Agent OID helper
functions (Continued)
  — SSAOidCmp, 496
  — SSAOidCpy, 496
  — SSAOidDup, 496
  — SSAOidFree, 496
  — SSAOidInit, 496
  — SSAOidNew, 496
  — SSAOidString, 496
  — SSAOidStrToOid, 496
  — SSAOidZero, 496
Sun Solstice Enterprise Agent registration and
communication helper functions
  — SSAAgentIsAlive, 493
  — SSAGetTrapPort, 493
  — SSARegSubagent, 493
  — SSARegSubtable, 493
  — SSARegSubtree, 493
  — SSASendTrap, 493
  — SSASubagentOpen, 493
Sun Solstice Enterprise Agent string helper
functions
  — SSAStringCpy, 498
  — SSAStringInit, 498
  — SSAStringToChar, 498
  — SSAStringZero, 498
sysevent_free — free memory for sysevent
handle, 502
sysevent_get_attr_list — get attribute list
pointer, 503
sysevent_get_class_name — get class name,
subclass name, ID or buffer size of
event, 504
sysevent_get_event_id — get class name,
subclass name, ID or buffer size of
event, 504
sysevent_get_pid — get vendor name,
publisher name or processor ID of
event, 506
sysevent_get_pub_name — get vendor name,
publisher name or processor ID of
event, 506
sysevent_get_size — get class name, subclass
name, ID or buffer size of event, 504
sysevent_get_subclass_name — get class name,
subclass name, ID or buffer size of
event, 504
sysevent_get_vendor_name — get vendor name, publisher name or processor ID of event, 506

tan — tangent function, 510
tangent function — tan, 510
tanh — hyperbolic tangent function, 511
test access CPU performance counters —
cpc_access, 57
test for NaN — isnan, 227
tied hash interface to the kstat facility —
Sun::Solaris::Kstat, 229
TNF_DEBUG — probe insertion interface, 543
TNF_PROBE — probe insertion interface
arg_name_n, 546
arg_type_n, 545
arg_value_n, 546
detail, 544
keys, 544
name, 544
TNF_PROBE_0 — probe insertion interface, 543
TNF_PROBE_0_DEBUG — probe insertion interface, 543
TNF_PROBE_1 — probe insertion interface, 543
TNF_PROBE_1_DEBUG — probe insertion interface, 543
TNF_PROBE_2 — probe insertion interface, 543
TNF_PROBE_2_DEBUG — probe insertion interface, 543
TNF_PROBE_3 — probe insertion interface, 543
TNF_PROBE_3_DEBUG — probe insertion interface, 543
TNF_PROBE_4 — probe insertion interface, 543
TNF_PROBE_4_DEBUG — probe insertion interface, 543
TNF_PROBE_5 — probe insertion interface, 543
TNF_PROBE_5_DEBUG — probe insertion interface, 543

Index 627
tnfctl_probe_state_get — interfaces to query and to change the state of a probe, 530

tnfctl_probe_trace — interfaces to query and to change the state of a probe, 530

tnfctl_probe_untrace — interfaces to query and to change the state of a probe, 530

tnfctl_register_funcs — register callbacks for probe creation and destruction, 534

tnfctl_strerror — map a tnfctl error code to a string, 535

tnfctl_trace_attrs_get — get the trace attributes from a tnfctl handle, 536

tnfctl_trace_state_set — control kernel tracing and process filtering, 538

touchlock — functions to manage lockfile(s) for user’s mailbox, 272

translate strings to and from events — cpc_eventtostr, 78

translate strings to and from events — cpc_strtoevent, 78

U

update a property value — ptree_update_propval, 410

update a property value — ptree_update_propval_by_name, 410

use CPU performance counters on lwps — cpc_bind_event, 58

use CPU performance counters on lwps — cpc_rele, 58

use CPU performance counters on lwps — cpc_take_sample, 58

V

volmgt_acquire — reserve removable media device, 554

volmgt_check — have Volume Management check for media, 557

volmgt_feature_enabled — check whether specific Volume Management features are enabled, 559

volmgt_inuse — check whether or not Volume Management is managing a pathname, 560

volmgt_release — release removable media device reservation, 562

volmgt_root — return the Volume Management root directory, 563

volmgt_running — return whether or not Volume Management is running, 564

volmgt_symdev — convert between Volume Management symbolic names, and the devices that correspond to them, 565

volmgt_symname — convert between Volume Management symbolic names, and the devices that correspond to them, 565

VTOC, disk’s read a disk’s VTOC — read_vtoc, 411

write a disk’s VTOC — write_vtoc, 411

W

wait for a card to be inserted or removed — SCF_Card_waitForCardRemoved, 480

wait for a card to be inserted or removed — SCF_Terminal_waitForCardAbsent, 480

wait for a card to be inserted or removed — SCF_Terminal_waitForCardPresent, 480

wait for PICL tree to refresh — picl_wait, 393

write to a segment — rsm_memseg_import_put16, 444

write to a segment — rsm_memseg_import_put32, 444

write to a segment — rsm_memseg_import_put64, 444

write to a segment — rsm_memseg_import_put8, 444

write to a segment — rsm_memseg_import_put, 444

write to a segment using a list of I/O requests — rsm_memseg_import_getv, 446

write to a segment using a list of I/O requests — rsm_memseg_import_putv, 446

write_vtoc — read and write a disk’s VTOC, 411

wsreg_add_child_component — add or remove a child component, 567

wsreg_add_compatible_version — add or remove a backward compatible version, 569

wsreg_add_dependent_component — add or remove a dependent component, 571
wsreg_add_display_name — add, remove, or return a localized display name, 573
wsreg_add_required_component — add or remove a required component, 575
wsreg_can_access_registry — determine access to product install registry, 577
wsreg_clone_component — clone a component, 579
wsreg_components_equal — determine equality of two components, 580
wsreg_create_component — create or release a component, 581
wsreg_free_component — create or release a component, 581
wsreg_free_component_array — create or release a component, 581
wsreg_get_child_components — add or remove a child component, 567
wsreg_get_compatible_versions — add or remove a backward compatible version, 569
wsreg_get_data — add or retrieve a key-value pair, 592
wsreg_get_data_pairs — add or retrieve a key-value pair, 592
wsreg_get_dependent_components — add or remove a dependent component, 571
wsreg_get_display_languages — add, remove, or return a localized display name, 573
wsreg_get_display_name — add, remove, or return a localized display name, 573
wsreg_get_id — set or get the uuid of a component, 594
wsreg_get_instance — set or get the instance of a component, 595
wsreg_get_location — set or get the location of a component, 597
wsreg_get_parent — set or get the parent of a component, 598
wsreg_get_required_components — add or remove a required component, 575
wsreg_get_type — set or get the type of a component, 599
wsreg_get_unique_name — set or get the unique name of a component, 601
wsreg_get_vendor — set or get the vendor of a component, 602
wsreg_get_version — set or get the version of a component, 603
wsreg_initialize — initialize wsreg library, 583
wsreg_query_create — create a new query, 584
wsreg_query_free — create a new query, 584
wsreg_query_get_id — set or get the uuid of a query, 585
wsreg_query_get_instance — set or get the instance of a query, 586
wsreg_query_get_location — set or get the location of a query, 587
wsreg_query_get_unique_name — set or get the unique name of a query, 588
wsreg_query_get_version — set or get the version of a query, 589
wsreg_query_set_id — set or get the uuid of a query, 585
wsreg_query_set_instance — set or get the instance of a query, 586
wsreg_query_set_location — set or get the location of a query, 587
wsreg_query_set_unique_name — set or get the unique name of a query, 588
wsreg_query_set_version — set or get the version of a query, 589
wsreg_register — register a component in the product install registry, 590
wsreg_remove_child_component — add or remove a child component, 567
wsreg_remove_compatible_version — add or remove a backward compatible version, 569
wsreg_remove_dependent_component — add or remove a dependent component, 571
wsreg_remove_display_name — add, remove, or return a localized display name, 573
wsreg_remove_required_component — add or remove a required component, 573
wsreg_remove_required_component — add or remove a required component, 573
wsreg_set_data — add or retrieve a key-value pair, 592
wsreg_set_id — set or get the uuid of a component, 594
wsreg_set_instance — set or get the instance of a component, 595
wsreg_set_location — set or get the location of a component, 597
wsreg_set_parent — set or get the parent of a component, 598
wsreg_set_required_components — add or remove a required component, 575
wsreg_set_type — set or get the type of a component, 599

Index 629
wsreg_set_uninstaller — set or get the uninstaller of a component, 600
wsreg_set_unique_name — set or get the unique name of a component, 601
wsreg_set_vendor — set or get the vendor of a component, 602
wsreg_set_version — set or get the version of a component, 603
wsreg_unregister — remove a component from the product install registry, 604

Y
y0 — Bessel functions of the second kind, 606
y1 — Bessel functions of the second kind, 606
yn — Bessel functions of the second kind, 606