Sun Studio 12 Update 1: Fortran User's Guide

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Contents

Preface

The *Fortran User's Guide* describes the environment and command-line options for the Sun Studio Fortran compiler, **f95**. This guide is intended for scientists, engineers, and programmers who have a working knowledge of the Fortran language and wish to learn how to use the Sun Fortran compiler effectively. Familiarity with the Solaris operating environment or UNIX® in general is also assumed.

Discussion of Fortran programming issues on Solaris operating environments, including input/output, application development, library creation and use, program analysis, porting, optimization, and parallelization can be found in the companion *Fortran Programming Guide*.

Typographic Conventions

The following table describes the typographic conventions that are used in this book.

TABLE P–1 Typographic Conventions

Typeface	Meaning	Example
`AaBbCc123`	The names of commands, files, and directories, and onscreen computer output	Edit your `.login` file. Use `ls -a` to list all files. `machine_name% you have mail.`
`AaBbCc123`	What you type, contrasted with onscreen computer output	`machine_name%` **`su`** `Password:`
aabbcc123	Placeholder: replace with a real name or value	The command to remove a file is `rm` *filename*.

TABLE P–1 Typographic Conventions *(Continued)*

Typeface	Meaning	Example
AaBbCc123	Book titles, new terms, and terms to be emphasized	Read Chapter 6 in the *User's Guide*. A *cache* is a copy that is stored locally. Do *not* save the file. **Note:** Some emphasized items appear bold online.

- The symbol ∇ stands for a blank space where a blank is significant:

∇∇`36.001`

- The FORTRAN 77 standard used an older convention, spelling the name "FORTRAN" capitalized. The current convention is to use lower case: "Fortran"
- References to online man pages appear with the topic name and section number. For example, a reference to the library routine `GETENV` will appear as `getenv`(3F), implying that the man command to access this man page would be: `man -s 3F getenv`

Shell Prompts in Command Examples

The following table shows the default UNIX® system prompt and superuser prompt for the C shell, Bourne shell, and Korn shell.

TABLE P–2 Shell Prompts

Shell	Prompt
C shell	`machine_name%`
C shell for superuser	`machine_name#`
Bourne shell and Korn shell	`$`
Bourne shell and Korn shell for superuser	`#`

Supported Platforms

This Sun™ Studio release supports systems that use the SPARC® and x86 families of processor architectures: UltraSPARC®, SPARC64, AMD64, Pentium, and Xeon EM64T. The supported systems for the version of the Solaris Operating System you are running are available in the hardware compatibility lists at `http://www.sun.com/bigadmin/hcl`. These documents cite any implementation differences between the platform types.

In this document, these x86 related terms mean the following:

- "x86" refers to the larger family of 64–bit and 32–bit x86 compatible products.
- "x64" points out specific 64–bit information about AMD64 or EM64T systems.
- "32–bit x86" points out specific 32–bit information about x86 based systems.

For supported systems, see the hardware compatibility lists.

Accessing Sun Studio Documentation

You can access the documentation at the following locations:

- The documentation is available from the documentation index page at `http://developers.sun.com/sunstudio/documentation`.
- Online help for all components of the IDE is available through the Help menu, as well as through Help buttons on many windows and dialog boxes, in the IDE.
- Online help for the Performance Analyzer is available through the Help menu, as well as through Help buttons on many windows and dialog boxes, in the Performance Analyzer.

The `docs.sun.com` web site (`http://docs.sun.com`) enables you to read, print, and buy Sun Microsystems manuals through the Internet.

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Documentation in Accessible Formats

The documentation is provided in accessible formats that are readable by assistive technologies for users with disabilities. You can find accessible versions of documentation as described in the following table.

Type of Documentation	Format and Location of Accessible Version
Manuals	HTML at `http://docs.sun.com`
Readmes	HTML on the developer portal at http://developers.sun.com/sunstudio/documentation/ss12u1/

Type of Documentation	Format and Location of Accessible Version
Man pages	HTML on the developer portal at http://developers.sun.com/sunstudio/documentation/ss12u1/
Online help	HTML available through the Help menu and Help buttons in the IDE
Release notes	HTML at `http://docs.sun.com`

Resources for Developers

Visit `http://developers.sun.com/sunstudio` to find these frequently updated resources:

- Articles on programming techniques and best practices
- Documentation of the software, as well as corrections to the documentation that is installed with your software
- Tutorials that take you step-by-step through development tasks using Sun Studio tools
- Information on support levels
- User forums
- Downloadable code samples
- New technology previews

The Sun Studio portal is one of a number of additional resources for developers at the Sun Developer Network web site, `http://developers.sun.com`.

Contacting Technical Support

If you have technical questions about this product that are not answered in this document, go to `http://www.sun.com/service/contacting`

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Please include the part number of the document in the subject line of your email. For example, the part number for this document is 820-7600–10.

◆ ◆ ◆ CHAPTER 1

1 Introduction

The Sun™ Studio Fortran compiler, **f95**, described here and in the companion *Fortran Programming Guide,* is available under the Solaris™ operating environment on SPARC®, UltraSPARC®, and x64/x86 platforms, and Linux environments on x86/x64 platforms. The compiler conforms to published Fortran language standards, and provides many extended features, including multiprocessor parallelization, sophisticated optimized code compilation, and mixed C/Fortran language support.

The **f95** compiler also provides a Fortran 77 compatibility mode that accepts most legacy Fortran 77 source codes. A separate Fortran 77 compiler is no longer included. See Chapter 5 for information on FORTRAN 77 compatibility and migration issues.

1.1 Standards Conformance

- **f95** conforms to part one of the ISO/IEC 1539-1:1997 Fortran standards document.
- Floating-point arithmetic is based on IEEE standard 754-1985, and international standard IEC 60559:1989.
- **f95** provides support for the optimization-exploiting features of the SPARC and x86 families of processor architectures: UltraSPARC, SPARC64, AMD64, Pentium Pro, and Xeon Intel® 64, on Solaris and Linux (x86) platforms.
- Sun Studio compilers conform to the OpenMP 3.0 shared memory parallelization API specifications. See the *OpenMP API User's Guide* for details.
- In this document, “Standard” means conforming to the versions of the standards listed above. “Non-standard” or “Extension” refers to features that go beyond these versions of these standards.

The responsible standards bodies may revise these standards from time to time. The versions of the applicable standards to which these compilers conform may be revised or replaced, resulting in features in future releases of the Sun Fortran compilers that create incompatibilities with earlier releases.

1.2 Features of the Fortran Compiler

The Sun Studio Fortran compiler, **f95**, provides the following features and extensions:

- Global program checking across routines for consistency of arguments, commons, parameters, and the like. (Only available on Solaris platforms).
- Optimized automatic and explicit loop parallelization for multiprocessor systems.
- VAX/VMS Fortran extensions, including:
  - Structures, records, unions, maps
  - Recursion
- OpenMP 3.0 parallelization directives.
- Global, peephole, and potential parallelization optimizations produce high performance applications. Benchmarks show that optimized applications can run significantly faster when compared to unoptimized code.
- Common calling conventions permit routines written in C or C++ to be combined with Fortran programs.
- Support for 64-bit enabled Solaris and Linux environments.
- Call-by-value using **%VAL**.
- Compatibility between Fortran 77 and Fortran 95/Fortran 2003 programs and object binaries.
- Interval Arithmetic programming.
- Some Fortran 2003 features, including Stream I/O.

See Appendix B for details on new and extended features added to the compiler with each software release.

1.3 Other Fortran Utilities

The following utilities provide assistance in the development of software programs in Fortran:

- **Sun Studio Performance Analyzer**— In depth performance analysis tool for single threaded and multi-threaded applications. See **analyzer**(1).
- **asa**— This Solaris utility is a Fortran output filter for printing files that have Fortran carriage-control characters in column one. Use **asa** to transform files formatted with Fortran carriage-control conventions into files formatted according to UNIX line-printer conventions. See **asa**(1).
- **fdumpmod**— A utility to display the names of modules contained in a file or archive. See **fdumpmod**(1).
- **fpp**— A Fortran source code preprocessor. See **fpp**(1).

- **fsplit** — This utility splits one Fortran file of several routines into several files, each with one routine per file. See **fsplit**(1)

1.4 Debugging Utilities

The following debugging utilities are available:

- **-Xlist**— A compiler option to check across routines for consistency of arguments, COMMON blocks, and so on. (Solaris platforms only)
- **Sun Studio dbx**—Provides a robust and feature-rich runtime and static debugger, and includes a performance data collector.

1.5 Sun Performance Library

The Sun Performance Library™ is a library of optimized subroutines and functions for computational linear algebra and Fourier transforms. It is based on the standard libraries LAPACK, BLAS1, BLAS2, BLAS3, FFTPACK, VFFTPACK, and LINPACK generally available through Netlib (**www.netlib.org**).

Each subprogram in the Sun Performance Library performs the same operation and has the same interface as the standard library versions, but is generally much faster and accurate and can be used in a multiprocessing environment.

See the **performance_library** README file, and the *Sun Performance Library User's Guide* for details. (Man pages for the performance library routines are in section 3P.)

1.6 Interval Arithmetic

The **f95** compiler provides the compiler flags **-xia** and **-xinterval** to enable new language extensions and generate the appropriate code to implement interval arithmetic computations. See the *Fortran 95 Interval Arithmetic Programming Reference* for details. (Interval arithmetic features are only supported on SPARC/UltraSPARC platforms.)

1.7 Man Pages

Online manual (**man**) pages provide immediate documentation about a command, function, subroutine, or collection of such things. The user's **MANPATH** environment variable should be set to the path to the installed Sun Studio **man** directory to access the Sun Studio **man** pages.

You can display a man page by running the command:

```
demo% man topic
```

Throughout the Fortran documentation, man page references appear with the topic name and man section number: **f95**(1) is accessed with **man f95**. Other sections, denoted by **ieee_flags**(3M) for example, are accessed using the **-s** option on the **man** command:

```
demo% man -s 3M ieee_flags
```

The Fortran library routines are documented in the man page section 3F.

The following lists **man** pages of interest to Fortran users:

f95(1)	The Fortran 95 command-line options
analyzer(1)	Sun Studio Performance Analyzer
asa(1)	Fortran carriage-control print output post-processor
dbx(1)	Command-line interactive debugger
fpp(1)	Fortran source code pre-processor
cpp(1)	C source code pre-processor
fdumpmod(1)	Display contents of a MODULE (**.mod**) file.
fsplit(1)	Pre-processor splits Fortran source routines into single files
ieee_flags(3M)	Examine, set, or clear floating-point exception bits
ieee_handler(3M)	Handle floating-point exceptions
matherr(3M)	Math library error handling routine
ld(1)	Link editor for object files

1.8 README Files

The **README** pages on the Sun Developer Network (SDN) portal (`http://developers.sun.com/sunstudio/`) describe new features, software incompatibilities, bugs, and information that was discovered after the manuals were printed. These README pages are part of the documentation on the portal for this release, and are also linked from the HTML documentation index that is part of the installed software at `file:/opt/SUNWspro/docs`.

TABLE 1–1 README Pages of Interest

README Page	Describes...
fortran_95	new and changed features, known limitations, documentation errata for this release of the Fortran compiler, **f95**.
fpp_readme	overview of **fpp** features and capabilities
interval_arithmetic	overview of the interval arithmetic features in **f95**
math_libraries	optimized and specialized math libraries available.
profiling_tools	using the performance profiling tools, **prof**, **gprof**, and **tcov**.
runtime_libraries	libraries and executables that can be redistributed under the terms of the End User License.
performance_library	overview of the Sun Performance Library
openmp	new and changed features in the OpenMP parallelization API

The URL to the **README** page is displayed by the **-xhelp=readme** command-line option. For example, the command:

```
% f95 -xhelp=readme
```

displays the URL for viewing the **fortran_95** README for this release on the SDN portal.

1.9 Command-Line Help

You can view very brief descriptions of the **f95** command line options by invoking the compiler's **-help** option as shown below:

```
%f95 -help=flags
Items within [ ] are optional. Items within < > are variable parameters.
Bar | indicates choice of literal values.
-someoption[={yes|no}] implies -someoption is equivalent to -someoption=yes

_____________________________________________________________
-a                  Collect data for tcov basic block profiling
-aligncommon[=<a>] Align common block elements to the specified
                    boundary requirement; <a>={1|2|4|8|16}
-ansi               Report non-ANSI extensions.
-autopar            Enable automatic loop parallelization
-Bdynamic           Allow dynamic linking
-Bstatic            Require static linking
-C                  Enable runtime subscript range checking
-c                  Compile only; produce .o files but suppress
```

```
                                linking
...etc.
```

◆ ◆ ◆ CHAPTER 2

Using Sun Studio Fortran

This chapter describes how to use the Fortran compiler.

The principal use of any compiler is to transform a program written in a procedural language like Fortran into a data file that is executable by the target computer hardware. As part of its job, the compiler may also automatically invoke a system linker to generate the executable file.

The compiler can also be used to:

- Generate a parallelized executable file for multiple processors (**`-openmp`**).
- Analyze program consistency across source files and subroutines and generate a report (**`-Xlist`**).
- Transform source files into:
  - Relocatable binary (**`.o`**) files, to be linked later into an executable file or static library (**`.a`**) file.
  - A dynamic shared library (**`.so`**) file (**`-G`**).

  Link files into an executable file.
- Compile an executable file with runtime debugging enabled (**`-g`**).
- Compile with runtime statement or procedure level profiling (**`-pg`**).
- Check source code for ANSI standards conformance (**`-ansi`**).

2.1 A Quick Start

This section provides a quick overview of how to use the Fortran compiler to compile and run Fortran programs. A full reference to command-line options appears in the next chapter.

The very basic steps to running a Fortran application involve using an editor to create a Fortran source file with a **.f**, **.for**, **.f90**, **.f95**, **.F**, **.F90**, or **.F95** filename suffix; invoking the compiler to produce an executable; and finally, launching the program into execution by typing the name of the file:

Example: This program displays a message on the screen:

```
demo% cat greetings.f
      PROGRAM GREETINGS
      PRINT *, 'Real programmers write Fortran!'
      END
demo% f95 greetings.f
demo% a.out
 Real programmers write Fortran!
demo%
```

In this example, **f95** compiles source file **greetings.f** and links the executable program onto the file, **a.out**, by default. To launch the program, the name of the executable file, **a.out**, is typed at the command prompt.

Traditionally, UNIX compilers write executable output to the default file called **a.out**. It can be awkward to have each compilation write to the same file. Moreover, if such a file already exists, it will be overwritten by the next run of the compiler. Instead, use the **-o** compiler option to explicitly specify the name of the executable output file:

```
demo% f95 -o greetings greetings.f
demo% greetings
 Real programmers write Fortran!
demo%
```

In the preceding example, the **-o** option tells the compiler to write the executable code to the file **greetings**. (By convention, executable files usually are given the same name as the main source file, but without an extension.)

Alternatively, the default **a.out** file could be renamed via the **mv** command after each compilation. Either way, run the program by typing the name of the executable file at a shell prompt.

The next sections of this chapter discuss the conventions used by the **f95** commands, compiler source line directives, and other issues concerning the use of these compiler. The next chapter describes the command-line syntax and all the options in detail.

2.2 Invoking the Compiler

The syntax of a *simple* compiler command invoked at a shell prompt is:

f95 [*options*] *files...*

Here *files*… is one or more Fortran source file names ending in **.f**, **.F**, **.f90**, **.f95**, **.F90**, **.F95**, or **.for**; *options* is one or more of the compiler option flags. (Files with names ending in a **.f90** or **.f95** extension are "free-format" Fortran 95 source files recognized only by the **f95** compiler.)

In the example below, **f95** is used to compile two source files to produce an executable file named **growth** with runtime debugging enabled:

```
demo% f95 -g -o growth growth.f fft.f95
```

Note – You can invoke the Fortran compiler with either the **f95** or **f90** command.

New: The compiler will also accept source files with the extension **.f03** or **.F03**. These are treated as equivalent to **.f95** and **.F95** and could be used as a way to indicate that a source file contains Fortran 2003 extensions.

"2.2.2 Command-Line File Name Conventions" on page 25, describes the various source file extensions accepted by the compiler.

2.2.1 Compile-Link Sequence

In the previous example, the compiler automatically generates the loader object files, **growth.o** and **fft.o**, and then invokes the system linker to create the executable program file **growth**.

After compilation, the object files, **growth.o** and **fft.o**, will remain. This convention permits easy relinking and recompilation of files.

If the compilation fails, you will receive a message for each error. No **.o** files are generated for those source files with errors, and no executable program file is written.

2.2.2 Command-Line File Name Conventions

The suffix extension attached to file names appearing on the command-line determine how the compiler will process the file. File names with a suffix extension other than one of those listed below, or without an extension, are passed to the linker.

TABLE 2–1 Filename Suffixes Recognized by the Fortran Compiler

Suffix	Language	Action
.f	Fortran 77 or Fortran 95 fixed-format	Compile Fortran source files, put object files in current directory; default name of object file is that of the source but with **.o** suffix.
.f95.f90	Fortran 95 free-format	Same action as **.f**
.f03	Fortran 2003 free-format	Same action as **.f**
.for	Fortran 77 orFortran 95	Same action as **.f**.
.F	Fortran 77 or Fortran 95 fixed-format	Apply the Fortran (or C) preprocessor to the Fortran 77 source file before compilation.
.F95.F90	Fortran 95 free-format	Apply the Fortran (or C) preprocessor to the Fortran 95 free-format source file before Fortran compiles it.
.F03	Fortran 2003 free-format	Same as **.F95**
.s	Assembler	Assemble source files with the assembler.
.S	Assembler	Apply the C preprocessor to the assembler source file before assembling it.
.il	Inline expansion	Process template files for inline expansion. The compiler will use templates to expand inline calls to selected routines. (Template files are special assembler files; see the **inline**(1) man page.)
.o	Object files	Pass object files through to the linker.
.a,**.s.o**,**.so.***n*	Libraries	Pass names of libraries to the linker. **.a** files are static libraries, **.so** and **.so.***n* files are dynamic libraries.

Fortran 95 free-format is described in "4.1 Source Language Features" on page 141.

2.2.3 Source Files

The Fortran compiler will accept multiple source files on the command line. A single source file, also called a *compilation unit*, may contain any number of procedures (main program, subroutine, function, block data, module, and so on). Applications may be configured with one source code procedure per file, or by gathering procedures that work together into single files. The *Fortran Programming Guide* describes the advantages and disadvantages of these configurations.

2.2.4 Source File Preprocessors

f95 supports two source file preprocessors, **fpp** and **cpp**. Either can be invoked by the compiler to expand source code "macros" and symbolic definitions prior to compilation. The compiler will use **fpp** by default; the **-xpp=cpp** option changes the default from **fpp** to **cpp**. (See also the discussion of the **-D***name* option).

fpp is a Fortran-specific source preprocessor. See the **fpp**(1) man page and the **fpp** README for details. It is invoked by default on files with a **.F**, **.F90**, **F95,** or **.F03** extension.

The source code for **fpp** is available from the Netlib web site at

`http://www.netlib.org/fortran/`

See **cpp**(1) for information on the standard Unix C language preprocessor. Use of **fpp** over **cpp** is recommended on Fortran source files.

2.2.5 Separate Compiling and Linking

You can compile and link in separate steps. The **-c** option compiles source files and generates **.o** object files, but does not create an executable. Without the **-c** option the compiler will invoke the linker. By splitting the compile and link steps in this manner, a complete recompilation is not needed just to fix one file, as shown in the following example:

Compile one file and link with others in separate steps:

```
demo% f95 -c file1.f                          (Make new object file)
demo% f95 -o prgrm file1.o file2.o file3.o        (Make executable file)
```

Be sure that the link step lists *all* the object files needed to make the complete program. If any object files are missing from this step, the link will fail with undefined external reference errors (missing routines).

2.2.6 Consistent Compiling and Linking

Ensuring a consistent choice of compiling and linking options is critical whenever compilation and linking are done in separate steps. Compiling any part of a program with some options requires linking with the same options. Also, a number of options require that *all* source files be compiled with that option, *including* the link step.

The option descriptions in Chapter 3 identify such options.

Example: Compiling **sbr.f** with **-fast**, compiling a C routine, and then linking in a separate step:

```
demo% f95 -c -fast sbr.f
demo% cc -c -fast simm.c
demo% f95 -fast sbr.o simm.o          link step; passes  -fast  to the linker
```

2.2.7 Unrecognized Command-Line Arguments

Any arguments on the command-line that the compiler does not recognize are interpreted as being possibly linker options, object program file names, or library names.

The basic distinctions are:

- Unrecognized *options* (with a **-**) generate warnings.
- Unrecognized *non-options* (no **-**) generate no warnings. However, they are passed to the linker and if the linker does not recognize them, they generate linker error messages.

For example:

```
demo% f95 -bit move.f                 <- -bit is not a recognized f95 option
f95: Warning: Option -bit passed to ld, if ld is invoked, ignored otherwise
demo% f95 fast move.f                 <- The user meant to type -fast
ld: fatal: file fast: cannot open file; errno=2
ld: fatal: File processing errors.  No output written to a.out
```

Note that in the first example, **-bit** is not recognized by **f95** and the option is passed on to the linker (**ld**), who tries to interpret it. Because single letter **ld** options may be strung together, the linker sees **-bit** as **-b -i -t**, which are all legitimate **ld** options! This may (or may not) be what the user expects, or intended.

In the second example, the user intended to type the **f95** option **-fast** but neglected the leading dash. The compiler again passes the argument to the linker which, in turn, interprets it as a file name.

These examples indicate that extreme care should be observed when composing compiler command lines!

2.2.8 Modules

f95 automatically creates module information files for each **MODULE** declaration encountered in the source files, and searches for modules referenced by a **USE** statement. For each module encountered (**MODULE** *module_name*), the compiler generates a corresponding file, *module_name***.mod**, in the current directory. For example, **f95** generates the module information file **list.mod** for the **MODULE list** unit found on file **mysrc.f95** .

See the **-M***path* and **-moddir** *dirlist* option flags for information on how to set the defaults paths for writing and searching for module information files.

See also the **-use** compiler option for implicitly invoking **MODULE** declarations in all compilation units.

Use the **fdumpmod**(1) command to display information about the contents of a **.mod** module information file.

For detailed information, see "4.9 Module Files" on page 163.

2.3 Directives

Use a source code *directive*, a form of Fortran comment, to pass specific information to the compiler regarding special optimization or parallelization choices. Compiler directives are also sometimes called *pragmas.* The compiler recognize a set of general directives and parallelization directives. **f95** also processes OpenMP shared memory multiprocessing directives.

Directives unique to **f95** are described in "4.8 Directives" on page 161. A complete summary of all the directives recognized by **f95** appears in Table C–1.

Note – Directives are not part of the Fortran standard.

2.3.1 General Directives

The various forms of a general Fortran directive are:

C$PRAGMA *keyword* **(** *a* [, *a*] … **)** [, *keyword* **(** *a* [, *a*] … **)**] ,…

C$PRAGMA SUN *keyword* **(** *a* [, *a*] … **)** [, *keyword* (*a* [, *a*] … **)**] ,…

C$PRAGMA SPARC *keyword* **(** *a* [, *a*] … **)** [, *keyword* **(** *a* [, *a*] … **)**] ,…

The variable *keyword* identifies the specific directive. Additional arguments or suboptions may also be allowed. (Some directives require the additional keyword **SUN** or **SPARC**, as shown above.)

A general directive has the following syntax:

- In column one, any of the comment-indicator characters **c**, **C**, **!**, or ***
- For **f95** free-format, **!** is the only comment-indicator recognized (**!$PRAGMA**). The examples in this chapter assume fixed-format.
- The next seven characters are **$PRAGMA**, no blanks, in either uppercase or lowercase.
- Directives using the **!** comment-indicator character may appear in any position on the line for free-format source programs.

Observe the following restrictions:

- After the first eight characters, blanks are ignored, and uppercase and lowercase are equivalent, as in Fortran text.
- Because it is a comment, a directive cannot be continued, but you can have many **C$PRAGMA** lines, one after the other, as needed.
- If a comment satisfies the above syntax, it is expected to contain one or more directives recognized by the compiler; if it does not, a warning is issued.
- The C preprocessor, **cpp**, will expand macro symbol definitions within a comment or directive line; the Fortran preprocessor, **fpp**, will not expand macros in comment lines. **fpp** will recognize legitimate **f95** directives and allow limited substitution outside directive keywords. However, be careful with directives requiring the keyword **SUN**. **cpp** will replace lower-case **sun** with a predefined value. Also, if you define a **cpp** macro **SUN**, it might interfere with the **SUN** directive keyword. A general rule would be to spell those pragmas in mixed case if the source will be processed by **cpp** or **fpp**, as in:

  ```
  C$PRAGMA Sun UNROLL=3
  ```

The Fortran compiler recognize the following general directives:

TABLE 2–2 Summary of General Fortran Directives

C *Directive*	**C$PRAGMA C(***list***)** Declares a list of names of external functions as C language routines.
IGNORE_TKR *Directive*	**C$PRAGMA IGNORE_TKR** {*name* {, *name*} ...} The compiler ignores the type, kind, and rank of the specified dummy argument names appearing in a generic procedure interface when resolving a specific call.
UNROLL *Directive*	**C$PRAGMA SUN UNROLL=***n* Advises the compiler that the following loop can be unrolled to a length *n*.
WEAK *Directive*	**C$PRAGMA WEAK(***name*[**=***name2*]**)** Declares *name* to be a weak symbol, or an alias for *name2*.
OPT *Directive*	**C$PRAGMA SUN OPT=***n* Set optimization level for a subprogram to *n*.
PIPELOOP *Directive*	**C$PRAGMA SUN PIPELOOP=***n* Assert dependency in the following loop exists between iterations *n* apart.

TABLE 2–2 Summary of General Fortran Directives *(Continued)*

PREFETCH *Directives*	**C$PRAGMA SUN_PREFETCH_READ_ONCE(***name***)C$PRAGMA SUN_PREFETCH_READ_MANY(***name***)C$PRAGMA SUN_PREFETCH_WRITE_ONCE(***name***)C$PRAGMA SUN_PREFETCH_WRITE_MANY(***name***)** Request compiler generate prefetch instructions for references to name. (Requires **-xprefetch** option, which is enabled by default. Prefetch directives can be disabled by compiling with **–xprefetch=no**. Target architecture must also support prefetch instructions, and the compiler optimization level must be greater than **–xO2**.)
ASSUME *Directives*	**C$PRAGMA** [**BEGIN**} **ASSUME (***expression* [**,***probability*]**)** **C$PRAGMA END ASSUME** Make assertions about conditions at certain points in the program that the compiler can assume are true.

2.3.1.1 The C Directive

The **C()** directive specifies that its arguments are external functions.It is equivalent to an **EXTERNAL** declaration except that unlike ordinary external names, the Fortran compiler will not append an underscore to these argument names. See the C-Fortran Interface chapter in the *Fortran Programming Guide* for more details.

The **C()** directive for a particular function should appear before the first reference to that function in each subprogram that contains such a reference.

Example - compiling **ABC** and **XYZ** for **C**:

```
      EXTERNAL ABC, XYZ
C$PRAGMA C(ABC, XYZ)
```

2.3.1.2 The IGNORE_TKR Directive

This directive causes the compiler to ignore the type, kind, and rank of the specified dummy argument names appearing in a generic procedure interface when resolving a specific call.

For example, in the procedure interface below, the directive specifies that **SRC** can be any data type, but **LEN** can be either **KIND=4** or **KIND=8**.The interface block defines two specific procedures for a generic procedure name.This example is shown in Fortran 95 free format.

```
INTERFACE BLCKX

SUBROUTINE BLCK_32(LEN,SRC)
  REAL SRC(1)
!$PRAGMA IGNORE_TKR SRC
  INTEGER (KIND=4) LEN
```

```
END SUBROUTINE

SUBROUTINE BLCK_64(LEN,SRC)
  REAL SRC(1)
!$PRAGMA IGNORE_TKR SRC
  INTEGER (KIND=8) LEN
END SUBROUTINE

END INTERFACE
```

The subroutine call:

```
INTEGER L
REAL S(100)
CALL BLCKX(L,S)
```

The call to **BLCKX** will call **BLCK_32** when compiled normally, and **BLCK_64** when compiled with **-xtypemap=integer:64**. The actual type of **S** does not determine which routine to call. This greatly simplifies writing generic interfaces for wrappers that call specific library routines based on argument type, kind, or rank.

Note that dummy arguments for assumed-shape arrays, Fortran pointers, or allocatable arrays cannot be specified on the directive. If no names are specified, the directive applies to all dummy arguments to the procedure, except dummy arguments that are assumed-shape arrays, Fortran pointers, or allocatable arrays.

2.3.1.3 The UNROLL Directive

The **UNROLL** directive requires that you specify **SUN** after **C$PRAGMA**.

The **C$PRAGMA SUN UNROLL=***n* directive instructs the compiler to unroll the following loop *n* times during its optimization pass. (The compiler will unroll a loop only when its analysis regards such unrolling as appropriate.)

n is a positive integer. The choices are:

- If *n*=1, the optimizer *may not* unroll any loops.
- If *n*>1, the optimizer *may* unroll loops *n* times.

If any loops are actually unrolled, the executable file becomes larger. For further information, see the *Fortran Programming Guide* chapter on performance and optimization.

Example - unrolling loops two times:

```
C$PRAGMA SUN UNROLL=2
```

2.3.1.4 The WEAK Directive

The **WEAK** directive defines a symbol to have less precedence than an earlier definition of the same symbol. This pragma is used mainly in sources files for building libraries. The linker does not produce an error message if it is unable to resolve a weak symbol.

```
C$PRAGMA WEAK (name1 [=name2])
```

WEAK (*name1*) defines *name1* to be a weak symbol. The linker does not produce an error message if it does not find a definition for *name1*.

WEAK (*name1*=*name2*) defines *name1* to be a weak symbol and an alias for *name2*.

If your program calls but does not define *name1*, the linker uses the definition from the library. However, if your program defines its own version of *name1*, then the program's definition is used and the weak global definition of *name1* in the library is not used. If the program directly calls *name2*, the definition from library is used; a duplicate definition of *name2* causes an error. See the Solaris *Linker and Libraries Guide* for more information.

2.3.1.5 The OPT Directive

The **OPT** directive requires that you specify **SUN** after **C$PRAGMA**.

The **OPT** directive sets the optimization level for a subprogram, overriding the level specified on the compilation command line. The directive must appear immediately before the target subprogram, and only applies to that subprogram. For example:

```
C$PRAGMA SUN OPT=2
        SUBROUTINE smart(a,b,c,d,e)
            ...etc
```

When the above is compiled with an **f95** command that specifies **-O4**, the directive will override this level and compile the subroutine at **-O2**. Unless there is another directive following this routine, the next subprogram will be compiled at **-O4**.

The routine must also be compiled with the **-xmaxopt**[=*n*] option for the directive to be recognized. This compiler option specifies a maximum optimization value for **PRAGMA OPT** directives: if a **PRAGMA OPT** specifies an optimization level greater than the **-xmaxopt** level, the **-xmaxopt** level is used.

2.3.1.6 The PIPELOOP[=*n*] Directive

The **PIPELOOP=***n* directive requires that you specify **SUN** after **C$PRAGMA**.

This directive must appear immediately before a DO loop. *n* is a positive integer constant, or zero, and asserts to the optimizer a dependence between loop iterations. A value of zero indicates that the loop has no inter-iteration (loop-carried) dependencies and can be freely

pipelined by the optimizer. A positive *n* value implies that the I-th iteration of the loop has a dependency on the (I-*n*)-th iteration, and can be pipelined at best for only *n* iterations at a time. (Default if *n* is not specified is 0)

```
C    We know that the value of K is such that there can be no
C    cross-iteration dependencies (E.g. K>N)
C$PRAGMA SUN PIPELOOP=0
      DO I=1,N
       A(I)=A(I+K) + D(I)
       B(I)=B(I) + A(I)
      END DO
```

For more information on optimization, see the *Fortran Programming Guide.*

2.3.1.7 The PREFETCH Directives

The **-xprefetch** option flag, "3.4.157 **–xprefetch**[=*a*[,*a*]] on page 126, enables a set of **PREFETCH** directives that advise the compiler to generate prefetch instructions for the specified data element on processors that support prefetch.

```
C$PRAGMA SUN_PREFETCH_READ_ONCE(name)
C$PRAGMA SUN_PREFETCH_READ_MANY(name)
C$PRAGMA SUN_PREFETCH_WRITE_ONCE(name)
C$PRAGMA SUN_PREFETCH_WRITE_MANY(name)
```

See also the *C User's Guide*, or the *SPARC Architecture Manual, Version 9* for further information about prefetch instructions.

2.3.1.8 The ASSUME Directives

The **ASSUME** directive gives the compiler hints about conditions at certain points in the program. These assertions can help the compiler to guide its optimization strategies. The programmer can also use these directives to check the validity of the program during execution. There are two formats for **ASSUME**.

The syntax of the "point assertion" **ASSUME** is

```
C$PRAGMA ASSUME (expression [,probability])
```

Alternatively, the "range assertion" **ASSUME** is:

```
C$PRAGMA BEGIN ASSUME [expression [, probability)
      block of statements
C$PRAGMA END ASSUME
```

Use the point assertion form to state a condition that the compiler can assume at that point in the program. Use the range assertion form to state a condition that holds over the enclosed range of statements. The **BEGIN** and **END** pairs in a range assertion must be properly nested.

The required *expression* is a boolean expression that can be evaluated at that point in the program that does not involve user-defined operators or function calls except for those listed below.

The optional *probability* value is a real number from 0.0 to 1.0, or an integer 0 or 1, giving the probability of the expression being true. A probability of 0.0 (or 0) means never true, and 1.0 (or 1) means always true. If not specified, the expression is considered to be true with a high probability, but not a certainty. An assertion with a probability other than exactly 0 or 1 is a *non-certain assertion*. Similarly, an assertion with a probability expressed exactly as 0 or 1 is a *certain assertion*.

For example, if the programmer knows that the length of a **DO** loop is always greater than 10,000, giving this hint to the compiler can enable it to produce better code. The following loop will generally run faster with the **ASSUME** pragma than without it.

```
C$PRAGMA BEGIN ASSUME(__tripcount().GE.10000,1) !! a big loop
        do i = j, n
           a(i) = a(j) + 1
        end do
C$PRAGMA END ASSUME
```

Two intrinsic functions are available for use specifically in the expression clause of the **ASSUME** directive. (Note that their names are prefixed by two underscores.)

__branchexp()	Use in point assertions placed immediately before a branching statement with a boolean controlling expression. It yields the same result as the boolean expression controlling the branching statement.
__tripcount()	Yields the trip count of the loop immediately following or enclosed by the directive. When used in a point assertion, the statement following the directive must be the first line of a **DO**. When used in a range assertion, it applies to the outermost enclosed loop.

This list of special intrinsics might expand in future releases.

Use with the **-xassume_control** compiler option. (See "3.4.111 **–xassume_control**[=*keywords*]" on page 99) For example, when compiled with **-xassume_control=check**, the example above would produce a warning if the trip count ever became less than 10,000.

Compiling with **-xassume_control=retrospective** will generate a summary report at program termination of the truth or falsity of all assertions. See the **f95** man page for details on **-xassume_control**.

Another example:

```
C$PRAGMA ASSUME(__tripcount.GT.0,1)
       do i=n0, nx
```

Compiling the above example with **-xassume_control=check** will issue a runtime warning should the loop not be taken because the trip count is zero or negative.

2.3.2 Parallelization Directives

Parallelization directives explicitly request the compiler to attempt to parallelize the **DO** loop or the region of code that follows the directive. The syntax differs from general directives. Parallelization directives are only recognized when compiling with **-openmp**. Details regarding Fortran parallelization can be found in the *OpenMP API User's Guide* and the *Fortran Programming Guide*.

The Fortran compiler supports the OpenMP 3.0 shared memory parallelization model. Legacy Sun and Cray parallelization directives are now deprecated and should not be used.

2.3.2.1 OpenMP Parallelization Directives

The Fortran compiler recognizes the OpenMP Fortran shared memory multiprocessing API as the preferred parallel programming model. The API is specified by the OpenMP Architecture Review Board (`http://www.openmp.org`).

You must compile with the command-line option **-xopenmp**, to enable OpenMP directives. (see "3.4.149 **–xopenmp**[={**parallel**|**noopt**|**none**}]" on page 123.)

For more information about the OpenMP directives accepted by **f95**, see the *OpenMP API User's Guide*.

2.3.2.2 Legacy Sun/Cray Parallelization Directives

Note – Legacy Sun and Cray style parallelization directives are now deprecated. The OpenMP parallelization API is preferred. Information on how to migrate from legacy Sun/Cray directives to the OpenMP model appears in the *OpenMP API User's Guide*.

2.4 Library Interfaces and `system.inc`

The Fortran compiler provides an include file, **system.inc**, that defines the interfaces for most non-intrinsic library routines. Declare this include file to insure that functions you call and their arguments are properly typed, especially when default data types are changed with **-xtypemap**.

For example, the following may produce an arithmetic exception because function **getpid()** is not explicitly typed:

```
integer(4) mypid
mypid = getpid()
print *, mypid
```

The **getpid()** routine returns an integer value but the compiler assumes it returns a real value if no explicit type is declared for the function. This value is further converted to integer, most likely producing a floating-point error.

To correct this you should explicitly type **getuid()** and functions like it that you call:

```
integer(4) mypid, getpid
mypid = getpid()
print *, mypid
```

Problems like these can be diagnosed with the **-Xlist** (global program checking) option. The Fortran include file **"system.inc'** provides explicit interface definitions for these routines.

```
include 'system.inc'
integer(4) mypid
mypid = getpid()
print *, mypid
```

Including **system.inc** in program units calling routines in the Fortran library will automatically define the interfaces for you, and help the compiler diagnose type mismatches. (See the *Fortran Library Reference* for more information.)

2.5 Compiler Usage Tips

The next sections suggest a number of ways to use the Fortran compiler efficiently. A complete compiler options reference follows in the next chapter.

2.5.1 Determining Hardware Platform

Some compiler flags allow the user to tune code generation to a specific set of hardware platform options. The compiler's **-dryrun** option can be used to determine the native processor:

```
<sparc>%f95 -dryrun -xtarget=native
###     command line files and options (expanded):
### -dryrun -xarch=v8plusb -xcache=64/32/4:1024/64/4 -xchip=ultra3i

<x64>%f95 -dryrun -xtarget=native
###     command line files and options (expanded):
### -dryrun -xarch=sse2a -xcache=64/64/2:1024/64/16 -xchip=opteron
```

2.5.2 Using Environment Variables

You can specify options by setting the **FFLAGS** or **OPTIONS** variables.

Either **FFLAGS** or **OPTIONS** can be used explicitly in the command line. When you are using the implicit compilation rules of **make**, **FFLAGS** is used automatically by the **make** program.

Example: Set **FFLAGS**: (C Shell)

```
demo% setenv FFLAGS '-fast -Xlist'
```

Example: Use **FFLAGS** explicitly:

```
demo% f95 $FFLAGS any.f
```

When using **make**, if the **FFLAGS** variable is set as above and the makefile's compilation rules are *implicit*, that is, there is no *explicit* compiler command line, then invoking **make** will result in a compilation equivalent to:

f95 -fast -Xlist *files*...

make is a very powerful program development tool that can easily be used with all Sun compilers. See the **make**(1) man page and the *Program Development* chapter in the *Fortran Programming Guide*.

Note – Default implicit rules assumed by **make** may not recognize files with extensions **.f95** and **.mod** (Module files). See the *Fortran Programming Guide* and the Fortran readme file for details.

2.5.3 Memory Size

A compilation may need to use a lot of memory. This will depend on the optimization level chosen and the size and complexity of the files being compiled. On SPARC platforms, if the optimizer runs out of memory, it tries to recover by retrying the current procedure at a lower level of optimization and resumes subsequent routines at the original level specified in the **-O***n* option on the command line.

A processor running the compiler should have at least 64 megabytes of memory; 256 megabytes are recommended. Enough swap space should also be allocated. 200 megabytes is the minimum; 300 megabytes is recommended.

Memory usage depends on the size of each procedure, the level of optimization, the limits set for virtual memory, the size of the disk swap file, and various other parameters.

Compiling a single source file containing many routines could cause the compiler to run out of memory or swap space.

If the compiler runs out of memory, try reducing the level of optimization, or split multiple-routine source files into files with one routine per file, using **fsplit**(1).

2.5.3.1 Swap Space Limits

The SunOS™ operating system command, **swap -s**, displays available swap space. See **swap**(1M).

Example: Use the **swap** command:

```
demo% swap -s
total: 40236k bytes allocated + 7280k reserved = 47516k used, 1058708k available
To determine the actual real memory:

demo% /usr/sbin/dmesg | grep mem
mem = 655360K (0x28000000)
avail mem = 602476544
```

2.5.3.2 Increasing Swap Space

Use **mkfile**(1M) and **swap**(1M) to increase the size of the swap space on a workstation. You must become superuser to do this. **mkfile** creates a file of a specific size, and **swap -a** adds the file to the system swap space:

```
demo# mkfile -v 90m /home/swapfile
/home/swapfile 94317840 bytes
demo# /usr/sbin/swap -a  /home/swapfile
```

2.5.3.3 Control of Virtual Memory

Compiling very large routines (thousands of lines of code in a single procedure) at optimization level **-O3** or higher may require additional memory that could degrade compile-time performance. You can control this by limiting the amount of virtual memory available to a single process.

In a **sh** shell, use the **ulimit** command. See **sh**(1).

Example: Limit virtual memory to 16 Mbytes:

```
demo$ ulimit -d 16000
```

In a **csh** shell, use the **limit** command. See **csh**(1).

Example: Limit virtual memory to 16 Mbytes:

```
demo% limit datasize 16M
```

Each of these command lines causes the optimizer to try to recover at 16 Mbytes of data space.

This limit cannot be greater than the system's total available swap space and, in practice, must be small enough to permit normal use of the system while a large compilation is in progress. Be sure that no compilation consumes more than half the space.

Example: With 32 Mbytes of swap space, use the following commands:

In a **sh** shell:

```
demo$ ulimit -d 1600
```

In a **csh** shell:

```
demo% limit datasize 16M
```

The best setting depends on the degree of optimization requested and the amount of real and virtual memory available.

In 64-bit Solaris environments, the soft limit for the size of an application data segment is 2 Gbytes. If your application needs to allocate more space, use the shell's **limit** or **ulimit** command to remove the limit.

For **csh** use:

```
demo% limit datasize unlimited
```

For **sh** or **ksh**, use:

```
demo$ ulimit -d unlimited
```

See the *Solaris 64-bit Developer's Guide* for more information.

◆ ◆ ◆ CHAPTER 3

Fortran Compiler Options

This chapter details the command–line options for the **f95** compiler.

- A description of the syntax used for compiler option flags starts at "3.1 Command Syntax" on page 41.
- Summaries of options arranged by functionality starts at "3.3 Options Summary" on page 43.
- The complete reference detailing each compiler option flag starts at "3.4 Options Reference" on page 50.

3.1 Command Syntax

The general syntax of the compiler command line is:

f95 [*options*] *list_of_files additional_options*

Items in square brackets indicate optional parameters. The brackets are not part of the command. The *options* are a list of option keywords prefixed by dash (**–**). Some keyword options take the next item in the list as an argument. The *list_of_files* is a list of source, object, or library file names separated by blanks. Also, there are some options that must appear after the list of source files, and these could include additional lists of files (for example, **-B**, **-l**, and **-L**).

3.2 Options Syntax

Typical compiler option formats are:

TABLE 3–1 Options Syntax

Syntax Format	Example
–flag	**–g**
–flagvalue	**–Dnostep**
–flag=value	**–xunroll=4**
–flag value	**–o outfile**

The following typographical conventions are used when describing the individual options:

TABLE 3–2 Typographic Notations for Options

Notation	Meaning	Example: Text/Instance
[ ]	Square brackets contain arguments that are optional.	**-O[n]** **-O4, -O**
{ }	Curly brackets (braces) contain a set of choices for a required option.	**-d{y|n}** **-dy**
|	The "pipe" or "bar" symbol separates arguments, only *one* of which may be chosen.	**-B{dynamic|static}** **-Bstatic**
:	The colon, like the comma, is sometimes used to separate arguments.	**-R***dir***[:***dir***]** **-R/local/libs:/U/a**
…	The ellipsis indicates omission in a series.	**-xinline=***f1***[,…***fn***]** **-xinline=alpha,dos**

Brackets, pipe, and ellipsis are *meta characters* used in the descriptions of the options and are not part of the options themselves.

Some general guidelines for options are:

- **–l***x* is the option to link with library **lib***x***.a**. It is always safer to put **-l***x* after the list of file names to insure the order libraries are searched.
- In general, processing of the compiler options is from left to right, allowing selective overriding of macro options (options that include other options). This rule does not apply to linker options. However, some options, **-I**, **-L**, and **-R** for example, accumulate values rather than override previous values when repeated on the same command line.
- In an optional list of choices, such as **-xhasc**[**=**{**yes**|**no**}], the first choice listed is the value assumed when the option flag appears on the command line without a value. For example, **-xhasc** is equivalent to **-xhasc=yes**.

- Source files, object files, and libraries are compiled and linked in the order in which they appear on the command line.

3.3 Options Summary

In this section, the compiler options are grouped by function to provide an easy reference. The details will be found on the pages in the following sections, as indicated.

Note that not all options are available on both SPARC and x64/x86 platforms. Check the detailed reference section for availability.

The following table summarizes the **f95** compiler options by functionality. The table does not include obsolete and legacy option flags. Some flags serve more than one purpose and appear more than once.

TABLE 3–3 Compiler Options Grouped by Functionality

Function		Option Flag
Compilation Mode:		
	Compile only; do not produce an executable file	**-c**
	Show commands built by the driver but do not compile	**-dryrun**
	Support Fortran 77 extensions and compatibility	**-f77**
	Specify path for writing compiled **.mod** Module files	**-moddir=***path*
	Specify name of object, library, or executable file to write	**-o** *filename*
	Compile and generate only assembly code	**-S**
	Strip symbol table from executable	**-s**
	Suppress compiler messages, except error messages	**-silent**
	Define path to directory for temporary files	**-temp=***path*
	Show elapsed time for each compilation phase	**-time**
	Show version number of compiler and its phases	**-V**
	Verbose messages	**-v**
	Specify non-standard aliasing situations	**-xalias=***list*
	Compile with multiple processors	**-xjobs=***n*
Compiled Code:		

TABLE 3–3 Compiler Options Grouped by Functionality *(Continued)*

Function		Option Flag
	Add/suppress trailing underscores on external names	**-ext_names=***x*
	Inline specified user functions	**-inline=***list*
	Compile position independent code	**-KPIC/-kpic**
	Inline certain math library routines	**-libmil**
	STOP returns integer status value to shell	**-stop_status[=***yn***]**
	Specify code address space	**-xcode=***x*
	Enable prefetch instructions	**-xprefetch[=***x***]**
	Specify use of optional registers	**-xregs=***x*
	Specify default data mappings	**-xtypemap=***x*
Data Alignment:		
	Specify alignment of data in COMMON blocks	**-aligncommon[=***n***]**
	Force COMMON block data alignment to allow double word fetch/store	**-dalign**
	Force alignment of all data on 8-byte boundaries	**-dbl_align_all**
	Align COMMON block data on 8-byte boundaries	**-f**
	Specify memory alignment and behavior	**-xmemalign[=***ab***]**
Debugging:		
	Enable runtime subscript range checking	**-C**
	Compile for debugging with **dbx**	**-g**
	Flag use of undeclared variables	**-u**
	Check **C$PRAGMA ASSUME** assertions	**-xassume_control=check**
	Check for stack overflow at runtime	**-xcheck=stkovf**
	Enable runtime task common check	**-xcommonchk**
	Compile for Performance Analyzer	**-xF**
	Generate cross-reference listings	**-Xlist***x*
	Enable debugging without object files	**-xs**
Diagnostics:		
	Flag use of non-standard extensions	**-ansi**

TABLE 3–3 Compiler Options Grouped by Functionality *(Continued)*

Function		Option Flag
	Suppress named warning messages	**-erroff=**
	Display error tag names with error messages	**-errtags**
	Show summary of compiler options	**-flags, -help**
	Show version number of the compiler and its phases	**-V**
	Verbose messages	**-v**
	Verbose parallelization messages	**-vpara**
	Show/suppress warning messages	**-w***n*
	Display compiler README file	**-xhelp=readme**
Licensing:		
	Show license server information	**-xlicinfo**
Linking and Libraries:		
	Allow/require dynamic/static libraries	**-B***x*
	Allow only dynamic/static library linking	**-dy, -dn**
	Build a dynamic (shared object) library	**-G**
	Assign name to dynamic library	**-h***name*
	Add directory to library search path	**-L***path*
	Link with library **lib***name***.a** or **lib***name***.so**	**-l***name*
	Do not build library search path into executable.	**-norunpath**
	Build runtime library search path into executable	**-R***path*
	Disable use of incremental linker, **ild**	**-xildoff**
	Link with optimized math library	**-xlibmopt**
	Link with Sun Performance Library	**-xlic_lib=sunperf**
	Link editor option	**-z***x*
	Generate pure libraries with no relocations	**-ztext**
Numerics and Floating-Point:		
	Use non-standard floating-point preferences	**-fnonstd**
	Select SPARC non-standard floating point	**-fns**
	Enable runtime floating-point overflow during input	**-fpover**

TABLE 3–3 Compiler Options Grouped by Functionality *(Continued)*

Function		Option Flag
	Select IEEE floating-point rounding mode	**-fpround=***r*
	Select floating-point optimization level	**-fsimple=***n*
	Select floating-point trapping mode	**-ftrap=***t*
	Specify rounding method for formatted input/output	**-iorounding=***mode*
	Promote single precision constants to double precision	**-r8const**
	Enable interval arithmetic and set the appropriate floating-point environment (includes **-xinterval**)	**-xia[=***e***]**
	Enable interval arithmetic extensions	**-xinterval[=***e***]**
Optimization and Performance:		
	Analyze loops for data dependencies	**-depend**
	Optimize using a selection of options	**-fast**
	Specify optimization level	**-O***n*
	Pad data layout for efficient use of cache	**-pad[=***p***]**
	Allocate local variables on the memory stack	**-stackvar**
	Enable loop unrolling	**-unroll[=***m***]**
	Enable optimization across source files	**-xcrossfile[=***n***]**
	Invoke interprocedural optimizations pass	**-xipo[=***n***]**
	Set highest optimization level for **#pragma OPT**	**-xmaxopt[=***n***]**
	Compile for post-compilation optimizations	**-xbinopt=prepare**
	Enable/adjust compiler generated prefetch instructions	**-xprefetch=***list*
	Control automatic generation of prefetch instructions	**-xprefetch_level=***n*
	Enable generation or use of performance profiling data	**-xprofile=***p*
	Assert that no memory-based traps will occur	**-xsafe=mem**
	Do no optimizations that increase code size	**-xspace**
	Generate calls to vector library functions automatically	**-xvector[=***yn***]**
Parallelization:		
	Enable automatic parallelization of DO loops	**-autopar**
	Show loop parallelization information	**-loopinfo**

TABLE 3–3 Compiler Options Grouped by Functionality *(Continued)*

Function		Option Flag
	Compile for hand-coded multithreaded programming	**-mt**
	Accept OpenMP API directives and set appropriate environment	**-xopenmp[=***keyword***]**
	Recognize reduction operations in loops with automatic parallelization	**-reduction**
	Verbose parallelization messages	**-vpara**
Source Code:		
	Define preprocessor symbol	**-D***name***[=***val***]**
	Undefine preprocessor symbol	**-U***name*
	Accept extended (132 character) source lines	**-e**
	Apply preprocessor to **.F** and/or **.F90** and **.F95** files but do not compile	**-F**
	Accept Fortran 95 fixed-format input	**-fixed**
	Preprocess all source files with the **fpp** preprocessor	**-fpp**
	Accept Fortran 95 free-format input	**-free**
	Add directory to include file search path	**-I***path*
	Add directory to module search path	**-M***path*
	Recognize upper and lower case as distinct	**-U**
	Tread hollerith as character in actual arguments	**-xhasc={yes|no}**
	Select preprocessor, **cpp** or **fpp**, to use	**-xpp[={fpp|cpp}]**
	Allow recursive subprogram calls	**-xrecursive**
Target Platform:		
	Specify memory model, 32 or 64 bits.	**-m32 | –m64**
	Specify target platform instruction set for the optimizer	**-xarch=***a*
	Specify target cache properties for optimizer	**-xcache=***a*
	Specify target processor for the optimizer	**-xchip=***a*
	Specify target platform for the optimizer	**-xtarget=***a*

3.3.1 Commonly Used Options

The compiler has many features that are selectable by optional command–line parameters. The short list below of commonly used options is a good place to start.

TABLE 3–4 Commonly Used Options

Action	Option
Debug—global program checking across routines for consistency of arguments, commons, and so on.	**–Xlist**
Debug—produce additional symbol table information to enable the **dbx** and debugging.	**–g**
Performance—invoke the optimizer to produce faster running programs.	**–O[***n***]**
Performance—Produce efficient compilation and run times for the native platform, using a set of predetermined options.	**–fast**
Dynamic (**–Bdynamic**) or static (**–Bstatic**) library binding.	**–B***x*
Compile only—Suppress linking; make a **.o** file for each source file.	**–c**
Output file—Name the executable output file *nm* instead of **a.out**.	**–o nm**
Source code—Compile fixed format Fortran source code.	**-fixed**

3.3.2 Macro Flags

Some option flags are macros that expand into a specific set of other flags. These are provided as a convenient way to specify a number of options that are usually expressed together to select a certain feature.

TABLE 3–5 Macro Option Flags

Option Flag	Expansion
-dalign	**-xmemalign=8s -aligncommon=16**
-f	**-aligncommon=16**
-fast	See description of **–fast** for complete current expansion.
-fnonstd	**-fns -ftrap=common**
-xia=widestneed	**-xinterval=widestneed -ftrap=%none -fns=no -fsimple=0**
-xia=strict	**-xinterval=strict -ftrap=%none -fns=no -fsimple=0**
-xtarget	**-xarch=***a* **-xcache=***b* **-xchip=***c*

Settings that follow the macro flag on the command line override or add to the the expansion of the macro.

3.3.3 Backward Compatibility and Legacy Options

The following options are provided for backward compatibility with earlier compiler releases, and certain Fortran legacy capabilities.

TABLE 3–6 Backward Compatibility Options

Action	Option
Preserve actual arguments over **ENTRY** statements	**-arg=local**
Allow assignment to constant arguments.	**–copyargs**
Treat hollerith constant as character or typeless in call argument lists.	**-xhasc[={yes|no}]**
Support Fortran 77 extensions and conventions	**-f77**
Nonstandard arithmetic—allow nonstandard arithmetic.	**–fnonstd**
Optimize performance for the host system.	**–native**
DO loops—use one trip **DO** loops.	**–onetrip**
Allow legacy aliasing situations	**-xalias=***keywords*

Use of these option flags is not recommended for producing portable Fortran programs.

3.3.4 Obsolete Option Flags

The following options are considered obsolete and should not be used. They might be removed from later releases of the compiler.

TABLE 3–7 Obsolete **f95** Options

Option Flag	Equivalent
-a	**-xprofile=tcov**
-cg89	**-xtarget=ss2**
-cg92	**-xtarget=ss1000**

TABLE 3–7 Obsolete **f95** Options *(Continued)*

Option Flag	Equivalent
-explicitpar	Parallelization using Sun/Cray directives now deprecated. Use OpenMP parallelization.
-mp	Use OpenMP parallelization; Sun/Cray parallelization deprecated
-native	-xtarget=native
-noqueue	License queueing. No longer needed.
-p	Profiling. Use **-pg** or the Performance Analyzer
-parallel	Parallelization with Sun/Cray directives now deprecated. Use OpenMP parallelization instead.
-pic	**-xcode=pic13**
-PIC	**-xcode=pic32**
-sb	Ignored.
-sbfast	Ignored.
-silent	Ignored.
-xarch={**v7,v8,v8a**}	Use **–m32**

3.4 Options Reference

This section describes all of the **f95** compiler command–line option flags, including various risks, restrictions, caveats, interactions, examples, and other details.

Unless indicated otherwise, each option is valid on both SPARC and x64/x86 platforms. Option flags valid only on SPARC platforms are marked **(SPARC)**. Option flags valid only on x64/x86 platforms are marked **(x86)**.

Option flags marked (*Obsolete*) are obsolete and should not be used. In many cases they have been superceded by other options or flags that should be used instead.

3.4.1 –a

(*Obsolete*) Profile by basic block using **tcov**, old style.

This is the old style of basic block profiling for **tcov**. See **-xprofile=tcov** for information on the new style of profiling and the **tcov**(1) man page for more details.

3.4.2 –aligncommon[={1|2|4|8|16}]

Specify the alignment of data in common blocks and standard numeric sequence types.

The value indicates the maximum alignment (in bytes) for data elements within common blocks and standard numeric sequence types.

Note – A *standard numeric sequence type* is a derived type containing a **SEQUENCE** statement and only default component data types (**INTEGER, REAL, DOUBLEPRECISION, COMPLEX** without **KIND=** or * *size*) . Any other type, such as **REAL*8**, will make the type non-standard.

For example, **-aligncommon=4** would align data elements with natural alignments of 4 bytes or more on 4-byte boundaries.

This option does not affect data with natural alignment smaller than the specified size.

Without **-aligncommon**, the compiler aligns elements in common blocks and numeric sequence types on (at most) 4-byte boundaries.

Specifying **-aligncommon** without a value defaults to 1 - all common block and numeric sequence type elements align on byte boundaries (no padding between elements).

-aligncommon=16 reverts to **-aligncommon=8** on platforms that are not 64-bit enabled.

Do not use **-aligncommon=1** with **-xmemalign** as these declarations will conflict and could cause a segmentation fault on some platforms and configurations.

3.4.3 –ansi

Identify many nonstandard extensions.

Warning messages are issued for any uses of non–standard Fortran extensions in the source code.

3.4.4 –arg=local

Preserve actual arguments over **ENTRY** statements.

When you compile a subprogram with alternate entry points with this option, **f95** uses copy/restore to preserve the association of dummy and actual arguments.

This option is provided for compatibility with legacy Fortran 77 programs. Code that relies on this option is non-standard.

3.4.5 –autopar

Enable automatic loop parallelization.

Finds and parallelizes appropriate loops for running in parallel on multiple processors. Analyzes loops for inter–iteration data dependencies and loop restructuring. If the optimization level is not specified **-O3** or higher, it will automatically be raised to **-O3**.

Also specify the **-stackvar** option when using any of the parallelization options, including **-autopar**. The **-stackvar** option may provide better performance when using **-autopar** because it may allow the optimizer to detect additional opportunities for parallelization. See the description of the **-stackvar** option for information on how to set the sizes for the main thread stack and for the slave thread stacks.

Avoid **-autopar** if the program already contains explicit calls to the **libthread** threads library. See note in "3.4.56 –mt" on page 76.

The **-autopar** option is not appropriate on a single–processor system, and the compiled code will generally run slower.

To run a parallelized program in a multithreaded environment, you must set the **PARALLEL** (or **OMP_NUM_THREADS**) environment variable prior to execution. This tells the runtime system the maximum number of threads the program can create. The default is 1. In general, set the **PARALLEL** or **OMP_NUM_THREADS** variable to the number of available virtual processors on the target platform, which can be determined by using the Solaris **psrinfo**(1) command.

If you use **-autopar** and compile and link in *one* step, the multithreading library and the thread–safe Fortran runtime library will automatically be linked. If you use **-autopar** and compile and link in *separate* steps, then you must also link with **-autopar** to insure linking the appropriate libraries.

The**–reduction** option may also be useful with **–autopar**.

Refer to the *Fortran Programming Guide* for more information on parallelization. For explicit, user-controlled parallelization, use OpenMP directives and the **–xopenmp** option.

3.4.6 –B{static|dynamic}

Prefer dynamic or require static library linking.

No space is allowed between **-B** and **dynamic** or **static**. The default, without **-B** specified, is **-Bdynamic**.

- **–Bdynamic**: Prefer *dynamic* linking (try for shared libraries).
- **–Bstatic**: Require *static* linking (no shared libraries).

Also note:

- If you specify **static**, but the linker finds only a dynamic library, then the library is not linked with a warning that the "library was not found."
- If you specify **dynamic**, but the linker finds only a static version, then that library is linked, with no warning.

You can toggle **-Bstatic** and **-Bdynamic** on the command line. That is, you can link some libraries statically and some dynamically by specifying **-Bstatic** and **-Bdynamic** any number of times on the command line, as follows:

```
f95 prog.f -Bdynamic -lwells -Bstatic -lsurface
```

These are loader and linker options. Compiling and linking in separate steps with **-B***x* on the compile command will require it in the link step as well.

You cannot specify both **-Bdynamic** and **-dn** on the command line because **-dn** disables linking of dynamic libraries.

In a 64-bit Solaris environment, many system libraries are available only as shared dynamic libraries. These include **libm.so** and **libc.so** (**libm.a** and **libc.a** are not provided). This means that **-Bstatic** and **-dn** may cause linking errors in 64-bit Solaris environments. Applications must link with the dynamic libraries in these cases.

Mixing static Fortran runtime system libraries with dynamic Fortran runtime system libraries is not recommended and can result in linker errors or silent data corruption. Always link with the latest shared dynamic Fortran runtime system libraries.

See the *Fortran Programming Guide* for more information on static and dynamic libraries.

3.4.7 –C

Check array references for out of range subscripts and conformance at runtime.

Subscripting arrays beyond their declared sizes may result in unexpected results, including segmentation faults. The **-C** option checks for possible array subscript violations in the source code and during execution. **-C** also adds runtime checks for array conformance in array syntax expressions

Specifying **-C** may make the executable file larger.

If the **-C** option is used, array subscript violations are treated as an error. If an array subscript range violation is detected in the source code during compilation, it is treated as a compilation error.

If an array subscript violation can only be determined at runtime, the compiler generates range–checking code into the executable program. This may cause an increase in execution

time. As a result, it is appropriate to enable full array subscript checking while developing and debugging a program, then recompiling the final production executable without subscript checking.

3.4.8 –c

Compile only; produce object **.o** files, but suppress linking.

Compile a **.o** file for each source file. If only a single source file is being compiled, the **-o** option can be used to specify the name of the **.o** file written.

3.4.9 –copyargs

Allow assignment to constant arguments.

Allow a subprogram to change a dummy argument that is a constant. This option is provided only to allow legacy code to compile and execute without a runtime error.

- Without **-copyargs**, if you pass a constant argument to a subroutine, and then within the subroutine try to change that constant, the run aborts.
- With **-copyargs**, if you pass a constant argument to a subroutine, and then within the subroutine change that constant, the run does not necessarily abort.

Code that aborts unless compiled with **-copyargs** is, of course, not Fortran standard compliant. Also, such code is often unpredictable.

3.4.10 –D*name*[=*def*]

Define symbol *name* for the preprocessor.

This option only applies to **.F**, **.F90**, **.F95**, and **.F03** source files.

–D*name*=*def* Define *name* to have value *def*

–D*name* Define *name* to be **1**

On the command line, this option will define *name* as if:

#define *name*[=*def*]

had appears in the source file. If no **=***def* specified, the name *name* is defined as the value 1. The macro symbol *name* is passed on to the preprocessor **fpp** (or **cpp**— see the **-xpp** option) for expansion.

The predefined macro symbols have two leading underscores. The Fortran syntax may not support the actual values of these macros—they should appear only in **fpp** or **cpp** preprocessor directives. (Note the two leading underscores.)

- The product version is predefined (in hex) in **__SUNPRO_F90**, and **__SUNPRO_F95**. For example **__SUNPRO_F95** is **0x830** for the Sun Studio 12 release.
- The following macros are predefined on appropriate systems:

  __sparc, **__unix**, **__sun**, **__SVR4**, **__i386** , **__SunOS_5_6**, **__SunOS_5_7**, **__SunOS_5_8**, **__SunOS_5_9**, **__SunOS_5_10**

  For instance, the value **__sparc** is defined on SPARC systems.
- The following are predefined with no underscores, but they might be deleted in a future release: **sparc**, **unix**, **sun**
- On SPARC V9 systems, the **__sparcv9** macro is also defined.
- On 64-bit x86 systems, the macros **__amd64** and **__x86_64** are defined.

Compile with the verbose option (**-v**) to see the definitions created by the compiler.

You can use these values in such preprocessor conditionals as the following:

```
#ifdef __sparc
```

f95 uses the **fpp**(1) preprocessor by default. Like the C preprocessor **cpp**(1), **fpp** expands source code macros and enables conditional compilation of code. Unlike **cpp**, **fpp** understands Fortran syntax, and is preferred as a Fortran preprocessor. Use the **-xpp=cpp** flag to force the compiler to specifically use **cpp** rather than **fpp**.

3.4.11 –dalign

Align COMMON blocks and standard numerical sequence types, and generate faster multi-word load/stores.

This flag changes the data layout in COMMON blocks, numeric sequence types, and EQUIVALENCE classes, and enables the compiler to generate faster multi-word load/stores for that data.

The data layout effect is that of the **-f** flag: double- and quad-precision data in COMMON blocks and EQUIVALENCE classes are laid out in memory along their "natural" alignment, which is on 8-byte boundaries (or on 16-byte boundaries for quad-precision when compiling for 64-bit environments with **-m64**). The default alignment of data in COMMON blocks is on 4-byte boundaries. The compiler is also allowed to assume natural alignment and generate faster multi-word load/stores to reference the data.

Using **-dalign** along with **-xtypemap=real:64,double:64,integer:64** also causes 64-bit integer variables to be double-word aligned on SPARC processors.

Note – **-dalign** may result in nonstandard alignment of data, which could cause problems with variables in **EQUIVALENCE** or **COMMON** and may render the program non-portable if **-dalign** is required.

-dalign is a macro equivalent to:

-xmemalign=8s -aligncommon=16 *on SPARC platforms*

-aligncommon=8 *on 32-bit x86 platforms*

-aligncommon=16 *on 64-bit x86 platforms.*

If you compile one subprogram with **-dalign**, compile all subprograms of the program with **-dalign**. This option is included in the **-fast** option.

Note that because **-dalign** invokes **-aligncommon**, standard numeric sequence types are also affected by this option. See "3.4.2 **–aligncommon**[={**1**|**2**|**4**|**8**|**16**}]" on page 51

3.4.12 –dbl_align_all[={yes|no}]

Force alignment of data on 8–byte boundaries

The value is either **yes** or **no**. If **yes**, all variables will be aligned on 8–byte boundaries. Default is **-dbl_align_all=no**.

When compiling for 64-bit environments with **-m64**, this flag will align quad-precision data on 16-byte boundaries.

This flag does not alter the layout of data in COMMON blocks or user-defined structures.

Use with **-dalign** to enable added efficiency with multi-word load/stores.

If used, all routines must be compiled with this flag.

3.4.13 –depend[={yes|no}]

Analyze loops for inter-iteration data dependencies and performs loop restructuring. Loop restructuring includes loop interchange, loop fusion, scalar replacement, and elimination of "dead" array assignments.

On SPARC platforms, **-xdepend** is turned on for all optimization levels **-xO3** and above, and is off for lower opt levels. Also, an explicit setting of **-xdepend** overrides any implicit setting.

On x86 platforms, if optimization is not at **-xO3** or higher, the compiler raises the optimization to **-xO3** and issues a warning.

If you do not specify **-xdepend**, the default is **-xdepend=no** which means the compiler does not analyze loops for data dependencies. If you specify **-xdepend** but do not specify an argument, the compiler sets the option to **-xdepend=yes** which means the compiler analyzes loops for data dependencies.

Dependency analysis is included in **-xautopar**. The dependency analysis is done at compile time. Dependency analysis may help on single-processor systems. However, if you try **-xdepend** on single-processor systems, you should not also specify **-xautopar** , otherwise the **-xdepend** optimization is done for multiple-processor systems.

3.4.14 –dn

Disallow dynamic libraries. See "3.4.16 **–d{y|n}**" on page 57.

3.4.15 –dryrun

Show commands built by the **f95** command-line driver, but do not compile.

Useful when debugging, this option displays the commands and suboptions the compiler will invoke to perform the compilation.

3.4.16 –d{y|n}

Allow or disallow *dynamic* libraries for the entire executable.

- **–dy**: Yes, *allow* dynamic/shared libraries.
- **–dn**: No, *do not allow* dynamic/shared libraries.

The default, if not specified, is **-dy**.

Unlike **-B***x*, this option applies to the *whole* executable and need appear only once on the command line.

–dy|–dn are loader and linker options. If you compile and link in separate steps with these options, then you need the same option in the link step.

In a 64-bit Solaris environment, many system libraries are not available only as shared dynamic libraries. These include **libm.so** and **libc.so** (**libm.a** and **libc.a** are not provided). This means that **-dn** and **-Bstatic** may cause linking errors in 64-bit Solaris environments and 32-bit x86 Solaris platforms, and all 32-bit Solaris platforms starting with the Solaris 10 release. Applications must link with the dynamic libraries in these cases.

3.4.17 –e

Accept extended length input source line.

Extended source lines can be up to 132 characters long. The compiler pads on the right with trailing blanks to column 132. If you use continuation lines while compiling with **-e**, then do not split character constants across lines, otherwise, unnecessary blanks may be inserted in the constants.

3.4.18 –erroff[={%all|%none|*taglist*}]

Suppress warning messages listed by tag name.

Suppress the display of warning messages specified in the comma–separated list of tag names *taglist*. If **%all**, suppress all warnings, which is equivalent to the **-w** option. If **%none**, no warnings are suppressed. **–erroff** without an argument is equivalent to **–erroff=%all**.

Example:

```
f95 -erroff=WDECL_LOCAL_NOTUSED ink.f
```

Use the **-errtags** option to see the tag names associated with warning messages.

3.4.19 –errtags[={yes|no}]

Display the message tag with each warning message.

With **-errtags=yes**, the compiler's internal error tag name will appear along with warning messages. **-errtags** alone is equivalent to **-errtags=yes**.

The default is not to display the tag (**-errtags=no**).

```
demo% f95 -errtags ink.f
ink.f:
 MAIN:
"ink.f", line 11: Warning: local variable "i" never used (WDECL_LOCAL_NOTUSED)
```

3.4.20 –errwarn[={%all|%none|*taglist*}]

Treat warning messages as errors.

The taglist specifies a list of comma-separated tag names of warning messages that should be treated as errors. If **%all**, treat all warnings as errors. If **%none**, no warnings are treated as errors.

See also **-errtags**.

3.4.21 –ext_names=*e*

Create external names with or without trailing underscores.

e must be either **plain**, **underscores**, or **fsecond-underscore** The default is **underscores**.

–ext_names=plain: Do not add trailing underscore.

–ext_names=underscores: Add trailing underscore.

–ext_names=fsecond-underscore: Append two underscores to external names that contain an underscore, and a single underscore to those that do not.

An external name is a name of a subroutine, function, block data subprogram, or labeled common. This option affects both the name of the routine's entry point and the name used in calls to it. Use this flag to allow Fortran routines to call (and be called by) other programming language routines.

fsecond-underscore is provided for compatibility with **gfortran**.

3.4.22 –F

Invoke the source file preprocessor, but do not compile.

Apply the **fpp** preprocessor to **.F**, **.F90**, **.F95**, and **.F03** source files listed on the command line, and write the processed result on a file with the same name but with filename extension changed to **.f** (or **.f95** or **.f03**), but do not compile.

Example:

```
f95 -F source.F
```

writes the processed source file to **source.f**

fpp is the default preprocessor for Fortran. The C preprocessor, **cpp**, can be selected instead by specifying **-xpp=cpp**.

3.4.23 –f

Align double- and quad-precision data in COMMON blocks.

-f is a legacy option flag equivalent to **-aligncommon=16**. Use of **-aligncommon** is preferred.

The default alignment of data in COMMON blocks is on 4-byte boundaries. **-f** changes the data layout of double- and quad-precision data in COMMON blocks and EQUIVALENCE classes to be placed in memory along their "natural" alignment, which is on 8-byte boundaries (or on 16-byte boundaries for quad-precision when compiling for 64-bit SPARC environments with **-m64**).

Note – **-f** may result in nonstandard alignment of data, which could cause problems with variables in **EQUIVALENCE** or **COMMON** and may render the program non-portable if **-f** is required.

Compiling *any* part of a program with **-f** requires compiling *all* subprograms of that program with **-f**.

By itself, this option does not enable the compiler to generate faster multi-word fetch/store instructions on double and quad precision data. The **-dalign** option does this and invokes **-f** as well. Use of **-dalign** is preferred over the older **-f**. See "3.4.11 **–dalign**" on page 55. Because **-dalign** is part of the **-fast** option, so is **-f**.

3.4.24 –f77[=*list*]

Select Fortran 77 compatibility mode.

This option flag enables porting legacy Fortran 77 source programs, including those with language extensions accepted by the **f77** compiler, to the **f95** Fortran compiler.

list is a comma-separated list selected from the following possible keywords:

keyword	meaning
%all	Enable all the Fortran 77 compatibility features.
%none	Disable all the Fortran 77 compatibility features.
backslash	Accept backslash as an escape sequence in character strings.
input	Allow input formats accepted by **f77**.
intrinsics	Limit recognition of intrinsics to only Fortran 77 intrinsics.
logical	Accept Fortran 77 usage of logical variables, such as: - assigning integer values to logical variables- allowing arithmetic expressions in logical conditional statements, with **.NE.0** representing **.TRUE.**- allowing relational operators **.EQ.** and **.NE.** with logical operands
misc	Allow miscellaneous **f77** Fortran 77 extensions.
output	Generate **f77**-style formatted output, including list-directed and **NAMELIST** output.
subscript	Allow non-integer expressions as array subscripts.

keyword	meaning
tab	Enable **f77**-style TAB-formatting, including unlimited source line length. No blank padding will be added to source lines shorter than 72 characters.

All keywords can be prefixed by **no%** to disable the feature, as in:

```
-f77=%all,no%backslash
```

The default, when **-f77** is not specified, is **-f77=%none**. Using **-f77** without a list is equivalent to specifying **-f77=%all**.

Exceptions Trapping and -f77:

Specifying **-f77** does not change the Fortran trapping mode, which is **-ftrap=common**. **f95** differs from the Fortran 77 compiler's behavior regarding arithmetic exception trapping. The Fortran 77 compiler allowed execution to continue after an arithmetic exception occurred. Compiling with **-f77** also causes the program to call **ieee_retrospective** on program exit to report on any arithmetic exceptions that might have occurred. Specify **-ftrap=%none** following the **-f77** option flag on the command line to mimic the original Fortran 77 behavior.

See "4.12 Mixing Languages" on page 166 for complete information on **f77** compatibility and Fortran 77 to Fortran 95 migration.

See also the **-xalias** flag for handling non-standard programming syndromes that may cause incorrect results.

3.4.25 –fast

Select options that optimize execution performance.

Note – This option is defined as a particular selection of other options that is subject to change from one release to another, and between compilers. Also, some of the options selected by **-fast** might not be available on all platforms. Compile with the **-dryrun** flag to see the expansion of **-fast**.

-fast provides high performance for certain benchmark applications. However, the particular choice of options may or may not be appropriate for your application. Use **-fast** as a good starting point for compiling your application for best performance. But additional tuning may still be required. If your program behaves improperly when compiled with **-fast**, look closely at the individual options that make up **-fast** and invoke only those appropriate to your program that preserve correct behavior.

Note also that a program compiled with **-fast** may show good performance and accurate results with some data sets, but not with others. Avoid compiling with **-fast** those programs that depend on particular properties of floating-point arithmetic.

Because some of the options selected by **-fast** have linking implications, if you compile and link in separate steps be sure to link with **-fast** also.

–fast selects the following options:

- The **-xtarget=native** hardware target.
  If the program is intended to run on a different target than the compilation machine, follow the **-fast** with a code–generator option. For example: **f95 -fast -xtarget=ultraT2 ...**
- The **-O5** optimization level option.
- The **-depend** option analyzes loops for data dependencies and possible restructuring.
- The **-libmil** option for system–supplied inline expansion templates.
  For C functions that depend on exception handling, follow **-fast** by **-nolibmil** (as in **-fast -nolibmil**). With **-libmil**, exceptions cannot be detected with **errno** or **matherr**(3m).
- The **-fsimple=2** option for aggressive floating–point optimizations.
  –fsimple=2 is unsuitable if strict IEEE 754 standards compliance is required. See "3.4.36 **–fsimple**[={**1**|**2**|**0**}]" on page 67.
- The **-dalign** option to generate double loads and stores for double and quad data in common blocks. Using this option can generate nonstandard Fortran data alignment in common blocks.
- The **-xlibmopt** option selects optimized math library routines.
- **-pad=local** inserts padding between local variables, where appropriate, to improve cache usage. **(SPARC)**
- **-xvector=lib** transforms certain math library calls within DO loops to single calls to a vectorized library equivalent routine with vector arguments. (**SPARC**)
- **–fns** selects non-standard floating-point arithmetic exception handling and gradual underflow. See "3.4.30 **–fns[={yes|no}]**" on page 64.
- **-fround=nearest** is selected because **–xvector** and **–xlibmopt** require it. (**Solaris**)
- Trapping on common floating-point exceptions, **-ftrap=common**, is the enabled with **f95**.
- **-nofstore** cancels forcing expressions to have the precision of the result. **(x86)**
- **-xregs=frameptr** allows the compiler to use the frame-pointer register as an unallocated callee-saves register. Specify **-xregs=no%frameptr** after **-fast** and the frame pointer register will not be used as a general purpose register. (**x86**)

It is possible to add or subtract from this list by following the **-fast** option with other options, as in:

```
f95 -fast -fsimple=1 -xnolibmopt ...
```

which overrides the **-fsimple=2** option and disables the **-xlibmopt** selected by **-fast**.

Because **-fast** invokes **-dalign**, **-fns**, **-fsimple=2**, programs compiled with **-fast** can result in nonstandard floating-point arithmetic, nonstandard alignment of data, and nonstandard ordering of expression evaluation. These selections might not be appropriate for most programs.

Note that the set of options selected by the **-fast** flag can change with each compiler release. Invoking the compiler with **-dryrun** displays the **-fast** exapansion:

```
<sparc>%f95 -dryrun -fast |& grep ###
          ###     command line files and options (expanded):
          ### -dryrun -xO5 -xarch=sparcvis2 -xcache=64/32/4:1024/64/4
              -xchip=ultra3i -xdepend=yes -xpad=local -xvector=lib
              -dalign -fsimple=2 -fns=yes -ftrap=common -xlibmil
              -xlibmopt -fround=nearest
```

3.4.26 –fixed

Specify fixed–format Fortran 95 source input files.

All source files on the command–line will be interpreted as fixed format regardless of filename extension. Normally, **f95** interprets only **.f** files as fixed format, **.f95** as free format.

3.4.27 –flags

Synonym for **-help**.

3.4.28 -fma={none|fused}

(**SPARC**) Enable automatic generation of floating-point, fused, multiply-add instructions. **-fma=none** disables generation of these instructions. **-fma=fused** allows the compiler to attempt to find opportunities to improve the performance of the code by using floating-point, fused, multiply-add instructions. The default is **-fma=none**.

Minimum requirements are **-xarch=sparcfmaf** and an optimization level of at least **-xO2** for the compiler to generate fused multiply-add instructions. The compiler will mark the binary program if fused multiply-add instructions have been generated to prevent execution of the program on platforms that do not support them.

Fused multiply-adds eliminate the intermediate rounding step between the multiply and the add. Consequently, programs may produce different results when compiled with **-fma=fused**, although precision will tend to be increased rather than decreased.

3.4.29 –fnonstd

Initialize floating–point hardware to non–standard preferences.

This option is a macro for the combination of the following option flags:

–fns -ftrap=common

Specifying **-fnonstd** is approximately equivalent to the following two calls at the beginning of a Fortran main program.

```
i=ieee_handler("set", "common", SIGFPE_ABORT)
call nonstandard_arithmetic()
```

The **nonstandard_arithmetic()** routine replaces the obsolete **abrupt_underflow()** routine of earlier releases.

To be effective, the main program must be compiled with this option.

Using this option initializes the floating-point hardware to:

- Abort (trap) on floating-point exceptions.
- Flush underflow results to zero if it will improve speed, rather than produce a subnormal number as the IEEE standard requires.

See **-fns** for more information about gradual underflow and subnormal numbers.

The **-fnonstd** option allows hardware traps to be enabled for floating–point overflow, division by zero, and invalid operation exceptions. These are converted into SIGFPE signals, and if the program has no SIGFPE handler, it terminates with a dump of memory.

For more information, see the **ieee_handler**(3m) and **ieee_functions**(3m) man pages, the *Numerical Computation Guide*, and the *Fortran Programming Guide*.

3.4.30 –fns[={yes|no}]

Select nonstandard floating–point mode.

The default is the standard floating–point mode (**–fns=no**). (See the "Floating–Point Arithmetic" chapter of the *Fortran Programming Guide*.)

Optional use of **=yes** or **=no** provides a way of toggling the **-fns** flag following some other macro flag that includes it, such as **-fast**. **-fns** without a value is the same as **-fns=yes**.

This option flag enables nonstandard floating-point mode when the program begins execution. On SPARC platforms, specifying nonstandard floating-point mode disables "gradual underflow", causing tiny results to be flushed to zero rather than producing subnormal

numbers. It also causes subnormal operands to be silently replaced by zero. On those SPARC systems that do not support gradual underflow and subnormal numbers in hardware, use of this option can significantly improve the performance of some programs.

Where *x* does not cause total underflow, *x* is a *subnormal number* if and only if |x| is in one of the ranges indicated:

TABLE 3–8 Subnormal REAL and DOUBLE

Data Type	Range
REAL	0.0 < |x| < 1.17549435e–38
DOUBLE PRECISION	0.0 < |x| < 2.22507385072014e–308

See the *Numerical Computation Guide* for details on subnormal numbers, and the *Fortran Programming Guide* chapter "Floating–Point Arithmetic" for more information about this and similar options. (Some arithmeticians use the term *denormalized number* for *subnormal number*.)

The standard initialization of floating–point preferences is the default:

- IEEE 754 floating–point arithmetic is *nonstop* (do not abort on exception).
- Underflows are gradual.

On x86 platforms, this option is enabled only for Pentium III and Pentium 4 processors (sse or sse2 instruction sets).

On x86, **-fns** selects SSE flush-to-zero mode and where available, denormals-are-zero mode. This flag causes subnormal results to be flushed to zero. Where available, this flag also causes subnormal operands to be treated as zero. This flag has no effect on traditional x87 floating-point operations not utilizing the SSE or SSE2 instruction set.

To be effective, the main program must be compiled with this option.

3.4.31 –fpover[={yes|no}]

Detect floating-point overflow in formatted input.

With **-fpover=yes** specified, the I/O library will detect runtime floating-point overflows in formatted input and return an error condition (1031). The default is no such overflow detection (**–fpover=no**). **-fpover** without a value is equivalent to **-fpover=yes**. Combine with **–ftrap** to get full diagnostic information.

3.4.32 –fpp

Force preprocessing of input with **fpp**.

Pass all the input source files listed on the **f95** command line through the **fpp** preprocessor, regardless of file extension. (Normally, only files with **.F**, **.F90**, or **.F95** extension are automatically preprocessed by **fpp**.) See also "3.4.156 **–xpp=**{**fpp**|**cpp**}" on page 126.

3.4.33 –fprecision={single|double|extended}

(**x86**) Initialize non-default floating-point rounding precision mode.

On x86, sets the floating-point precision mode to either **single**, **double**, or **extended**.

With a value of **single** or **double**, this flag causes the rounding precision mode to be set to single or double precision respectively at program initiation. With **extended**, or by default when the **-fprecision** flag is not specified, the rounding precision mode is initialized to extended precision.

This option is effective only on x86 systems and only if used when compiling the main program.

3.4.34 –free

Specify free–format source input files.

All source files on the command–line will be interpreted as **f95** free format regardless of filename extension. Normally, **f95** interprets **.f** files as fixed format, **.f95** as free format.

3.4.35 –fround={nearest|tozero|negative|positive}

Set the IEEE rounding mode in effect at startup.

The default is **-fround=nearest**.

To be effective, compile the main program with this option.

This option sets the IEEE 754 rounding mode that:

- Can be used by the compiler in evaluating constant expressions.
- Is established at runtime during the program initialization.

When the value is **tozero**, **negative**, or **positive**, the option sets the rounding direction to *round-to-zero*, *round-to-negative-infinity*, or *round-to-positive-infinity*, respectively, when the program begins execution. When **-fround** is not specified, **-fround=nearest** is used as the default and the rounding direction is *round-to-nearest*. The meanings are the same as those for the **ieee_flags** function. (See the "Floating–Point Arithmetic" chapter of the *Fortran Programming Guide*.)

3.4.36 –fsimple[={1|2|0}]

Select floating–point optimization preferences.

Allow the optimizer to make simplifying assumptions concerning floating–point arithmetic. (See the "Floating–Point Arithmetic" chapter of the *Fortran Programming Guide*.)

For consistent results, compile all units of a program with the same **-fsimple** option.

The defaults are:

- Without the **-fsimple** flag, the compiler defaults to **-fsimple=0**
- With **-fsimple** without a value, the compiler uses **-fsimple=1**

The different floating–point simplification levels are:

–fsimple=0 Permit no simplifying assumptions. Preserve strict IEEE 754 conformance.

–fsimple=1 Allow conservative simplifications. The resulting code does not strictly conform to IEEE 754, but numeric results of most programs are unchanged.

With **-fsimple=1**, the optimizer can assume the following:

- IEEE 754 default rounding/trapping modes do not change after process initialization.
- Computations producing no visible result other than potential floating point exceptions may be deleted.
- Computations with Infinity or NaNs ("Not a Number") as operands need not propagate NaNs to their results; for example, **x*0** may be replaced by **0**.
- Computations do not depend on sign of zero.

With **-fsimple=1**, the optimizer is *not* allowed to optimize completely without regard to roundoff or exceptions. In particular, a floating–point computation cannot be replaced by one that produces different results with rounding modes held constant at run time.

–fsimple=2 In addition to **–fsimple=1**, permit aggressive floating point optimizations. This can cause some programs to produce different numeric results due to changes in the way expressions are evaluated. In particular, the Fortran standard rule requiring compilers to honor explicit parentheses around subexpressions to control expression evaluation order may be broken with **-fsimple=2**. This could result in numerical rounding differences with programs that depend on this rule.

For example, with **-fsimple=2**, the compiler may evaluate **C-(A-B)** as **(C-A)+B**, breaking the standard's rule about explicit parentheses, if the resulting code is better optimized. The compiler might also replace repeated

computations of *x/y* with *x*z*, where *z=1/y* is computed once and saved in a temporary, to eliminate the costly divide operations.

Programs that depend on particular properties of floating-point arithmetic should not be compiled with **-fsimple=2**.

Even with **-fsimple=2**, the optimizer still is not permitted to introduce a floating point exception in a program that otherwise produces none.

–fast selects **-fsimple=2.**

3.4.37 –fstore

(x86) Force precision of floating-point expressions.

For assignment statements, this option forces all floating-point expressions to the precision of the destination variable. This is the default. However, the **-fast** option includes **-nofstore** to disable this option. Follow **-fast** with **-fstore** to turn this option back on.

3.4.38 –ftrap=*t*

Set floating–point trapping mode in effect at startup.

t is a comma–separated list that consists of one or more of the following:

%all, **%none**, **common**, **[no%]invalid**, **[no%]overflow**, **[no%]underflow**, **[no%]division**, **[no%]inexact**.

-ftrap=common is a macro for **-ftrap=invalid,overflow,division**.

The **f95** default is **-ftrap=common**. This differs from the C and C++ compiler defaults, which is **-ftrap=none**.

Sets the IEEE 745 trapping mode in effect at startup but does not install a SIGFPE handler. You can use **ieee_handler**(3M) or **fex_set_handling**(3M) to simultaneously enable traps and install a SIGFPE handler. If you specify more than one value, the list is processed sequentially from left to right. The common exceptions, by definition, are invalid, division by zero, and overflow.

Example: **-ftrap=%all,no%inexact** means set all traps, except **inexact**.

The meanings for **-ftrap=***t* are the same as for **ieee_flags()**, except that:

- **%all** turns on all the trapping modes, and will cause trapping of spurious and expected exceptions. Use **common** instead.

- **%none** turns off all trapping modes.
- A **no%** prefix turns off that specific trapping mode.

To be effective, compile the main program with this option.

For further information, see the "Floating–Point Arithmetic" chapter in the *Fortran Programming Guide*.

3.4.39 –G

Build a dynamic shared library instead of an executable file.

Direct the linker to build a *shared dynamic* library. Without **-G**, the linker builds an executable file. With **-G**, it builds a dynamic library. Use **-o** with **-G** to specify the name of the file to be written. See the *Fortran Programming Guide* chapter "Libraries" for details.

3.4.40 –g

Compile for debugging and performance analysis.

Produce additional symbol table information for debugging with **dbx**(1) debugging utility and for performance analysis with the Performance Analyzer.

Although some debugging is possible without specifying **-g**, the full capabilities of **dbx** and **debugger** are only available to those compilation units compiled with **-g**.

Some capabilities of other options specified along with **-g** may be limited. See the **dbx** documentation for details.

To use the full capabilities of the Performance Analyzer, compile with **-g**. While some performance analysis features do not require **-g**, you must compile with **-g** to view annotated source, some function level information, and compiler commentary messages. (See the **analyzer**(1) man page and the manual *Sun Studio Performance Analyzer*.)

The commentary messages generated with **-g** describe the optimizations and transformations the compiler made while compiling your program. The messages, interleaved with the source code, can be displayed by the **er_src**(1) command.

Note that commentary messages only appear if the compiler actually performed any optimizations. You are more likely to see commentary messages when you request high optimization levels, such as with **-xO4**, or **-fast**.

3.4.41 –h*name*

Specify the name of the generated dynamic shared library.

This option is passed on to the linker. For details, see the Solaris *Linker and Libraries Guide*, and the *Fortran Programming Guide* chapter "Libraries."

The **-h***name* option records the name *name* to the shared dynamic library being created as the internal name of the library. A space between **-h** and *name* is optional (except if the library name is **elp**, for which the space will be needed). In general, *name* must be the same as what follows the **-o**. Use of this option is meaningless without also specifying **-G**.

Without the **-h***name* option, no internal name is recorded in the library file.

If the library has an internal name, whenever an executable program referencing the library is run the runtime linker will search for a library with the same internal name in any path the linker is searching. With an internal name specified, searching for the library at runtime linking is more flexible. This option can also be used to specify *versions* of shared libraries.

If there is no internal name of a shared library, then the linker uses a specific path for the shared library file instead.

3.4.42 –help

Display a summary list of compiler options.

See also "3.4.125 **–xhelp=**{**readme**|**flags**}" on page 110.

3.4.43 –I*path*

Add *path* to the **INCLUDE** file search path.

Insert the directory path *path* at the start of the **INCLUDE** file search path. No space is allowed between **-I** and *path*. Invalid directories are ignored with no warning message.

The *include file search path* is the list of directories searched for **INCLUDE** files—file names appearing on preprocessor **#include** directives, or Fortran **INCLUDE** statements.

Example: Search for **INCLUDE** files in **/usr/app/include**:

```
demo% f95 -I/usr/app/include growth.F
```

Multiple **-I***path* options may appear on the command line. Each adds to the top of the search path list (first path searched).

The search order for relative paths on **INCLUDE** or **#include** is:

1. The directory that contains the source file
2. The directories that are named in the **-I** options
3. The directories in the compiler's internal default list
4. **/usr/include/**

To invoke the preprocessor, you must be compiling source files with a **.F**, **.F90**, **.F95**, or **.F03** suffix.

3.4.44 -i8

(*There is no* **i8** *option.*)

Use **–xtypemap=integer:64** to specify 8–byte **INTEGER** with this compiler.

3.4.45 –inline=[%auto][[,][no%]*f1*,...[no%]*fn*]

Enable or disable inlining of specified routines.

Request the optimizer to inline the user–written routines appearing in a comma-separated list of function and subroutine names. Prefixing a routine name with **no%** disables inlining of that routine.

Inlining is an optimization technique whereby the compiler effectively replaces a subprogram reference such as a **CALL** or function call with the actual subprogram code itself. Inlining often provides the optimizer more opportunities to produce efficient code.

Specify **%auto** to enable automatic inlining at optimization levels **-O4** or **-O5**. Automatic inlining at these optimization levels is normally turned off when explicit inlining is specified with **-inline**.

Example: Inline the routines **xbar, zbar, vpoint**:

```
demo% f95 -O3 -inline=xbar,zbar,vpoint *.f
```

Following are the restrictions; no warnings are issued:

- Optimization must be **-O3** or greater.
- The source for the routine must be in the file being compiled, unless **-xipo** or**–xcrossfile** are also specified.
- The compiler determines if actual inlining is profitable and safe.

The appearance of **-inline** with **-O4** disables the automatic inlining that the compiler would normally perform, unless **%auto** is also specified. With **-O4**, the compilers normally try to inline all appropriate user–written subroutines and functions. Adding **-inline** with **-O4** may degrade performance by restricting the optimizer's inlining to only those routines in the list. In this case, use the **%auto** suboption to enable automatic inlining at **-O4** and **-O5**.

```
demo% f95 -O4 -inline=%auto,no%zpoint *.f
```

In the example above, the user has enabled **-O4**'s automatic inlining while disabling any possible inlining of the routine **zpoint()** that the compiler might attempt.

3.4.46 –iorounding[={compatible|processor-defined}]

Set floating-point rounding mode for formatted input/output.

Sets the **ROUND=** specifier globally for all formatted input/output operations.

With **-iorounding=compatible**, the value resulting from data conversion is the one closer to the two nearest representations, or the value away from zero if the value is halfway between them.

With **-iorounding=processor-defined**, the rounding mode is the processor's default mode. This is the default when **-iorounding** is not specified.

3.4.47 –Kpic

(Obsolete) Synonym for **-pic**.

3.4.48 –KPIC

(Obsolete) Synonym for **-PIC**.

3.4.49 –L*path*

Add *path* to list of directory paths to search for libraries.

Adds *path* to the *front* of the list of object–library search directories. A space between -L and *path* is optional. This option is passed to the linker. See also "3.4.50 **–l***x*" on page 73.

While building the executable file, **ld**(1) searches *path* for archive libraries (**.a** files) and shared libraries (**.so** files). **ld** searches *path* before searching the default directories. (See the *Fortran*

Programming Guide chapter "Libraries" for information on library search order.) For the relative order between **LD_LIBRARY_PATH** and **-L***path*, see **ld**(1).

Note – Specifying **/usr/lib** or **/usr/ccs/lib** with **-L** *path* may prevent linking the unbundled **libm**. These directories are searched by default.

Example: Use **-L***path* to specify library search directories:

```
demo% f95 -L./dir1 -L./dir2 any.f
```

3.4.50 –l*x*

Add library **lib***x***.a** to linker's list of search libraries.

Pass **-l***x* to the linker to specify additional libraries for **ld** to search for unresolved references. **ld** links with object library **lib***x*. If shared library **lib***x***.so** is available (and **-Bstatic** or **-dn** are not specified), **ld** uses it, otherwise, **ld** uses static library **lib***x***.a**. If it uses a shared library, the name is built in to **a.out**. No space is allowed between **-l** and *x* character strings.

Example: Link with the library **libVZY**:

```
demo% f95 any.f -lVZY
```

Use **-l***x* again to link with more libraries.

Example: Link with the libraries **liby** and **libz**:

```
demo% f95 any.f -ly -lz
```

See also the "Libraries" chapter in the *Fortran Programming Guide* for information on library search paths and search order.

3.4.51 –libmil

Inline selected **libm** library routines for optimization.

There are inline templates for some of the **libm** library routines. This option selects those inline templates that produce the fastest executable for the floating–point options and platform currently being used.

For more information, see the man pages **libm_single**(3F) and **libm_double**(3F)

3.4.52 –loopinfo

Show loop parallelization results.

Show which loops were and were not parallelized with the**–autopar** option.

–loopinfo displays a list of messages on standard error:

```
demo% f95 -c -fast -autopar -loopinfo shalow.f
...
"shalow.f", line 172: PARALLELIZED, and serial version generated
"shalow.f", line 173: not parallelized, not profitable
"shalow.f", line 181: PARALLELIZED, fused
"shalow.f", line 182: not parallelized, not profitable
...
...etc
```

3.4.53 –M*path*

Specify **MODULE** directory, archive, or file.

Look in path for Fortran modules referenced in the current compilation. This path is searched in addition to the current directory.

path can specify a directory, **.a** archive file of precompiled module files, or a **.mod** precompiled module file. The compiler determines the type of the file by examining its contents.

An archive **.a** file must be explicitly specified on a **-M** option flag to be searched for modules. The compiler will not search archive files by default.

Only **.mod** files with the same names as the **MODULE** names appearing on **USE** statements will be searched. For example, the statement **USE ME** causes the compiler to look only for the module file **me.mod**

When searching for modules, the compiler gives higher priority to the directory where the module files are being written. This is controlled by the **-moddir** compiler option, or the **MODDIR** environment variable. When neither are specified, the default write-directory is the current directory. When both are specified, the write-directory is the path specified by the **-moddir** flag.

This means that if only the **-M** flag appears, the current directory will be searched for modules first before any object listed on the **-M** flag. To emulate the behavior of previous releases, use:

```
-moddir=empty-dir -Mdir -M
```

where *empty-dir* is the path to an empty directory.

A space between the **-M** and the path is allowed. For example, **-M /home/siri/PK15/Modules**

On Solaris, if the path identifies a regular file that is not an archive or a module file, the compiler passes the option to the linker, **ld**, which will treat it as a linker mapfile. This feature is provided as a convenience similar to the C and C++ compilers.

See "4.9 Module Files" on page 163 for more information about modules in Fortran.

3.4.54 –m32 | –m64

Specify memory model for compiled binary object.

Use **-m32** to create 32-bit executables and shared libraries. Use **-m64** to create 64-bit executables and shared libraries.

The ILP32 memory model (32-bit int, long, pointer data types) is the default on all Solaris platforms and on Linux platforms that are not 64-bit enabled. The LP64 memory model (64-bit long, pointer data types) is the default on Linux platforms that are 64-bit enabled. -**m64** is permitted only on platforms that are enabled for the LP64 model.

Object files or libraries compiled with **-m32** cannot be linked with object files or libraries compiled with **-m64**.

When compiling applications with large amounts of static data using **-m64, -xmodel=medium** may also be required.

Be aware that some Linux platforms do not support the medium model.

Note that in previous compiler releases, the memory model, ILP32 or LP64, was implied by the choice of the instruction set with **-xarch**. Starting with the Sun Studio 12 compilers, this is no longer the case. On most platforms, just adding **-m64** to the command line is sufficient to create 64-bit objects.

On Solaris, **-m32** is the default. On Linux systems supporting 64-bit programs, **-m64 -xarch=sse2** is the default.

3.4.55 –moddir=*path*

Specify where the compiler will write compiled **.mod** MODULE files.

The compiler will write the **.mod** MODULE information files it compiles in the directory specified by *path*. The directory path can also be specified with the **MODDIR** environment variable. If both are specified, this option flag takes precedence.

The compiler uses the current directory as the default for writing **.mod** files.

See "4.9 Module Files" on page 163 for more information about modules in Fortran.

3.4.56 –mt

Require linking to thread–safe libraries.

If you do your own low–level thread management (for example, by calling the **libthread** library), compiling with **-mt** prevents conflicts.

Use **-mt** if you mix Fortran with multithreaded C code that calls the **libthread** library. See also the Solaris *Multithreaded Programming Guide*.

–mt is implied automatically when compiling with the **-autopar** option.

Note the following:

- A function subprogram that does I/O should not itself be referenced as part of an I/O statement. Such *recursive* I/O may cause the program to deadlock with **-mt**.
- In general, do *not* compile your own multithreaded code with **-autopar**. The compiler-generated calls to the threads library and the program's own calls may conflict, causing unexpected results.
- On a single–processor system, performance may be degraded with the **-mt** option.

3.4.57 –native

(*Obsolete*) Optimize performance for the host system.

This option is a synonym for **-xtarget=native**, which is preferred. The **-fast** option sets **-xtarget=native**.

3.4.58 –noautopar

Disables automatic parallelization invoked by **-autopar** earlier on the command line.

3.4.59 –nodepend

(SPARC) Cancel any **-depend** appearing earlier on the command line.

3.4.60 -nofstore

(x86) Cancel **-fstore** on command line.

The compiler default is **-fstore**. **-fast** includes **-nofstore**.

3.4.61 –nolib

Disable linking with system libraries.

Do *not* automatically link with *any* system or language library; that is do *not* pass any default **-l***x* options on to **ld**. The normal behavior is to link system libraries into the executables automatically, without the user specifying them on the command line.

The **-nolib** option makes it easier to link one of these libraries statically. The system and language libraries are required for final execution. It is your responsibility to link them in manually. This option provides you with complete control.

Link **libm** statically and **libc** dynamically with **f95**:

```
demo% f95 -nolib any.f95 -Bstatic -lm -Bdynamic -lc
```

The order for the **-l***x* options is important. Follow the order shown in the examples.

3.4.62 –nolibmil

Cancel **-libmil** on command line.

Use this option *after* the **-fast** option to disable inlining of **libm** math routines:

```
demo% f95 -fast -nolibmil ...
```

3.4.63 –noreduction

Disable **-reduction** on command line.

This option disables **-reduction**.

3.4.64 –norunpath

Do not build a runtime shared library search path into the executable.

The compiler normally builds into an executable a path that tells the runtime linker where to find the shared libraries it will need. The path is installation dependent. The **-norunpath** option prevents that path from being built in to the executable.

This option is helpful when libraries have been installed in some nonstandard location, and you do not wish to make the loader search down those paths when the executable is run at another site. Compare with **-R***paths*.

See the *Fortran Programming Guide* chapter on "Libraries" for more information.

3.4.65 –O[*n*]

Specify optimization level.

n can be **1**, **2**, **3**, **4**, or **5**. No space is allowed between **-O** and *n*.

If **-O[***n***]** is not specified, only a very basic level of optimization limited to local common subexpression elimination and dead code analysis is performed. A program's performance may be significantly improved when compiled with an optimization level than without optimization. Use of **-O** (which sets **-O3**) or **-fast** (which sets **-O5**) is recommended for most programs.

Each **-O***n* level includes the optimizations performed at the levels below it. Generally, the higher the level of optimization a program is compiled with, the better runtime performance obtained. However, higher optimization levels may result in increased compilation time and larger executable files.

Debugging with **-g** does not suppress **-O***n*, but **-O***n* limits **-g** in certain ways; see the **dbx** documentation.

The **-O3** and **-O4** options reduce the utility of debugging such that you cannot display variables from **dbx**, but you can still use the **dbx where** command to get a symbolic traceback.

If the optimizer runs out of memory, it attempts to proceed over again at a lower level of optimization, resuming compilation of subsequent routines at the original level.

For details on optimization, see the *Fortran Programming Guide* chapters "Performance Profiling" and "Performance and Optimization."

3.4.66 –O

This is equivalent to **-O3**.

3.4.67 –01

Provides a minimum of statement–level optimizations.

Use if higher levels result in excessive compilation time, or exceed available swap space.

3.4.68 –02

Enables basic block level optimizations.

This level usually gives the smallest code size. (See also **-xspace**.)

–03 is preferred over **-02** unless **-03** results in unreasonably long compilation time, exceeds swap space, or generates excessively large executable files.

3.4.69 –03

Adds loop unrolling and global optimizations at the function level. Adds **-depend** automatically.

Usually **-03** generates larger executable files.

3.4.70 –04

Adds automatic inlining of routines contained in the same file.

Usually **-04** generates larger executable files due to inlining.

The **-g** option suppresses the **-04** automatic inlining described above.**–xcrossfile** increases the scope of inlining with **-04**.

3.4.71 –05

Attempt aggressive optimizations.

Suitable only for that small fraction of a program that uses the largest fraction of compute time. **-05**'s optimization algorithms take more compilation time, and may also degrade performance when applied to too large a fraction of the source program.

Optimization at this level is more likely to improve performance if done with profile feedback. See **-xprofile=***p*.

3.4.72 –o *name*

Specify the name of the executable file to be written.

There must be a blank between **-o** and *name*. Without this option, the default is to write the executable file to **a.out**. When used with **-c**, **-o** specifies the target **.o** object file; with **-G** it specifies the target **.so** library file.

3.4.73 –onetrip

Enable one trip **DO** loops.

Compile **DO** loops so that they are executed at least once. **DO** loops in standard Fortran are not performed at all if the upper limit is smaller than the lower limit, unlike some legacy implementations of Fortran.

3.4.74 –openmp

Synonym for **-xopenmp**.

3.4.75 –p

(*Obsolete*) Compile for profiling with the **prof** profiler.

Prepare object files for profiling, see **prof** (1). If you compile and link in separate steps, and also compile with the **-p** option, then be sure to link with the **-p** option. **-p** with **prof** is provided mostly for compatibility with older systems. **-pg** profiling with **gprof** is possibly a better alternative. See the *Fortran Programming Guide* chapter on Performance Profiling for details.

3.4.76 –pad[=*p*]

Insert padding for efficient use of cache.

This option inserts padding between arrays or character variables, if they are static local and not initialized, or if they are in common blocks. The extra padding positions the data to make better use of cache. In either case, the arrays or character variables can not be equivalenced.

p, if present, must be either **%none** or either (or both) **local** or **common**:

`local`	Add padding between adjacent *local* variables.
`common`	Add padding between variables in common blocks.
`%none`	Do not add padding. (Compiler default.)

If both **`local`** and **`common`** are specified, they can appear in any order.

Defaults for **`-pad`**:

- The compiler does no padding by default.
- Specifying **`-pad`**, but without a value is equivalent to **`-pad=local,common`**.

The **`-pad[=`***p***`]`** option applies to items that satisfy the following criteria:

- The items are arrays or character variables
- The items are static local or in common blocks

For a definition of local or static variables, see "3.4.91 **`–stackvar`**" on page 86.

The program must conform to the following restrictions:

- Neither the arrays nor the character strings are equivalenced
- If **`-pad=common`** is specified for compiling a file that references a common block, it must be specified when compiling all files that reference that common block. The option changes the spacing of variables within the common block. If one program unit is compiled with the option and another is not, references to what should be the same location within the common block might reference different locations.
- If **`-pad=common`** is specified, the declarations of common block variables in different program units must be the same except for the names of the variables.The amount of padding inserted between variables in a common block depends on the declarations of those variables. If the variables differ in size or rank in different program units, even within the same file, the locations of the variables might not be the same.
- If **`-pad=common`** is specified, **`EQUIVALENCE`** declarations involving common block variables are flagged with a warning message and the block is not padded.
- Avoid overindexing arrays in common blocks with **`-pad=common`** specified. The altered positioning of adjacent data in a padded common block will cause overindexing to fail in unpredictable ways.

It is the programmer's responsibility to make sure that common blocks are compiled consistently when **`-pad`** is used. Common blocks appearing in different program units that are compiled inconsistently with **`-pad=common`** will cause errors. Compiling with **`-Xlist`** will report when common blocks with the same name have different lengths in different program units.

3.4.77 –pg

Compile for profiling with the **gprof** profiler.

Compile self–profiling code in the manner of **-p**, but invoke a runtime recording mechanism that keeps more extensive statistics and produces a **gmon.out** file when the program terminates normally. Generate an execution profile by running **gprof**. See the **gprof**(1) man page and the *Fortran Programming Guide* for details.

Library options must be *after* the source and **.o** files (**–pg** libraries are static).

Note – There is no advantage compiling with **-xprofile** if you specify **-pg**. These two features do not prepare or use data provided by the other.

Profiles generated by using **prof**(1) or **gprof**(1) on 64 bit Solaris platforms or just **gprof** on 32 bit Solaris platforms include approximate user CPU times. These times are derived from PC sample data (see **pcsample**(2)) for routines in the main executable and routines in shared libraries specified as linker arguments when the executable is linked. Other shared libraries (libraries opened after process startup using **dlopen**(3DL)) are not profiled.

On 32 bit Solaris systems, profiles generated using **prof**(1) are limited to routines in the executable. 32 bit shared libraries can be profiled by linking the executable with **-pg** and using **gprof**(1).

The Solaris 10 software does not include system libraries compiled with **-p**. As a result, profiles collected on Solaris 10 platforms do not include call counts for system library routines.

The compiler options **-p, -pg**, or **-xpg** should not be used to compile multi-threaded programs, because the runtime support for these options is not thread-safe. If a program that uses multiple threads is compiled with these options invalid results or a segmentation fault could occur at runtime.

If you compile and link in separate steps, and you compile with **-pg**, then be sure to link with **-pg**.

3.4.78 –pic

Compile position–independent code for shared library.

On SPARC, **–pic** is equivalent to **-xcode=pic13**. See "3.4.117 **–xcode=***keyword*" on page 104 for more information on position-indepented code.

On x86, produces position-independent code. Use this option to compile source files when building a shared library. Each reference to a global datum is generated as a dereference of a pointer in the global offset table. Each function call is generated in pc-relative addressing mode through a procedure linkage table.

3.4.79 –PIC

Compile position–independent code with 32-bit addresses.

On SPARC, **–PIC** is equivalent to **-xcode=pic32**. See "3.4.117 **–xcode=***keyword*" on page 104 for more information about position-independent code.

On x86, **–PIC** is equivalent to **–pic**.

3.4.80 –Qoption *pr ls*

Pass the suboption list *ls* to the compilation phase *pr*.

There must be blanks separating **Qoption**, *pr,* and *ls*. The **Q** can be uppercase or lowercase. The list is a comma–delimited list of suboptions, with no blanks within the list. Each suboption must be appropriate for that program phase, and can begin with a minus sign.

This option is provided primarily for debugging the internals of the compiler by support staff. Use the **LD_OPTIONS** environment variable to pass options to the linker. See the chapter on linking and libraries in the *Fortran Programming Guide*.

3.4.81 –qp

Synonym for **-p**.

3.4.82 –R *ls*

Build dynamic library search paths into the executable file.

With this option, the linker, **ld**(1), stores a list of dynamic library search paths into the executable file.

ls is a colon–separated list of directories for library search paths. The blank between **-R** and *ls* is optional.

Multiple instances of this option are concatenated together, with each list separated by a colon.

The list is used at runtime by the runtime linker, **ld.so**. At runtime, dynamic libraries in the listed paths are scanned to satisfy any unresolved references.

Use this option to let users run shippable executables without a special path option to find needed dynamic libraries.

Building an executable file using **-R***paths* adds directory paths to a default path that is always searched last.

For more information, see the "Libraries" chapter in the *Fortran Programming Guide*, and the Solaris *Linker and Libraries Guide*.

3.4.83 –r8const

Promote single-precision constants to **REAL*8** constants.

All single-precision **REAL** constants are promoted to **REAL*8**. Double-precision (**REAL*8**) constants are not changed. This option only applies to constants. To promote both constants and variables, see "3.4.173 **–xtypemap=***spec*" on page 137.

Use this option flag carefully. It could cause interface problems when a subroutine or function expecting a **REAL*4** argument is called with a **REAL*4** constant that gets promoted to **REAL*8**. It could also cause problems with programs reading unformatted data files written by an unformatted write with **REAL*4** constants on the I/O list.

3.4.84 -recl=a[,b]

Set default output record length.

Set the default record length (in characters) for either or both preconnected units output (standard output) and error (standard error). This option must be specified using one of the following forms:

- **-recl=out:***N*
- **-recl=error:***N*
- **–recl=out:***N1*,**error:***N2*
- **-recl=error:***N1*,**out:***N2*
- **-recl=all:***N*

where *N, N1, N2* are all positive integers in the range from 72 to 2147483646. **out** refers to standard output, **error** to standard error, and **all** sets the default record length to both. The default is -**recl=all:80**. This option is only effective if the program being compiled has a Fortran main program.

3.4.85 –reduction

Recognize reduction operations in loops.

Analyze loops for reduction operations during automatic parallelization. There is potential for roundoff error with the reduction.

A *reduction operation* accumulates the elements of an array into a single scalar value. For example, summing the elements of a vector is a typical reduction operation. Although these operations violate the criteria for parallelizability, the compiler can recognize them and parallelize them as special cases when **-reduction** is specified. See the *Fortran Programming Guide* chapter "Parallelization" for information on reduction operations recognized by the compilers.

This option is usable only with the automatic parallelization option **–autopar**. It is ignored otherwise. Explicitly parallelized loops are not analyzed for reduction operations.

3.4.86 –S

Compile and only generate assembly code.

Compile the named programs and leave the assembly–language output on corresponding files suffixed with **.s**. No **.o** file is created.

3.4.87 –s

Strip the symbol table out of the executable file.

This option makes the executable file smaller and more difficult to reverse engineer. However, this option inhibits debugging with **dbx** or other tools, and overrides **-g**.

3.4.88 –sb

(*Obsolete-this option is ignored*)

3.4.89 –sbfast

(*Obsolete — this option is ignored.*)

3.4.90 –silent

(*Obsolete*) Suppress compiler messages.

Normally, the **f95** compiler does not issue messages, other than error diagnostics, during compilation. This option flag is provided for compatibility with the legacy **f77** compiler, and its use is redundant except with the **-f77** compatibility flag.

3.4.91 –stackvar

Allocate local variables on the stack whenever possible.

This option makes writing recursive and re-entrant code easier and provides the optimizer more freedom when parallelizing loops.

Use of **-stackvar** is recommended with any of the parallelization options.

Local variables are variables that are not dummy arguments, **COMMON** variables, variables inherited from an outer scope, or module variables made accessible by a **USE** statement.

With **-stackvar** in effect, local variables are allocated on the stack unless they have the attributes **SAVE** or **STATIC**. Note that explicitly initialized variables are implicitly declared with the **SAVE** attribute. A structure variable that is not explicitly initialized but some of whose components are initialized is, by default, not implicitly declared **SAVE**. Also, variables equivalenced with variables that have the **SAVE** or **STATIC** attribute are implicitly **SAVE** or **STATIC**.

A statically allocated variable is implicitly initialized to zero unless the program explicitly specifies an initial value for it. Variables allocated on the stack are not implicitly initialized except that components of structure variables can be initialized by default.

Putting large arrays onto the stack with **-stackvar** can overflow the stack causing segmentation faults. Increasing the stack size may be required.

The initial thread executing the program has a *main* stack, while each helper thread of a multithreaded program has its own *thread* stack.

The default size of the main stack is about 8 Megabytes. The default thread stack size is 4 Megabytes on 32–bit systems, 8 Megabytes on 64–bit systems. The **limit** command (with no parameters) shows the current main stack size. If you get a segmentation fault using **-stackvar**, try increasing the main and thread stack sizes.

Example: Show the current *main* stack size:

```
demo% limit
cputime         unlimited
filesize        unlimited
datasize        523256 kbytes
stacksize       8192 kbytes      <——
coredumpsize    unlimited
descriptors     64
memorysize      unlimited
demo%
```

Example: Set the *main* stack size to 64 Megabytes:

```
demo% limit stacksize 65536
```

Example: Set each *thread* stack size to 8 Megabytes:

```
demo% setenv STACKSIZE 8192
```

You can set the stack size to be used by each slave thread by giving the **STACKSIZE** environment variable a value (in Kilobytes):

```
% setenv STACKSIZE 8192
```

sets the stack size for each slave thread to 8 Mb.

The **STACKSIZE** environment variable also accepts numerical values with a suffix of either **B**, **K**, **M**, or **G** for bytes, kilobytes, megabytes, or gigabytes respectively. The default is kilobytes.

Note that the **STACKSIZE** environment variable affects only programs compiled with the **–xopenmp** or **–xautopar** options, and has no affect on programs using the pthreads interface on Solaris systems.

For further information of the use of **-stackvar** with parallelization, see the "Parallelization" chapter in the *Fortran Programming Guide*. See **csh**(1) for details on the **limit** command.

Compile with **-xcheck=stkovf** to enable runtime checking for stack overflow situations. See "3.4.115 **–xcheck=***keyword*" on page 102.

3.4.92 –stop_status[={yes|no}]

Permit **STOP** statement to return an integer status value.

The default is **-stop_status=no**.

With **-stop_status=yes**, a **STOP** statement may contain an integer constant. That value will be passed to the environment as the program terminates:

```
STOP 123
```

The value must be in the range 0 to 255. Larger values are truncated and a run–time message issued. Note that

STOP "*stop string*'

is still accepted and returns a status value of 0 to the environment, although a compiler warning message will be issued.

The environment status variable is **$status** for the C shell **csh**, and **$?** for the Bourne and Korn shells, **sh** and **ksh**.

3.4.93 –temp=*dir*

Define directory for temporary files.

Set directory for temporary files used by the compiler to be *dir*. No space is allowed within this option string. Without this option, the files are placed in the **/tmp** directory.

This option takes precedence over the value of the **TMPDIR** environment variable.

3.4.94 –time

Time each compilation phase.

The time spent and resources used in each compiler pass is displayed.

3.4.95 –U

Recognize upper and lower case in source files.

Do not treat uppercase letters as equivalent to lowercase. The default is to treat uppercase as lowercase except within character–string constants. With this option, the compiler treats **Delta**, **DELTA**, and **delta** as different symbols. Calls to intrinsic functions are not affected by this option.

Portability and mixing Fortran with other languages may require use of **-U**. See the *Fortran Programming Guide* chapter on porting programs to Sun Studio Fortran.

3.4.96 -U*name*

Undefine preprocessor macro *name*.

This option applies only to source files that invoke the **fpp** or **cpp** pre-processor. It removes any initial definition of the preprocessor macro *name* created by **-D***name* on the same command line, including those implicitly placed there by the command-line driver, regardless of the order the options appear. It has no effect on any macro definitions in source files. Multiple **-U***name* flags can appear on the command line. There must be no space between **-U** and the macro *name*.

3.4.97 –u

Report undeclared variables.

Make the default type for all variables be *undeclared* rather than using Fortran implicit typing, as if **IMPLICIT NONE** appeared in each compilation unit. This option warns of undeclared variables, and does not override any **IMPLICIT** statements or explicit *type* statements.

3.4.98 –unroll=*n*

Enable unrolling of DO loops where possible.

n is a positive integer. The choices are:

- *n*=1 inhibits all loop unrolling.
- *n*>1 *suggests* to the optimizer that it attempt to unroll loops *n* times.

Loop unrolling generally improves performance, but will increase the size of the executable file. For more information on this and other compiler optimizations, see the "Performance and Optimization" chapter in the *Fortran Programming Guide*. See also "2.3.1.3 The **UNROLL** Directive" on page 32.

3.4.99 –use=*list*

Specify implicit **USE** modules.

list is a comma-separated list of module names or module file names.

Compiling with **-use=***module_name* has the effect of adding a **USE** *module_name* statement to each subprogram or module being compiled. Compiling with **-use=***module_file_name* has the effect of adding a **USE** *module_name* for each of the modules contained in the specified file.

See "4.9 Module Files" on page 163 for more information about modules in Fortran.

3.4.100 –V

Show name and version of each compiler pass.

This option prints the name and version of each pass as the compiler executes.

This information may be helpful when discussing problems with Sun service engineers.

3.4.101 –v

Verbose mode -show details of each compiler pass.

Like **-V**, shows the name of each pass as the compiler executes, and details the options, macro flag expansions, and environment variables used by the driver.

3.4.102 -vax=*keywords*

Specify choice of VAX VMS Fortran extensions enabled.

The *keywords* specifier must be one of the following suboptions or a comma-delimited list of a selection of these.

blank_zero	**Interpret blanks in formatted input as zeros on internal files.**
debug	Interpret lines starting with the character 'D' to be regular Fortran statements rather than comments, as in VMS Fortran.
rsize	Interpret unformatted record size to be in words rather than bytes.
struct_align	Layout components of a VAX structure in memory as in VMS Fortran, without padding. Note: this can cause data misalignments, and should be used with **–xmemalign** to avoid such errors.
%all	Enable all these VAX VMS features.
%none	Disable all these VAX VMS features.

Sub-options can be individually selected or turned off by preceeding with **no%**.

Example:

```
-vax=debug,rsize,no%blank_zero
```

3.4.103 –vpara

Show verbose parallelization messages.

As the compiler analyzes loops explicitly marked for parallelization with directives, it issues warning messages about certain data dependencies it detects; but the loop will still be parallelized.

Use with **-xopenmp** and OpenMP API directives.

Warnings are issued with the compiler detects the following situations:

- Problematic use of OpenMP data sharing attributes clauses, such as declaring a variable shared whose accesses in an OpenMP parallel region may cause data race, or declaring a variable private whose value in a parallel region is used after the parallel region.

No warnings appear if all parallelization directives are processed without issues.

Note – Sun Studio compilers support the OpenMP API parallelization model. Consequently, legacy **C$MIC** parallelization directives are deprecated and ignored. See the *OpenMP API User's Guide* for information on migrating to the OpenMP API.

3.4.104 –w[*n*]

Show or suppress warning messages.

This option shows or suppresses most warning messages. However, if one option overrides all or part of an option earlier on the command line, you do get a warning.

n may be 0, 1, 2 ,3, or 4.

-w0 shows just error messages. This is equivalent to **-w**. **-w1** shows errors and warnings. This is the default without **-w**.**-w2** shows errors, warnings, and cautions.**-w3** shows errors, warnings, cautions, and notes.**-w4** shows errors, warnings, cautions, notes, and comments.

3.4.105 –Xlist[*x*]

(*Solaris only*) Produce listings and do global program checking (GPC).

Use this option to find potential programming bugs. It invokes an extra compiler pass to check for consistency in subprogram call arguments, common blocks, and parameters, across the global program. The option also generates a line–numbered listing of the source code, including a cross reference table. The error messages issued by the **-Xlist** options are advisory warnings and do not prevent the program from being compiled and linked.

Note – Be sure to correct all syntax errors in the source code before compiling with **-Xlist**. Unpredictable reports may result when run on a source code with syntax errors.

Example: Check across routines for consistency:

```
demo% f95 -Xlist  fil.f
```

The above example writes the following to the output file **fil.lst**:

- A line–numbered source listing (default)
- Error messages (embedded in the listing) for inconsistencies across routines
- A cross reference table of the identifiers (default)

By default, the listings are written to the file **name.lst**, where **name** is taken from the first listed source file on the command line.

A number of sub–options provide further flexibility in the selection of actions. These are specified by suffixes to the main **-Xlist** option, as shown in the following table

TABLE 3–9 **–Xlist** Suboptions

Option	Feature
–Xlist	Show errors, listing, and cross reference table
–Xlistc	Show call graphs and errors
–XlistE	Show errors
–Xlisterr*[nnn]*	Suppress error *nnn* messages
–Xlistf	Show errors, listing, and cross references, but no object files
–Xlisth	Terminate compilation if errors detected
–XlistI	Analyze **#include** and **INCLUDE** files as well as source files
–XlistL	Show listing and errors only
–Xlistl*n*	Set page length to *n* lines
-XlistMP	Check OpenMP directives (**SPARC**)
–Xlisto *name*	Output report file to *name* instead of *file***.lst**
–Xlists	Suppress unreferenced names from the cross–reference table
–Xlistv*n*	Set checking level to *n* (1,2,3, or 4) -default is 2
–Xlistw*[nnn]*	Set width of output line to *nnn* columns -default is 79
–Xlistwar*[nnn]*	Suppress warning *nnn* messages
–XlistX	Show cross–reference table and errors

See the *Fortran Programming Guide* chapter "Program Analysis and Debugging" for details.

This option is not available on Linux systems.

3.4.106 –xa

Synonym for **-a**.

3.4.107 -xaddr32[={yes|no}]

(x86/x64 only) The **-xaddr32=yes** compilation flag restricts the resulting executable or shared object to a 32-bit address space.

An executable that is compiled in this manner results in the creation of a process that is restricted to a 32-bit address space. When **-xaddr32=no** is specified a usual 64 bit binary is produced. If the **-xaddr32** option is not specified, **-xaddr32=no** is assumed. If only **-xaddr32** is specified **-xaddr32=yes** is assumed.

This option is only applicable to **-m64** compilations and only on Solaris platforms supporting **SF1_SUNW_ADDR32** software capability. Since Linux kernel does not support address space limitation this option is not available on Linux. The **-xaddr32** option is ignored on Linux.

When linking, if a single object file was compiled with **-xaddr32=yes** the whole output file is assumed to be compiled with **-xaddr32=yes**. A shared object that is restricted to a 32-bit address space must be loaded by a process that executes within a restricted 32-bit mode address space. For more information refer to the **SF1_SUNW_ADDR32** software capabilities definition, described in the *Linker and Libraries Guide*.

3.4.108 –xalias[=*keywords*]

Specify degree of aliasing to be assumed by the compiler.

Some non-standard programming techniques can introduce situations that interfere with the compiler's optimization strategies. The use of overindexing, pointers, and passing global or non-unique variables as subprogram arguments, can introduce ambiguous aliasing situations that could result code that does not work as expected.

Use the **-xalias** flag to inform the compiler about the degree to which the program deviates from the aliasing requirements of the Fortran standard.

The flag may appear with or without a list of keywords. The *keywords* list is comma-separated, and each keyword indicates an aliasing situation present in the program.

Each keyword may be prefixed by **no%** to indicate an aliasing type that is not present.

The aliasing keywords are:

TABLE 3–10 **-xalias** Option Keywords

keyword	meaning
dummy	Dummy (formal) subprogram parameters can alias each other and global variables.
no%dummy	(Default). Usage of dummy parameters follows the Fortran standard and do not alias each other or global variables.

TABLE 3–10 **-xalias** Option Keywords *(Continued)*

keyword	meaning
craypointer	(Default). Cray pointers can point at any global variable or a local variable whose address is taken by the **LOC()** function. Also, two Cray pointers might point at the same data. This is a safe assumption that could inhibit some optimizations.
no%craypointer	Cray pointers point only at unique memory addresses, such as obtained from **malloc()**. Also, no two Cray pointers point at the same data. This assumption enables the compiler to optimize Cray pointer references.
actual	The compiler treats actual subprogram arguments as if they were global variables. Passing an argument to a subprogram might result in aliasing through Cray pointers.
no%actual	(Default) Passing an argument does not result in further aliasing.
overindex	■ A reference to an element in a COMMON block might refer to any element in a COMMON block or equivalence group. ■ Passing any element of a COMMON block or equivalence group as an actual argument to a subprogram gives access to any element of that COMMON block or equivalence group to the called subprogram. ■ Variables of a sequence derived type are treated as if they were COMMON blocks, and elements of such a variable might alias other elements of that variable. ■ Individual array bounds may be violated, but except as noted above, the referenced array element is assumed to stay within the array. Array syntax, **WHERE**, and **FORALL** statements are not considered for overindexing. If overindexing occurs in these constructs, they should be rewritten as **DO** loops.
no%overindex	(Default) Array bounds are not violated. Array references do not reference other variables.
ftnpointer	Calls to external functions might cause Fortran pointers to point at target variables of any type, kind, or rank.
no%ftnpointer	(Default) Fortran pointers follow the rules of the standard.

Specifying **-xalias** without a list gives the best performance for most programs that do not violate Fortran aliasing rules, and corresponds to:

```
no%dummy,no%craypointer,no%actual,no%overindex,no%ftnpointer
```

To be effective, **-xalias** should be used when compiling with optimization levels **-xO3** and higher.

The compiler default, with no **-xalias** flag specified, assumes that the program conforms to the Fortran standard except for Cray pointers:

no%dummy,craypointer,no%actual,no%overindex,no%ftnpointer

Examples of various aliasing situations and how to specify them with **-xalias** are given in the Porting chapter of the *Fortran Programming Guide*.

3.4.109 -xannotate[={yes|no}]

(Solaris Only) Instructs the compiler to create binaries that can later be transformed by binary modification tools like **binopt**(1).

Future binary analysis, code coverage and memory error detection tools will also work with binaries built with this option.

Use the **-xannotate=no** option to prevent the modification of the binary file by these tools. The **-xannotate=yes** option must be used with optimization level **-xO1** or higher to be effective, and it is only effective on systems with the new linker support library interface - **ld_open()**. If the compiler is used on a system without this linker interface (for example Solaris 9 and early versions of Solaris 10), it silently will revert to **-xannotate=no**.

The default is **-xannotate=yes**, but if either of the above conditions is not met, the default reverts to **-xannotate=no**.

This option is not available on Linux systems.

3.4.110 –xarch=*isa*

Specify instruction set architecture (ISA).

Architectures that are accepted by **-xarch** keyword *isa* are shown in Table 3–11:

TABLE 3–11 **–xarch** ISA Keywords

Platform	Valid **-xarch** Keywords
SPARC	**generic**, **generic64**, **native**, **native64**, **sparc**, **sparcvis**, **sparcvis2**, **sparcfmaf**, **v9**, **v9a**, **v9b**
x86	**generic**, **native**, **386**, **pentium_pro**, **sse**, **sse2**, **amd64**, **pentium_proa**, **ssea**, **sse2a**, **amd64a**, **sse3,sse3a, ssse3, sse4_1, sse4_2, amdsse4a**

Note that although **-xarch** can be used alone, it is part of the expansion of the **–xtarget** option and may be used to override the **-xarch** value that is set by a specific **-xtarget** option. For example:

```
% f95 -xtarget=ultra2 -xarch=sparcfmaf ...
```

overrides the **-xarch** set by **-xtarget=ultra2**

This option limits the code generated by the compiler to the instructions of the specified instruction set architecture by allowing only the specified set of instructions. This option does not guarantee use of any target–specific instructions.

If this option is used with optimization, the appropriate choice can provide good performance of the executable on the specified architecture. An inappropriate choice results in a binary program that is not executable on the intended target platform.

Note the following:

- Legacy 32–bit SPARC instruction set architectures V7 and V8 imply **–m32** and cannot be combined with **–m64**.
- Object binary files (**.o**) compiled with **sparc** and **sparcvis** can be linked and can execute together, but will run only on a **sparcvis**—compatible platform.
- Object binary files (**.o**) compiled with **sparc**, **sparcvis**, and **sparcvis2** can be linked and can execute together, but will run only on a **sparcvis2**–compatible platform.

For any particular choice, the generated executable may run much more slowly on earlier architectures. Also, although quad-precision (**REAL*16** and **long double**) floating-point instructions are available in many of these instruction set architectures, the compiler does not use these instructions in the code it generates.

The default when **-xarch** is not specified is **generic**.

Table 3–12 gives details for each of the **-xarch** keywords on SPARC platforms.

TABLE 3–12 **-xarch** Values for SPARC Platforms

-xarch=	Meaning (SPARC)
generic	**Compile using the instruction set common to most processors.** This is **v8plus** when compiling with **–m32**, and **sparc** with **–m64**.
generic64	**Compile for most 64–bit platforms.** (Solaris only) This option is equivalent to **-m64 -xarch=generic** and is provided for compatibility with earlier releases. Use **-m64** to specify 64-bit compilation instead of **-xarch=generic64**
native	**Compile for good performance on this system.** The compiler chooses the appropriate setting for the current system processor it is running on. This is the default for the **-fast** option.

TABLE 3–12 **-xarch** Values for SPARC Platforms *(Continued)*

-xarch=	Meaning (SPARC)
native64	**Compile for good performance in 64-bit mode on this system.** (Solaris only) This option is equivalent to **-m64 -xarch=native** and is provided for compatibility with earlier releases.
sparc	**Compile for the SPARC–V9 ISA.** Compile for the V9 ISA, but without the Visual Instruction Set (VIS), and without other implementation-specific ISA extensions. This option enables the compiler to generate code for good performance on the V9 ISA.
sparcvis	**Compile for the SPARC–V9 ISA with UltraSPARC extensions.** Compile for SPARC-V9 plus the Visual Instruction Set (VIS) version 1.0, and with UltraSPARC extensions. This option enables the compiler to generate code for good performance on the UltraSPARC architecture.
sparcvis2	**Compile for the SPARC-V9 ISA with UltraSPARC-III extensions.** Enables the compiler to generate object code for the UltraSPARC architecture, plus the Visual Instruction Set (VIS) version 2.0, and with UltraSPARC III extensions.
sparcfmaf	**Compile for the sparcfmaf version of the SPARC-V9 ISA.** Enables the compiler to use instructions from the SPARC-V9 instruction set, plus the UltraSPARC extensions, including the Visual Instruction Set (VIS) version 1.0, the UltraSPARC-III extensions, including the Visual Instruction Set (VIS) version 2.0, and the SPARC64 VI extensions for floating-point multiply-add. Note that you must use **-xarch=sparcfmaf**in conjunction with **-fma=fused** and some optimization level to get the compiler to attempt to find opportunities to use the multiply-add instructions automatically.
v9	Equivalent to **-m64 -xarch=sparc** Legacy makefiles and scripts that use **-xarch=v9** to obtain the 64-bit memory model need only use **-m64**.
v9a	Equivalent to **-m64 -xarch=sparcvis** and is provided for compatibility with earlier releases.
v9b	Equivalent to **-m64 -xarch=sparcvis2** and is provided for compatibility with earlier releases.

Table 3–13 details each of the **-xarch** keywords on x86 platforms. The default on x86 is **generic** (or **generic64** if **–m64** is specified) if **-xarch** is not specified.

TABLE 3–13 **-xarch** Values for x86 Platforms

-xarch=	Meaning (x86)
generic	Compile for good performance on most 32-bit x86 platforms. This is the default, and is equivalent to **-xarch=pentium_pro**.
generic64	Compile for good performance on most 64-bit x86 platforms. It is equivalent to **sse2**.
native	Compile for good performance on this x86 architecture. Use the best instruction set for good performance on most x86 processors. With each new release, the definition of "best" instruction set may be adjusted, if appropriate.
native64	Compile for good performance on this 64-bit x86 architecture.
386	Limits instruction set to the Intel 386/486 architecture.
pentium_pro	Limits instruction set to the Pentium Pro architecture.
pentium_proa	Adds the AMD extensions (3DNow!, 3DNow! extensions, and MMX extensions) to the 32-bit Pentium Pro architecture.
sse	Adds the SSE instruction set to **pentium_pro**. (See Note below.)
ssea	Adds the AMD extensions (3DNow!, 3DNow! extensions, and MMX extensions) to the 32-bit SSE architecture.
sse2	Adds the SSE2 instruction set to the **pentium_pro**. (See Note below.)
sse2a	Adds the AMD extensions (3DNow!, 3DNow! extensions, and MMX extensions) to the 32-bit SSE2 architecture.
sse3	Adds the SSE3 instruction set to the SSE2 instruction set.
amd64	On Solaris platforms, this is equivalent to **-m64 -xarch=sse2** Legacy makefiles and scripts that use -**xarch=amd64** to obtain the 64-bit memory model should use **-m64**.
amd64a	On Solaris platforms, this is equivalent to **–m64 –xarch=sse2a** .
sse3a	Adds AMD extended instructions, including 3DNow! to the SSE3 instruction set.
ssse3	Adds the SSSE3 instructions to the SSE3 instruction set.
sse4_1	Adds the SSE4.1 instructions to the SSSE3 instruction set.
sse4_2	Adds the SSE4.2 instructions to the SSE4.1 instruction set.
amdsse4a	Adds the SSE4a instructions to the AMD instruction set.

3.4.110.1 Special Cautions for x86/x64 Platforms:

There are some important considerations when compiling for x86 Solaris platforms.

- Programs compiled with **-xarch** set to **sse**, **sse2**, **sse2a**, or **sse3** and beyond must be run on platforms supporting these features and extensions..
- OS releases starting with Solaris 9 4/04 are SSE/SSE2-enabled on Pentium 4-compatible platforms. Earlier versions of Solaris OS are not SSE/SSE2- enabled.
- If you compile and link in separate steps, always link using the compiler and with same **-xarch** setting to ensure that the correct startup routine is linked.
- Arithmetic results on x86 may differ from results on SPARC due to the x86 80-byte floating-point registers. To minimize these differences, use the **-fstore** option or compile with **-xarch=sse2** if the hardware supports SSE2.
- Starting with Sun Studio 11 and the Solaris 10 OS, program binaries compiled and built using these specialized **-xarch** hardware flags are verified that they are being run on the appropriate platform.
- On systems prior to Solaris 10, no verification is done and it is the user's responsibility to ensure objects built using these flags are deployed on suitable hardware.
- Running programs compiled with these **-xarch** options on platforms that are not enabled with the appropriate features or instruction set extensions could result in segmentation faults or incorrect results occurring without any explicit warning messages.
- This warning extends also to programs that employ **.il** inline assembly language functions or **__asm()** assembler code that utilize SSE, SSE2, SSE2a, and SSE3 instructions and extensions.

3.4.111 –xassume_control[=*keywords*]

Set parameters to control **ASSUME** pragmas.

Use this flag to control the way the compiler handles **ASSUME** pragmas in the source code.

The **ASSUME** pragmas provide a way for the programmer to assert special information that the compiler can use for better optimization. These assertions may be qualified with a probability value. Those with a probability of 0 or 1 are marked as certain; otherwise they are considered non-certain.

You can also assert, with a probability or certainty, the trip count of an upcoming DO loop, or that an upcoming branch will be taken.

See "2.3.1.8 The **ASSUME** Directives" on page 34, for a description of the **ASSUME** pragmas recognized by the **f95** compiler.

The *keywords* on the **-xassume_control** option can be a single suboption keyword or a comma-separated list of keywords. The keyword suboptions recognized are:

optimize	The assertions made on **ASSUME** pragmas affect optimization of the program.
check	The compiler generates code to check the correctness of all assertions marked as certain, and emits a runtime message if the assertion is violated; the program continues if **fatal** is not also specified.
fatal	When used with **check**, the program will terminate when an assertion marked certain is violated.
retrospective[:*d*]	The *d* parameter is an optional tolerance value, and must be a real positive constant less than 1. The default is ".1". **retrospective** compiles code to count the truth or falsity of all assertions. Those outside the tolerance value *d* are listed on output at program termination.
%none	All **ASSUME** pragmas are ignored.

The compiler default is

-xassume_control=optimize

This means that the compiler recognizes **ASSUME** pragmas and they will affect optimization, but no checking is done.

If specified without parameters, **-xassume_control** implies

-xassume_control=check,fatal

In this case the compiler accepts and checks all certain **ASSUME** pragmas, but they do not affect optimization. Assertions that are invalid cause the program to terminate.

3.4.112 –xautopar

Synonym for **-autopar**.

3.4.113 –xbinopt={prepare|off}

(SPARC) Prepare binary for post-compilation optimization.

The compiled binary file is enabled for later optimizations, transformations, and analysis by **binopt**(1). This option may be used when building executables or shared objects, and it must be used with an optimization level of **-O1** or higher to be effective.

There will be a modest increase in the size of the binary file when built with this option, on the order of 5%.

If you compile and link in separate steps, **-xbinopt** must appear on both the compile and link steps.

If not all the source code for an application is compiled with **-xbinopt**, the **-xbinopt** flag should still appear on the final link step that builds the program binary, as shown below:

```
example% f95 -0 program -xbinopt=prepare a.o b.o c.f95
```

Only code compiled with **-xbinopt** can be optimized by **binopt**(1).

The default is **-xbinopt=off**.

3.4.114 –xcache=*c*

Define cache properties for the optimizer.

c must be one of the following:

- **generic**
- native
- *s1*/*l1*/*a1*[/*t1*]
- *s1*/*l1*/*a1*[/*t1*]:*s2*/*l2*/*a2*[/*t2*]
- *s1*/*l1*/*a1*[/*t1*]:*s2*/*l2*/*a2*[/*t2*]:*s3*/*l3*/*a3*[/*t3*]

The *si*/*li*/*ai*/*ti* are defined as follows:

si The size of the data cache at level *i*, in kilobytes*li* The line size of the data cache at level *i*, in bytes*ai* The associativity of the data cache at level *iti* The number of hardware threads sharing the cache at level *i (optional)*.

This option specifies the cache properties that the optimizer can use. It does not guarantee that any particular cache property is used.

Although this option can be used alone, it is part of the expansion of the **–xtarget** option; it is provided to allow overriding an **-xcache** value implied by a specific **-xtarget** option.

TABLE 3–14 **–xcache** Values

Value	Meaning
generic	Define the cache properties for good performance on most processors without any major performance degradation. This is the default.
native	Define the cache properties for good performance on this host platform.
s1/*l1*/*a1*[/*t1*}	Define level 1 cache properties.
s1/*l1*/*a1*[/*t1*}:*s2*/*l2*/*a2*[/*t2*}	Define levels 1 and 2 cache properties.

TABLE 3–14 **–xcache** Values *(Continued)*

Value	Meaning
s1/*l1*/*a1*[/*t1*]:*s2*/*l2*/*a2*[/*t2*]:*s3*/*l3*/*a3*[/*t3*]	Define levels 1, 2, and 3 cache properties

Example: **-xcache=16/32/4:1024/32/1** specifies the following:

A Level 1 cache has: 16K bytes, 32 byte line size, 4–way associativity.

A Level 2 cache has: 1024K bytes, 32 byte line size, direct mapping associativity.

3.4.115 –xcheck=*keyword*

Generate special runtime checks and initializations.

The *keyword* must be one of the following:

keyword	Feature
stkovf	Turn on runtime checking for stack overflow on subprogram entry. If a stack overflow is detected, a **SIGSEGV** segment fault will be raised. (**SPARC** only)
no%stkovf	Disable runtime checking for stack overflow. (**SPARC** only)
init_local	Perform special initialization of local variables. The compiler initializes local variables to a value that is likely to cause an arithmetic exception if it is used by the program before it is assigned. Memory allocated by the **ALLOCATE** statement will also be initialized in this manner. Module variables, **SAVE** variables, and variables in **COMMON** blocks are not initialized.
no%init_local	Disable local variable initialization. This is the default.
%all	Turn on all these runtime checking features.
%none	Disable all these runtime checking features.

Stack overflows, especially in multithreaded applications with large arrays allocated on the stack, can cause silent data corruption in neighboring thread stacks. Compile all routines with **-xcheck=stkovf** if stack overflow is suspected. But note that compiling with this flag does not guarantee that all stack overflow situations will be detected since they could occur in routines not compiled with this flag.

3.4.116 –xchip=*c*

Specify target processor for the optimizer.

This option specifies timing properties by specifying the target processor.

Although this option can be used alone, it is part of the expansion of the **–xtarget** option; it is provided to allow overriding a **-xchip** value implied by the a specific **-xtarget** option.

Some effects of **-xchip=***c* are:

- Instruction scheduling
- The way branches are compiled
- Choice between semantically equivalent alternatives

The following tables list the valid **-xchip** processor name values:

TABLE 3–15 Common **–xchip** SPARC Processor Names

-xchip=	Optimize for:
generic	most SPARC processors. (This is the default.)
native	this host platform.
sparc64vi	SPARC64 VI processor
sparc64vii	SPARC64 VII processor
ultra	UltraSPARC processor.
ultra2	UltraSPARC II processor.
ultra2e	UltraSPARC IIe processor.
ultra2i	UltraSPARC IIi processor.
ultra3	UltraSPARC III processor.
ultra3cu	UltraSPARC IIIcu processor.
ultra3i	UltraSPARC IIIi processor
ultra4	UltraSPARC IV processor
ultra4plus	UltraSPARC IV+ processor
ultraT1	UltraSPARC T1 processor
ultraT2	UltraSPARC T2 processor
ultraT2plus	UltraSPARC T2+ processor

On x86 platforms: the **-xchip** values are **pentium**, **pentium_pro**, **pentium3**, **pentium4**, **generic**, **opteron**, **core2, penryn, nehalem, amdfam10**, and **native**.

3.4.117 –xcode=*keyword*

(SPARC) Specify code address space on SPARC platforms.

The values for *keyword* are:

keyword	Feature
abs32	Generate 32-bit absolute addresses. Code+data+bss size is limited to 2**32 bytes. This is the default on 32-bit platforms.
abs44	Generate 44-bit absolute addresses. Code+data+bss size is limited to 2**44 bytes. Available only on 64-bit platforms.
abs64	Generate 64-bit absolute addresses. Available only on 64-bit platforms.
pic13	Generate position-independent code (small model). Equivalent to **-pic**. Permits references to at most 2**11 unique external symbols on 32-bit platforms, 2**10 on 64-bit platforms.
pic32	Generate position-independent code (large model). Equivalent to **-PIC**. Permits references to at most 2**30 unique external symbols on 32-bit platforms, 2**29 on 64-bit platforms.

The defaults for not specifying **-xcode=***keyword* explicitly are:

–xcode=abs32 on 32–bit platforms.**–xcode=abs44** on 64–bit platforms.

3.4.117.1 Position-Independent Code:

Use **-xcode=pic13** or **-xcode=pic32** when creating dynamic shared libraries to improve runtime performance.

While the code within a dynamic executable is usually tied to a fixed address in memory, position-independent code can be loaded anywhere in the address space of the process.

When you use position-independent code, relocatable references are generated as an indirect reference through a global offset table. Frequently accessed items in a shared object will benefit from compiling with **-xcode=pic13** or **-xcode=pic32** by not requiring the large number of relocations imposed by code that is not position-independent.

The size of the global offset table is limited to 8Kb.

There are two nominal performance costs with -**xcode={pic13|pic32}** :

- A routine compiled with either **-xcode=pic13** or **-xcode=pic32** executes a few extra instructions upon entry to set a register to point at the global offset table used for accessing a shared library's global or static variables.
- Each access to a global or static variable involves an extra indirect memory reference through the global offset table. If the compile is done with **pic32**, there are two additional instructions per global and static memory reference.

When considering the above costs, remember that the use of **-xcode=pic13** or **-xcode=pic32** can significantly reduce system memory requirements, due to the effect of library code sharing. Every page of code in a shared library compiled **-xcode=pic13** or **-xcode=pic32** can be shared by every process that uses the library. If a page of code in a shared library contains even a single non-pic (that is, absolute) memory reference, the page becomes nonsharable, and a copy of the page must be created each time a program using the library is executed.

The easiest way to tell whether or not a **.o** file has been compiled with **-xcode=pic13** or **-xcode=pic32** is with the **nm** command:

```
nm file.o | grep _GLOBAL_OFFSET_TABLE_
```

A **.o** file containing position-independent code will contain an unresolved external reference to **_GLOBAL_OFFSET_TABLE_** as marked by the letter **U**.

To determine whether to use **-xcode=pic13** or **-xcode=pic32**, check the size of the Global Offset Table (GOT) by using **elfdump -c** (see the **elfdump**(1) man page for more information) and for the section header, **sh_name: .got**. The **sh_size** value is the size of the GOT. If the GOT is less than 8,192 bytes, specify **-xcode=pic13**, otherwise specify **-xcode=pic32**.

In general, use the following guidelines to determine how you should use **-xcode**:

- If you are building an executable you should not use **-xcode=pic13** or **-xcode=pic32**.
- If you are building an archive library only for linking into executables you should not use **-xcode=pic13** or **-xcode=pic32**.
- If you are building a shared library, start with **-xcode=pic13** and once the GOT size exceed 8,192 bytes, use **-xcode=pic32**.
- If you are building an archive library for linking into shared libraries you should just use **-xcode=pic32**.

Compiling with the **-xcode=pic13** or **pic32** (or **-pic** or **-PIC**) options is recommended when building dynamic libraries. See the Solaris Linker and Libraries Guide.

3.4.118 –xcommonchk[={yes|no}]

Enable runtime checking of common block inconsistencies.

This option provides a debug check for common block inconsistencies in programs using **TASK COMMON** and parallelization. (See the discussion of the **TASK COMMON** directive in the "Parallelization" chapter in the *Fortran Programming Guide*.)

The default is **-xcommonchk=no**; runtime checking for common block inconsistencies is disabled because it will degrade performance. Use **-xcommonchk=yes** only during program development and debugging, and not for production-quality programs.

Compiling with **-xcommonchk=yes** enables runtime checking. If a common block declared in one source program unit as a regular common block appears somewhere else on a **TASK COMMON** directive, the program will stop with an error message indicating the first such inconsistency. **-xcommonchk** without a value is equivalent to **-xcommonchk=yes**.

3.4.119 –xcrossfile[={1|0}]

Enable optimization and inlining across source files.

Normally, the scope of the compiler's analysis is limited to each separate file on the command line. For example, **-O4**'s automatic inlining is limited to subprograms defined and referenced within the same source file.

With **-xcrossfile**, the compiler analyzes all the files named on the command line as if they had been concatenated into a single source file.

–xcrossfile is only effective when used with **-O4** or **-O5**.

Cross–file inlining creates a possible source file interdependence that would not normally be there. If any file in a set of files compiled together with **-xcrossfile** is changed, then all files must be recompiled to insure that the new code is properly inlined. See "3.4.45 **–inline=**[**%auto**][[**,**][**no%**]*f1*,…[**no%**]*fn*]" on page 71.

The default, without **-xcrossfile** on the command line, is **-xcrossfile=0**, and no cross-file optimizations are performed. To enable cross-file optimizations, specify **-xcrossfile** (equivalent to **-xcrossfile=1**).

Any **.s** assmbler source files in the compilation do not participate in the crossfile analysis. Also, the **-xcrossfile** flag is ignored if compiling with **-S**.

3.4.120 –xdebugformat={dwarf|stabs}

Sun Studio compilers are migrating the format of debugger information from the "stabs" format to the "dwarf" format. The default setting for this release is **-xdebugformat=dwarf**.

If you maintain software which reads debugging information, you now have the option to transition your tools from the stabs format to the dwarf format.

Use this option as a way of accessing the new format for the purpose of porting tools. There is no need to use this option unless you maintain software which reads debugger information, or unless a specific tool tells you that it requires debugger information in one of these formats.

-xdebugformat=stabs generates debugging information using the stabs standard format.

-xdebugformat=dwarf generates debugging information using the dwarf standard format.

If you do not specify **-xdebugformat**, the compiler assumes **-xdebugformat=dwarf**. It is an error to specify the option without an argument.

This option affects the format of the data that is recorded with the **-g** option. Some the format of that information is also controlled with this option. So **-xdebugformat** has a an effect even when **-g** is not used.

The dbx and Performance Analyzer software understand both stabs and dwarf format so using this option does not have any effect on the functionality of either tool.

This is a transitional interface so expect it to change in incompatible ways from release to release, even in a minor release. The details of any specific fields or values in either stabs or dwarf are also evolving.

Use the **dwarfdump**(1) command to determine the format of the debugging information in a compiled object or executable file.

3.4.121 –xdepend

Synonym for **-depend**.

3.4.122 –xF

Allow function–level reordering by the Performance Analyzer.

Allow the reordering of functions (subprograms) in the core image using the compiler, the performance analyzer and the linker. If you compile with the **-xF** option, then run the analyzer, you can generate a map file that optimizes the ordering of the functions in memory depending on how they are used together. A subsequent link to build the executable file can be directed to use that map by using the linker **-Mmapfile** option. It places each function from the executable file into a separate section. (The **f95 –M***path* option also passes a regular file to the linker; see the description of the **f95 –M***path* option.)

Reordering the subprograms in memory is useful only when the application text page fault time is consuming a large percentage of the application time. Otherwise, reordering may not improve the overall performance of the application. See the *Program Performance Analysis Tools* manual for further information on the analyzer.

3.4.123 –xfilebyteorder=*options*

Support file sharing between little-endian and big-endian platforms.

The flag identifies the byte-order and byte-alignment of data on unformatted I/O files. *options* must specify any combination of the following, but at least one specification must be present:

little*max_align*:*spec*

big*max_align*:*spec*

native:*spec*

max_align declares the maximum byte alignment for the target platform. Permitted values are 1, 2, 4, 8, and 16. The alignment applies to Fortran VAX structures and Fortran derived types that use platform-dependent alignments for compatibility with C language structures.

little specifies a "little-endian" file on platforms where the maximum byte alignment is *max_align*. For example, **little4** specifies a 32-bit x86 file, while **little16** describes a 64-bit x86 file.

big specifies a "big-endian" file with a maximum alignment of *max_align*. For example, **big8** describes a 32-bit SPARC file, while **big16** describes a 64-bit SPARC file.

native specifies a "native" file with the same byte order and alignment used by the compiling processor platform. The following are assumed to be "native":

Platform	"native" corresponds to:
32-bit SPARC	**big8**
64-bit SPARC	**big16**
32-bit x86	**little4**
64-bit x86	**little16**

spec must be a comma-separated list of the following:

%all

unit

filename

%all refers to all files and logical units except those opened as **"SCRATCH"**, or named explicitly elsewhere in the **-xfilebyteorder** flag. **%all** can only appear once.

unit refers to a specific Fortran unit number opened by the program.

filename refers to a specific Fortran file name opened by the program.

3.4.123.1 Examples:

```
-xfilebyteorder=little4:1,2,afile.in,big8:9,bfile.out,12
-xfilebyteorder=little8:%all,big16:20
```

3.4.123.2 Notes:

This option does not apply to files opened with **STATUS="SCRATCH"**. I/O operations done on these files are always with the byte-order and byte-alignment of the native processor.

The first default, when **-xfilebyteorder** does not appear on the command line, is **-xfilebyteorder=native:%all**.

A file name or unit number can be declared only once in this option.

When **-xfilebyteorder** does appear on the command line, it must appear with at least one of the little, big, or native specifications.

Files not explicitly declared by this flag are assumed to be native files. For example, compiling with **-xfilebyteorder=little4:zork.out** declares **zork.out** to be a little-endian 32-bit x86 file with a 4-byte maximum data alignment. All other files in the program are native files.

When the byte-order specified for a file is the same as the native processor but a different alignment is specified, the appropriate padding will be used even though no byte swapping is done. For example, this would be the case when compiling with **-m64** for 64-bit x86 platforms and **-xfilebyteorder=little4:***filename* is specified.

The declared types in data records shared between big-endian and little-endian platforms must have the same sizes. For example, a file produced by a SPARC executable compiled with **-xtypemap=integer:64,real:64,double:128** cannot be read by an x86 executable compiled with **-xtypemap=integer:64,real:64,double:64** since the default double precision data types will have different sizes. (However, note that starting with the release of Sun Studio 12 Update 1, **double:128** is accepted on x64 processors.)

If an option that changes the alignment of the components within a VAX structure (such as **–vax=struct_align**) or a derived type (such as **–aligncommon** or **–dalign**) is used on one platform, the same alignment option has to be used on other platforms sharing the same unformatted data file whose content is affected by the alignment option.

An I/O operation with an entire **UNION/MAP** data object on a file specified as non-native will result in a runtime I/O error. You can only execute I/O operations using the individual members of the **MAP** (and not an entire VAX record containing the **UNION/MAP**) on non-native files.

3.4.124 –xhasc[={yes|no}]

Treat Hollerith constant as a character string in an actual argument list.

With **-xhasc=yes**, the compiler treats Hollerith constants as character strings when they appear as an actual argument on a subroutine or function call. This is the default, and complies with the Fortran standard. (The actual call list generated by the compiler contains hidden string lengths for each character string.)

With **-xhasc=no**, Hollerith constants are treated as typeless values in subprogram calls, and only their addresses are put on the actual argument list. (No string length is generated on the actual call list passed to the subprogram.)

Compile routines with **-xhasc=no** if they call a subprogram with a Hollerith constant and the called subprogram expects that argument as **INTEGER** (or anything other than **CHARACTER**).

Example:

```
demo% cat hasc.f
                call z(4habcd, 'abcdefg')
                end
                subroutine z(i, s)
                integer i
                character *(*) s
                print *, "string length = ", len(s)
                return
                end
demo% f95 -o has0 hasc.f
demo% has0
 string length =   4    <-- should be 7
demo% f95 -o has1 -xhasc=no hasc.f
demo% has1
 string length =   7  <-- now correct length for s
```

Passing **4habcd** to **z** is handled correctly by compiling with **-xhasc=no**.

This flag is provided to aid porting legacy Fortran 77 programs.

3.4.125 –xhelp={readme|flags}

Show summary help information.

-xhelp=readme Show the online **README** file for this release of the compiler.

-xhelp=flags List the compiler option flags. Equivalent to **-help**.

3.4.126 –xhwcprof[={enable | disable}]

(SPARC) Enable compiler support for dataspace profiling.

With **-xhwcprof** enabled, the compiler generates information that helps tools associate profiled load and store instructions with the data-types and structure members (in conjunction with symbolic information produced with **-g**) to which they refer. It associates profile data with the data space of the target, rather than the instruction space, and provides insight into behavior that is not easily obtained from only instruction profiling.

While you can compile a specified set of object files with **-xhwcprof**, this option is most useful when applied to all object files in the application. This will provide coverage to identify and correlate all memory references distributed in the application's object files.

If you are compiling and linking in separate steps, use **-xhwcprof** at link time as well.

An instance of **-xhwcprof=enable** or **-xhwcprof=disable** overrides all previous instances of **-xhwcprof** in the same command line.

-xhwcprof is disabled by default. Specifying **-xhwcprof** without any arguments is the equivalent to **-xhwcprof=enable**.

-xhwcprof requires that optimization be turned on and that the debug data format be set to dwarf (**-xdebugformat=dwarf**), which is the default with this release of Sun Studio..

The combination of **-xhwcprof** and **-g** increases compiler temporary file storage requirements by more than the sum of the increases due to **-xhwcprof** and **-g** specified alone.

The following command compiles **example.f** and specifies support for hardware counter profiling and symbolic analysis of data types and structure members using DWARF symbols:

```
f95 -c -O -xhwcprof -g  example.f
```

For more information on hardware counter-based profiling, see the *Sun Studio Performance Analyzer* manual.

3.4.127 –xia[={widestneed|strict}]

(Solaris) Enable interval arithmetic extensions and set a suitable floating-point environment.

The default if not specified is **-xia=widestneed**.

Fortran extensions for interval arithmetic calculations are detailed in the *Interval Arithmetic Programming Reference.* See also "3.4.130 **–xinterval**[={*widestneed*|*strict*|*no*}]" on page 112.

The **-xia** flag is a macro that expands as follows:

-xia *or* **-xia=widestneed**	**-xinterval=widestneed -ftrap=%none -fns=no -fsimple=0**
-xia=strict	**-xinterval=strict -ftrap=%none -fns=no -fsimple=0**

3.4.128 –xinline=*list*

Synonym for **-inline**.

3.4.129 -xinstrument=[%no]datarace

Specify this option to compile and instrument your program for analysis by the Thread Analyzer.

(For information on the Thread Analyzer, see **tha**(1) for details.)

By compiling with this option you can then use the Performance Analyzer to run the instrumented program with **collect -r races** to create a data-race-detection experiment. You can run the instrumented code standalone but it runs more slowly.

Specify **-xinstrument=no%datarace** to turn off this feature. This is the default.

-xinstrument must be specified with an argument.

If you compile and link in seperate steps, you must specify **-xinstrument=datarace** in both the compilation and linking steps.

This option defines the preprocessor token **__THA_NOTIFY**. You can specify **#ifdef __THA_NOTIFY** to guard calls to **libtha**(3) routines.

This option also sets **-g**.

3.4.130 –xinterval[={*widestneed*|*strict*|*no*}]

(Solaris) Enable interval arithmetic extensions.

The optional value can be one of either **no**, **widestneed** or **strict**. The default if not specified is **widestneed**.

no	Interval arithmetic extensions not enabled.

widestneed	Promotes all non-interval variables and literals in any mixed-mode expression to the widest interval data type in the expression.
strict	Prohibits mixed-type or mixed-length interval expressions. All interval type and length conversions must be explicit.

Fortran extensions for interval arithmetic calculations are detailed in the *Fortran 95 Interval Arithmetic Programming Reference*. See also "3.4.127 **–xia**[={**widestneed**|**strict**}]" on page 111.

3.4.131 –xipo[={0|1|2}]

Perform interprocedural optimizations.

Performs whole-program optimizations by invoking an interprocedural analysis pass. Unlike **-xcrossfile**, **-xipo** will perform optimizations across all object files in the link step, and is not limited to just the source files on the compile command.

-xipo is particularly useful when compiling and linking large multi-file applications. Object files compiled with this flag have analysis information compiled within them that enables interprocedural analysis across source and pre-compiled program files. However, analysis and optimization is limited to the object files compiled with **-xipo**, and does not extend to object files on libraries.

-xipo=0 disables, and **-xipo=1** enables, interprocedural analysis. **-xipo=2** adds interprocedural aliasing analysis and memory allocation and layout optimizations to improve cache performance. The default is **-xipo=0**, and if **-xipo** is specified without a value, **-xipo=1** is used.

When compiling with **-xipo=2**, there should be no calls from functions or subroutines compiled without **-xipo=2** (for example, from libraries) to functions or subroutines compiled with **-xipo=2**.

As an example, if you interpose on the function **malloc()** and compile your own version of **malloc()** with **-xipo=2**, all the functions that reference **malloc()** in any library linked with your code would also have to be compiled with **-xipo=2**. Since this might not be possible for system libraries, your version of **malloc** should not be compiled with **-xipo=2**.

When compiling and linking are performed in separate steps, **-xipo** must be specified in both steps to be effective.

Example using **-xipo** in a single compile/link step:

```
demo% f95 -xipo -xO4 -o prog  part1.f part2.f part3.f
```

The optimizer performs crossfile inlining across all three source files. This is done in the final link step, so the compilation of the source files need not all take place in a single compilation and could be over a number of separate compilations, each specifying **-xipo**.

Example using **-xipo** in separate compile/link steps:

```
demo% f95 -xipo -xO4 -c part1.f part2.f
demo% f95 -xipo -xO4 -c part3.f
demo% f95 -xipo -xO4 -o prog  part1.o part2.o part3.o
```

The object files created in the compile steps have additional analysis information compiled within them to permit crossfile optimizations to take place at the link step.

A restriction is that libraries, even if compiled with **-xipo** do not participate in crossfile interprocedural analysis, as shown in this example:

```
demo% f95 -xipo -xO4 one.f two.f three.f
demo% ar -r mylib.a one.o two.o three.o
...
demo% f95 -xipo -xO4 -o myprog main.f four.f mylib.a
```

Here interprocedural optimizations will be performed between **one.f**, **two.f** and **three.f**, and between **main.f** and **four.f**, but not between **main.f** or **four.f** and the routines on **mylib.a**. (The first compilation may generate warnings about undefined symbols, but the interprocedural optimizations will be performed because it is a compile and link step.)

Other important information about **-xipo**:

- requires at least optimization level **-xO4**
- conflicts with **-xcrossfile**; if used together will result in a compilation error
- Building executables compiled with **-xipo** using a parallel make tool can cause problems if object files used in the build are common to the link steps running in parallel. Each link step should have its own copy of the object file being optimized prior to linking.
- objects compiled without **-xipo** can be linked freely with objects compiled with **-xipo**.
- The **-xipo** option generates significantly larger object files due to the additional information needed to perform optimizations across files. However, this additional information does not become part of the final executable binary file. Any increase in the size of the executable program will be due to the additional optimizations performed
- In this release, crossfile subprogram inlining is the only interprocedural optimization performed by **-xipo**.
- **.s** assembly language files do not participate in interprocedural analysis.
- The **-xipo** flag is ignored if compiling with **-S**.

When Not To Compile With `-xipo`:

Working with the set of object files in the link step, the compiler tries to perform whole-program analysis and optimizations. For any function or subroutine **`foo()`** defined in this set of object files, the compiler makes the following two assumptions:

(1) At runtime, **`foo()`** will not be called explicitly by another routine defined outside this set of object files, and

(2) calls to **`foo()`** from any routine in the set of object files will be not be interposed upon by a different version of **`foo()`** defined outside this set of object files.

If assumption (1) is not true for the given application, do not compile with **`-xipo=2`**.If assumption (2) is not true, do not compile with either **`-xipo=1`** or **`-xipo=2`**.

As an example, consider interposing on the function **`malloc()`** with your own source version and compiling with **`-xipo=2`**. Then all the functions in any library that reference **`malloc()`** that are linked with your code would have to also be compiled with **`-xipo=2`** and their object files would need to participate in the link step. Since this might not be possible for system libraries, your version of malloc should not be compiled with **`-xipo=2`**.

As another example, suppose that you build a shared library with two external calls, **`foo()`** and **`bar()`** inside two different source files, and **`bar()`** calls **`foo()`** inside its body. If there is a possibility that the function call **`foo()`** could be interposed at runtime, then compile neither source file for **`foo()`** or **`bar()`** with **`-xipo=1`** or **`-xipo=2`**. Otherwise, **`foo()`** could be inlined into **`bar()`**, which could cause incorrect results when compiled with **`-xipo`**.

3.4.132 –xipo_archive[={none|readonly|writeback}]

(**SPARC**) Allow crossfile optimization to include archive (**`.a`**) libraries.

The value must be one of the following:

`none`	No processing of archive files is performed. The compiler does not apply cross-module inlining or other cross-module optimizations to object files compiled using **`-xipo`** and extracted from an archive library at link time. To do that, both **`-xipo`** and either **`-xipo_archive=readonly`**or **`-xipo_archive=writeback`** must be specified at link time.

readonly	The compiler optimizes object files passed to the linker with object files compiled with **-xipo** that reside in the archive library (**.a**) before producing an executable. The option **-xipo_archive=readonly** enables cross-module inlining and interprocedural data flow analysis of object files in an archive library specified at link time. However, it does not enable cross-module optimization of the archive library's code except for code that has been inserted into other modules by cross module inlining. To apply cross-module optimization to code within an archive library, **-xipo_archive=writeback** is required. Note that doing so modifies the contents of the archive library from which the code was extracted.
writeback	The compiler optimizes object files passed to the linker with object files compiled with **-xipo** that reside in the archive library (**.a**) before producing an executable. Any object filed contained in the library that were optimized during the compilation are replaced with their optimized version. For parallel links that use a common set of archive libraries, each link should create its own copy of archive libraries to be optimized before linking.

If you do not specify a setting for **-xipo_archive**, the compiler assumes **-xipo_archive=none**.

3.4.133 –xjobs=*n*

Compile with multiple processors.

Specify the **-xjobs** option to set how many processes the compiler creates to complete its work. This option can reduce the build time on a multi-cpu machine. In this release of the **f95** compiler, **-xjobs** works only with the **-xipo** option. When you specify **-xjobs=***n*, the interprocedural optimizer uses *n* as the maximum number of code generator instances it can invoke to compile different files.

Generally, a safe value for *n* is 1.5 multiplied by the number of available virtual processors. Using a value that is many times the number of available virtual processors can degrade performance because of context switching overheads among spawned jobs. Also, using a very high number can exhaust the limits of system resources such as swap space.

You must always specify **-xjobs** with a value. Otherwise an error diagnostic is issued and compilation aborts.

Multiple instances of **-xjobs** on the command line override each other until the rightmost instance is reached.

The following example compiles more quickly on a system with two processors than the same command without the **-xjobs** option.

```
example% f95 -xipo -xO4 -xjobs=3 t1.f t2.f t3.f
```

3.4.134 –xknown_lib=*library_list*

Recognize calls to a known library.

When specified, the compiler treats references to certain known libraries as intrinsics, ignoring any user-supplied versions. This enables the compiler to perform optimizations over calls to library routines based on its special knowledge of that library.

The *library_list* is a comma-delimited list of keywords currently to **blas**, **blas1**, **blas2**, **blas3**, and **intrinsics**. The compiler recognizes calls to the following BLAS1, BLAS2, and BLAS3 library routines and is free to optimize appropriately for the Sun Performance Library implementation. The compiler will ignore user-supplied versions of these library routines and link to the BLAS routines in the Sun Performance Library.

-xknown_lib=	Feature
blas1	The compiler recognizes calls to the following BLAS1 library routines: **caxpy ccopy cdotc cdotu crotg cscal csrot csscal cswap dasum daxpy dcopy ddot drot drotg drotm drotmg dscal dsdot dswap dnrm2 dzasum dznrm2 icamax idamax isamax izamax sasum saxpy scasum scnrm2 scopy sdot sdsdot snrm2 srot srotg srotm srotmg sscal sswap zaxpy zcopy zdotc zdotu zdrot zdscal zrotg zscal zswap**
blas2	The compiler recognizes calls to the following BLAS2 library routines: **cgemv cgerc cgeru ctrmv ctrsv dgemv dger dsymv dsyr dsyr2 dtrmv dtrsv sgemv sger ssymv ssyr ssyr2 strmv strsv zgemv zgerc zgeru ztrmv ztrsv**
blas3	The compiler recognizes calls to the following BLAS2 library routines: **cgemm csymm csyr2k csyrk ctrmm ctrsm dgemm dsymm dsyr2k dsyrk dtrmm dtrsm sgemm ssymm ssyr2k ssyrk strmm strsm zgemm zsymm zsyr2k zsyrk ztrmm ztrsm**
blas	Selects all the BLAS routines. Equivalent to **-xknown_lib=blas1,blas2,blas3**
intrinsics	The compiler ignores any explicit **EXTERNAL** declarations for Fortran intrinsics, thereby ignoring any user-supplied intrinsic routines. (See the *Fortran Library Reference* for lists of intrinsic function names.)

3.4.135 –xlang=f77

(SPARC) Prepare for linking with runtime libraries compiled with earlier versions of **f77**.

f95 -xlang=f77 implies linking with the **f77compat** library, and is a shorthand way for linking **f95** object files with older Fortran 77 object files. Compiling with this flag insures the proper runtime environment.

Use **f95 -xlang=f77** when linking **f95** and **f77** compiled objects together into a single executable.

Note the following when compiling with **-xlang**:

- Do not compile with both **-xnolib** and **-xlang**.
- When mixing Fortran object files with C++, link using the C++ compiler and specify **-xlang=f95** on the **CC** command line.
- When mixing C++ objects with Fortran object files compiled with any of the parallelization options, the linking **CC** command line must also specify **-mt**.

3.4.136 –xlibmil

Synonym for **-libmil**.

3.4.137 –xlibmopt

Use library of optimized math routines.

Use selected math routines optimized for speed. This option usually generates faster code. It may produce slightly different results; if so, they usually differ in the last bit. The order on the command line for this library option is not significant.

3.4.138 –xlic_lib=sunperf

Link with the Sun Performance Library.

For example:

```
f95 -o pgx -fast pgx.f -xlic_lib=sunperf
```

As with **-l**, this option should appear on the command line after all source and object file names.

This option must be used to link with the Sun Performance Library. (See the *Sun Performance Library User's Guide*.)

3.4.139 –xlicinfo

(*Obsolete*) *Silently ignored by compiler*.

3.4.140 –xlinkopt[={1|2|0}]

(SPARC) Perform link-time optimizations on relocatable object files.

The post-optimizer performs a number of advanced performance optimizations on the binary object code at link-time. The optional value sets the level of optimizations performed, and must be 0, 1, or 2.

0	The post-optimizer is disabled. (This is the default.)
1	Perform optimizations based on control flow analysis, including instruction cache coloring and branch optimizations, at link time.
2	Perform additional data flow analysis, including dead-code elimination and address computation simplification, at link time.

Specifying the **-xlinkopt** flag without a value implies **-xlinkopt=1**.

These optimizations are performed at link time by analyzing the object binary code. The object files are not rewritten but the resulting executable code may differ from the original object codes.

This option is most effective when used to compile the whole program, and with profile feedback.

When compiling in separate steps, **-xlinkopt** must appear on both compile and link steps.

```
demo% f95 -c -xlinkopt a.f95 b.f95
demo% f95 -o myprog -xlinkopt=2 a.o b.o
```

Note that the level parameter is only used when the compiler is linking. In the example above, the postoptimization level used is 2 even though the object binaries were compiled with an implied level of 1.

The link-time post-optimizer cannot be used with the incremental linker, **ild**. The **-xlinkopt** flag will set the default linker to be **ld**. Enabling the incremental linker explicitly withthe **-xildon** flag will disable the **-xlinkopt** option if both are specified together.

For the **-xlinkopt** option to be useful, at least some, but not necessarily all, of the routines in the program must be compiled with this option. The optimizer can still perform some limited optimizations on object binaries not compiled with **-xlinkopt**.

The **-xlinkopt** option will optimize code coming from static libraries that appear on the compiler command line, but it will skip and not optimize code coming from shared (dynamic) libraries that appear on the command line. You can also use **-xlinkopt** when building shared libraries (compiling with **-G**).

The link-time post-optimizer is most effective when used with run-time profile feedback. Profiling reveals the most and least used parts of the code and directs the optimizer to focus its effort accordingly. This is particularly important with large applications where optimal placement of code performed at link time can reduce instruction cache misses. Typically, this would be compiled as shown below:

```
demo% f95 -o progt -xO5 -xprofile=collect:prog file.f95
demo% progt
demo% f95 -o prog -xO5 -xprofile=use:prog -xlinkopt file.95
```

For details on using profile feedback, see the **-xprofile** option

Note that compiling with this option will increase link time slightly. Object file sizes also increase, but the size of the executable remains the same. Compiling with the **-xlinkopt** and **-g** flags increases the size of the excutable by including debugging information.

3.4.141 –xloopinfo

Synonym for **-loopinfo**.

3.4.142 –xmaxopt[=*n*]

Enable optimization pragma and set maximum optimization level.

n has the value 1 through 5 and corresponds to the optimization levels of **-O1** through **-O5**. If not specified, the compiler uses 5.

This option enables the **C$PRAGMA SUN OPT=***n* directive when it appears in the source input. Without this option, the compiler treats these lines as comments. See "2.3.1.5 The **OPT** Directive" on page 33.

If this pragma appears with an optimization level greater than the maximum level on the **-xmaxopt** flag, the compiler uses the level set by **-xmaxopt**.

3.4.143 –xmemalign[=<*a*><*b*>]

(SPARC) Specify maximum assumed memory alignment and behavior of misaligned data accesses.

For memory accesses where the alignment is determinable at compile time, the compiler will generate the appropriate load/store instruction sequence for that data alignment.

For memory accesses where the alignment cannot be determined at compile time, the compiler must assume an alignment to generate the needed load/store sequence.

The **-xmemalign** flag allows the user to specify the maximum memory alignment of data to be assumed by the compiler for those indeterminate situations. It also specifies the error behavior at runtime when a misaligned memory access does take place.

The value specified consists of two parts: a numeric alignment value, <*a*>, and an alphabetic behavior flag, <*b*>.

Allowed values for alignment, <*a*>, are:

1 Assume at most 1-byte alignment.

2 Assume at most 2-byte alignment.

4 Assume at most 4-byte alignment.

8 Assume at most 8-byte alignment.

16 Assume at most 16-byte alignment.

Allowed values for error behavior on accessing misaligned data, <*b*>, are:

i Interpret access and continue execution

s Raise signal SIGBUS

f On 64–bit platforms, raise signal SIGBUS only for alignments less or equal to 4, otherwise interpret access and continue execution. On other platforms **f** is equivalent to **i**.

The defaults when compiling without **-xmemalign** specified are:

- **8i** for 32–bit platforms
- **8s** for 64–bit platforms with C and C++
- **8f** for 64–bit platforms with Fortran

The default for **-xmemalign** appearing without a value is **1i** for all platforms.

Note that **-xmemalign** itself does not force any particular data alignment to take place. Use **-dalign** or **-aligncommon** to force data alignment.

You must also specify **-xmemalign** whenever you link to an object file that was compiled with a **b** value of either **i** or **f**.

The **-dalign** option is a macro:

-dalign is a macro for: **-xmemalign=8s -aligncommon=16**

Do not use **-aligncommon=1** with **-xmemalign** as these declarations will conflict and could cause a segmentation fault on some platforms and configurations.

See "3.4.2 **–aligncommon**[=**{1|2|4|8|16}**]" on page 51 for details.

3.4.144 –xmodel=[small|kernel|medium]

(x86) Specify the data address model for shared objects on Solaris x64 platforms.

The **-xmodel** option enables the compiler to create 64- bit shared objects for the Solaris x64 platforms and should only be specified for the compilation of such objects.

This option is valid only when **-m64** is specified on 64–bit enabled x86 platforms ("x64").

small This option generates code for the small model in which the virutal address of code executed is known at link time and all symbols are known to be located in the virtual addresses in the range from 0 to $2^{31} - 2^{24} - 1$.

kernel Generates code for the kernel model in which all symbols are defined to be in the range from $2^{64} - 2^{31}$ to $2^{64} - 2^{24}$.

medium Generates code for the medium model in which no assumptions are made about the range of symbolic references to data sections. Size and address of the text section have the same limits as the small code model. Applications with large amounts of static data might require **–xmodel=medium** when compiling with **–m64**.

If you do not specify **-xmodel**, the compiler assumes **-xmodel=small**. Specifying **-xmodel** without an argument is an error.

It is not neccessary to compile all routines with this option as long as you an ensure that objects being accessed are within range.

3.4.145 –xnolib

Synonym for **-nolib**.

3.4.146 –xnolibmil

Synonym for **-nolibmil**.

3.4.147 –xnolibmopt

Do not use fast math library.

Use with **-fast** to override linking the optimized math library:

```
f95 -fast -xnolibmopt …
```

3.4.148 –x0*n*

Synonym for **-0***n*.

3.4.149 –xopenmp[={parallel|noopt|none}]

Enable explicit parallelization with Fortran OpenMP Version 3.0 directives.

The flag accepts the following optional keyword suboptions:

parallel

- Enables recognition of OpenMP pragmas, and the program is parallelized accordingly.
- The minimum optimization level for **-xopenmp=parallel** is **-x03**. The compiler changes the optimization from a lower level to **-x03** if necessary, and issues a warning.
- Defines preprocessor token **_OPENMP**
- Invokes **-stackvar** automatically.

noopt

- Enables recognition of OpenMP pragmas, and the program is parallelized accordingly.
- The compiler does not raise the optimization level if it is lower than **-x03**. If you explicitly set the optimization to a level lower than **-x03**, as in **-x02 -xopenmp=noopt** the compiler will issue an error. If you do not specify an optimization level with **-xopenmp=noopt**, the OpenMP pragmas are recognized, the program is parallelized accordingly, but no optimization is done.
- Defines preprocessor token **_OPENMP**
- Invokes **-stackvar** automatically.

none Disables recognition of OpenMP pragmas and does not change the optimization level. (This is the compiler's default.)

-xopenmp specified without a suboption keyword is equivalent to **-xopenmp=parallel**. *Note that this default might change in later releases.*

To debug OpenMP programs with dbx, compile with **-g -xopenmp=noopt** to be able to breakpoint within parallel regions and display the contents of variables.

The OpenMP directives are summarized in the *OpenMP API User's Guide*.

To run a parallelized program in a multithreaded environment, you must set the **PARALLEL** (or **OMP_NUM_THREADS**) environment variable prior to execution. This tells the runtime system the maximum number of threads the program can create. The default is 1. In general, set the **PARALLEL** or **OMP_NUM_THREADS** variable to the number of available virtual processors on the target platform.

To enable nested parallelism, you must set the **OMP_NESTED** environment variable to **TRUE**. Nested parallelism is disabled by default. See the Sun Studio *OpenMP API User's Guide* for details on nested parallelism.

OpenMP requires the definition of the preprocessor symbol **_OPENMP** to have the decimal value YYYYMM where YYYY and MM are the year and month designations of the version of the OpenMP Fortran API that the implementation supports. For the current Sun Studio release the value is 200830 for OpenMP version 3.0.

When compiling and linking in separate steps, also specify **-xopenmp** on the link step. This is especially important when compiling libraries that contain OpenMP directives.

3.4.150 –xpad

Synonym for **-pad**.

3.4.151 –xpagesize=*size*

Set the preferred page size for the stack and the heap.

On SPARC platforms, the *size* value must be one of the following:

8K 64K 512K 4M 32M 256M 2G 16G or **default**

On x86 platforms, the *size* value must be one of the following:

4K 2M 4M or **default**

For example: **-xpagesize=4M**

Not all these page sizes are supported on all platforms and depend on the architecture and Solaris environment. The page size specified must be a valid page size for the Solaris operating environment on the target platform, as returned by **getpagesizes**(3C). If it is not, the request will be silently ignored at run-time. The Solaris environment offers no guarantee that the page size request will be honored.

You can use **pmap**(1) or **meminfo**(2) to determine if your running program received the requested page size.

If you specify **-xpagesize=default**, the flag is ignored; **-xpagesize** specified without a *size* value is equivalent to **-xpagesize=default**.

This option is a macro for the combination **-xpagesize_heap=***size* **-xpagesize_stack=***size*. These two options accept the same arguments as **-xpagesize**. You can set them both with the same value by specifying **-xpagesize=***size* or you can specify them individually with different values.

Compiling with this flag has the same effect as setting the **LD_PRELOAD** environment variable to **mpss.so.1** with the equivalent options, or running the Solaris 9 command **ppgsz**(1) with the equivalent options, before starting the program. See the Solaris 9 man pages for details.

3.4.152 –xpagesize_heap=*size*

Set the preferred page size for the heap.

The *size* value is the same as described for **-xpagesize**.

See **-xpagesize** for details.

3.4.153 –xpagesize_stack=*size*

(SPARC) Set the preferred page size for the stack.

The *size* value is the same as described for **-xpagesize**.

See **-xpagesize** for details.

3.4.154 -xpec[={yes|no}]

Generate a PEC (Portable Executable Code) binary.

PEC binaries may be used with Automatic Tuning System, ATS. More information about ATS is available at http://cooltools.sunsource.net/ats/index.html.

A binary built with **-xpec** is usually 5 to 10 times larger than if it is built without. The default is **-xpec=no**.

Without an argument, **-xpec** is equivalent to **-xpec=yes**.

3.4.155 –xpg

Synonym for **-pg**.

3.4.156 –xpp={fpp|cpp}

Select source file preprocessor.

The default is **-xpp=fpp**.

The compilers use **fpp**(1) to preprocess **.F**, **.F95**, or **.F03** source files. This preprocessor is appropriate for Fortran. Previous versions used the standard C preprocessor **cpp**. To select **cpp**, specify **-xpp=cpp**.

3.4.157 –xprefetch[=*a*[,*a*]]

Enable prefetch instructions on those architectures that support prefetch.

See "2.3.1.7 The **PREFETCH** Directives" on page 34 for a description of the Fortran **PREFETCH** directives.

a must be one of the following:

auto	Enable automatic generation of prefetch instructions
no%auto	Disable automatic generation of prefetch instructions
explicit	Enable explicit prefetch macros (SPARC only)
no%explicit	Disable explicit prefetch macros (SPARC only
latx:*factor*	(**SPARC**) Adjust the compiler's assumed prefetch-to-load and prefetch-to-store latencies by the specified factor. The factor must be a positive floating-point or integer number. If you are running computationally intensive codes on large SPARC multiprocessors, you might find it advantageous to use **-xprefetch**=**latx:***factor*. This option instructs the code generator to adjust the default latency time between a prefetch and its associated load or store by the specified factor. The prefetch latency is the hardware delay between the execution of a prefetch instruction and the time the data being prefetched is available in the

cache. The compiler assumes a prefetch latency value when determining how far apart to place a prefetch instruction and the load or store instruction that uses the prefetched data.

Note – The assumed latency between a prefetch and a load may not be the same as the assumed latency between a prefetch and a store.

The compiler tunes the prefetch mechanism for optimal performance across a wide range of machines and applications. This tuning may not always be optimal. For memory-intensive applications, especially applications intended to run on large multiprocessors, you may be able to obtain better performance by increasing the prefetch latency values. To increase the values, use a factor that is greater than 1. A value between .5 and 2.0 will most likely provide the maximum performance.

For applications with datasets that reside entirely within the external cache, you may be able to obtain better performance by decreasing the prefetch latency values. To decrease the values, use a factor that is less than 1.

To use the **-xprefetch=latx:***factor* option, start with a factor value near 1.0 and run performance tests against the application. Then increase or decrease the factor, as appropriate, and run the performance tests again. Continue adjusting the factor and running the performance tests until you achieve optimum performance. When you increase or decrease the factor in small steps, you will see no performance difference for a few steps, then a sudden difference, then it will level off again.

yes **-xprefetch=yes** is the same as **-xprefetch=auto,explicit**

no **-xprefetch=no** is the same as **-xprefetch=no%auto,no%explicit**

With **-xprefetch**, **-xprefetch=auto**, and **-xprefetch=yes**, the compiler is free to insert prefetch instructions into the code it generates. This may result in a performance improvement on architectures that support prefetch.

3.4.157.1 Defaults:

If **-xprefetch** is not specified, **-xprefetch=no%auto,explicit** is assumed.

If only **-xprefetch** is specified, **-xprefetch=auto,explicit** is assumed.

The default of **no%auto** is assumed unless explicitly overridden with the use of **-xprefetch** without any arguments or with an argument of **auto** or **yes**. For example, **-xprefetch=explicit** is the same as **-xprefetch=explicit,no%auto**.

The default of **explicit** is assumed unless explicitly overridden with an argument of **no%explicit** or an argument of **no**. For example, **-xprefetch=auto** is the same as **-xprefetch=auto,explicit**.

If automatic prefetching is enabled, such as with **-xprefetch** or **-xprefetch=yes**, but a latency factor is not specified, then **-xprefetch=latx:1.0** is assumed.

3.4.157.2 Interactions:

With **-xprefetch=explicit**, the compiler will recognize the directives:

$PRAGMA SUN_PREFETCH_READ_ONCE (*name***)**
$PRAGMA SUN_PREFETCH_READ_MANY (*name***)**
$PRAGMA SUN_PREFETCH_WRITE_ONCE (*name***)**
$PRAGMA SUN_PREFETCH_WRITE_MANY (*name***)**

The **-xchip** setting effects the determination of the assumed latencies and therefore the result of a **latx:***factor* setting.

The **latx:***factor* suboption is valid only when automatic prefetching (**auto**) is enabled on SPARC processors.

3.4.157.3 Warnings:

Explicit prefetching should only be used under special circumstances that are supported by measurements.

Because the compiler tunes the prefetch mechanism for optimal performance across a wide range of machines and applications, you should only use **-xprefetch=latx:***factor* when the performance tests indicate there is a clear benefit. The assumed prefetch latencies may change from release to release. Therefore, retesting the effect of the latency factor on performance whenever switching to a different release is highly recommended.

3.4.158 –xprefetch_auto_type=indirect_array_access

Generate indirect prefetches for a data arrays accessed indirectly.

Generates indirect prefetches for the loops indicated by the option **-xprefetch_level=**{**1**|**2**|**3**} in the same fashion the prefetches for direct memory accesses are generated. The prefix **no%** can be added to negate the declaration.

The default is **-xprefetch_auto_type=no%indirect_array_access**.

Requires **-xprefetch=auto** and an optimization level **-xO3** or higher.

Options such as **-xdepend** can affect the aggressiveness of computing the indirect prefetch candidates and therefore the aggressiveness of the automatic indirect prefetch insertion due to better memory alias disambiguation information.

3.4.159 -xprefetch_level={1|2|3}

Control the automatic generation of prefetch instructions.

This option is only effective when compiling with:

- **-xprefetch=auto**,
- with optimization level 3 or greater,
- on a platform that supports prefetch .

The default for **-xprefetch=auto** without specifying **-xprefetch_level** is level 2.

Prefetch level 2 generates additional opportunities for prefetch instructions than level 1. Prefetch level 3 generates additional prefetch instructions than level 2.

Prefetch levels 2 and 3 may note be effective on older SPARC or x86 platforms.

3.4.160 –xprofile={collect[:*name*]|use[:*name*]|tcov}

Collect or optimize with runtime profiling data, or perform basic block coverage analysis.

Compiling with high optimization levels (**-xO5**) is enhanced by providing the compiler with runtime performance feedback. To produce the profile feedback the compiler needs to do its best optimizations, you must compile first with **-xprofile=collect**, run the executable against a typical data set, and then recompile at the highest optimization level and with **-xprofile=use**.

See also the **f95**(1) man page for additional information about **–xprofile** and environment variables.

collect[**:***name*] Collect and save execution frequency data for later use by the optimizer with **-xprofile=use**. The compiler generates code to measure statement execution frequency.

The *name* is the optional name of the directory in which profile data will be stored when the program is executed. If specified, *name* should be an absolute UNIX pathname. If *name* is not specified, profile data for a profiled program named *program* will be stored in a directory named *program*`.profile` in the current working directory at the time that *program* is executed.

At runtime a program compiled with **-xprofile=collect:***name* will create by default the subdirectory *name***.profile** to hold the runtime feedback information. The program writes its runtime profile data to the file named **feedback** in this subdirectory. If you run the program several times, the execution frequency data accumulates in the **feedback** file; that is, output from prior runs is not lost.

You can set the environment variables **SUN_PROFDATA** and **SUN_PROFDATA_DIR** to control the file and directory where a program compiled with **-xprofile=collect** writes its runtime profile data. With these variables set, the program compiled with **-xprofile=collect** writes its profile data to **$SUN_PROFDATA_DIR/$SUN_PROFDATA**.

These environment variables similarly control the path and names of the profile data files written by **tcov**, as described in the **tcov**(1) man page.

Profile collection is "MT-safe". That is, profiling a program that does its own multitasking by compiling with **-mt** and calling the multitasking library directly will give accurate results.

When compiling and linking in separate steps, the link step must also specify **-xprofile=collect** if it appears on the compile step.

use[**:***nm*] Use execution frequency data to optimize strategically at optimization level **-xO5**.

As with **collect:nm**, the *nm* is optional and may be used to specify the name of the program.

The program is optimized by using the execution frequency data previously generated and saved in the profile data files written by a previous execution of the program compiled with **-xprofile=collect**.

The source files and other compiler options must be exactly the same as used for the compilation that created the compiled program that generated the **feedback** file. If compiled with **-xprofile=collect:***nm*, the same program name *nm* must appear in the optimizing compilation: **-xprofile=use:***nm*.

See also **-xprofile_ircache** for speeding up compilationg between the collect and use phases.

See also **-xprofile_pathmap** for controlling where the compiler looks for profile data files.

tcov Basic block coverage analysis using "new" style **tcov**. Optimization level must be **-O2** or greater.

Code instrumentation is similar to that of **-a**, but **.d** files are no longer generated for each source file. Instead, a single file is generated, whose name is based on the name of the final executable. For example, if **stuff** is the executable file, then **stuff.profile/tcovd** is the data file.

When running **tcov**, you must pass it the **-x** option to make it use the new style of data. If not, **tcov** uses the old **.d** files, if any, by default for data, and produces unexpected output.

Unlike **-a**, the **TCOVDIR** environment variable has no effect at compile–time. However, its value is used at program runtime to identify where to create the profile subdirectory.

See the **tcov**(1) man page, the "Performance Profiling" chapter of the *Fortran Programming Guide*, and the *Program Performance Analysis Tools* manual for more details.

Note – The report produced by **tcov** can be unreliable if there is inlining of subprograms due to **-O4** or **-inline**. Coverage of calls to routines that have been inlined is not recorded.

3.4.161 –xprofile_ircache[=*path*]

(SPARC) Save and reuse compilation data between collect and use profile phases.

Use with **-xprofile=collect|use** to improve compilation time during the use phase by reusing compilation data saved from the collect phase.

If specified, *path* will override the location where the cached files are saved. By default, these files will be saved in the same directory as the object file. Specifying a path is useful when the collect and use phases happen in two different places.

A typical sequence of commands might be:

```
demo% f95 -xO5 -xprofile=collect -xprofile_ircache t1.c t2.c
demo% a.out      collects feedback data
demo% f95 -xO5 -xprofile=use -xprofile_ircache t1.c t2.c
```

With large programs, compilation time in the use phase can improve significantly by saving the intermediate data in this manner. But this will be at the expense of disk space, which could increase considerably.

3.4.162 –xprofile_pathmap=*collect_prefix*:*use_prefix*

(SPARC) Set path mapping for profile data files.

Use the **-xprofile_pathmap** option with the **-xprofile=use** option.

Use **-xprofile_pathmap** when the compiler is unable to find profile data for an object file that is compiled with **-xprofile=use**, and:

- You are compiling with **-xprofile=use** into a directory that is not the directory used when previously compiling with **-xprofile=collect**.
- Your object files share a common basename in the profile but are distinguished from each other by their location in different directories.

The *collect-prefix* is the prefix of the UNIX pathname of a directory tree in which object files were compiled using **-xprofile=collect**.

The *use-prefix* is the prefix of the UNIX pathname of a directory tree in which object files are to be compiled using **-xprofile=use**.

If you specify multiple instances of **-xprofile_pathmap**, the compiler processes them in the order of their occurrence. Each *use-prefix* specified by an instance of **-xprofile_pathmap** is compared with the object file pathname until either a matching *use-prefix* is identified or the last specified *use-prefix* is found not to match the object file pathname.

3.4.163 –xrecursive

Allow routines without **RECURSIVE** attribute call themselves recursively.

Normally, only subprograms defined with the **RECURSIVE** attribute can call themselves recursively.

Compiling with **-xrecursive** enables subprograms to call themselves, even if they are not defined with the **RECURSIVE** attribute. But, unlike subroutines defined **RECURSIVE**, use of this flag does not cause local variables to be allocated on the stack by default. For local variables to have separate values in each recursive invocation of the subprogram, compile also with **-stackvar** to put local variables on the stack.

Indirect recursion (routine A calls routine B which then calls routine A) can give inconsistent results at optimization levels greater than **-xO2**. Compiling with the **-xrecursive** flag guarantees correctness with indirect recursion, even at higher optimization levels.

Compiling with **-xrecursive** can cause performance degradations.

3.4.164 –xreduction

Synonym for **-reduction**.

3.4.165 –xregs=*r*

Specify register usage.

r is a comma–separated list that consists of one or more of the following:

[**no%**]**appl**, [**no%**]**float**.

Where the **%** is shown, it is a required character.

Example: **-xregs=appl,no%float**

Prefix the suboption with **no%** to disable the feature.

appl (SPARC) Allow the compiler to generate code using the application registers as scratch registers. These are the **g2, g3**, and **g4** registers on 32–bit processors, and **g2, g3** on 64–bit processors.

float (SPARC only) Allow the compiler to use the floating–point registers as scratch registers for integer values. This option has no effect on the compiler's use of floating-point registers for floating-point values.

no%float Do not use the floating–point registers. With this option, a source program cannot contain any floating–point code.

frameptr (x86 only) Allow the compiler to use the frame-pointer register (**%ebp** on 32–bit x86, **%rbp** on 64–bit x86 processors) as an unallocated callee-saves register to improve program performance. **-xregs=frameptr** is ignored when also compiling with **-xpg** or **-p**.

The default is **-xregs=appl,float** on SPARC platforms,**-xregs=appl,float,no%frameptr** on x86.

It is strongly recommended that you compile code intended for shared libraries that will link with applications with **-xregs=no%appl,float**. At the very least, the shared library should explicitly document how it uses the application registers so that applications linking with those libraries know how to cope with the issue.

For example, an application using the registers in some global sense (such as using a register to point to some critical data structure) would need to know exactly how a library with code compiled without **-xregs=no%appl** is using the application registers in order to safely link with that library.

3.4.166 –xs

Allow debugging by **dbx** without object (**.o**) files.

With **-xs**, all debug information is copied into the executable file. If you move executables to another directory, then you can use **dbx** and ignore the object (**.o**) files. Use this option when you cannot retain the **.o** files.

Without **-xs**, if you move the executables, you must move both the source files and the object (**.o**) files, or set the path with either the dbx **pathmap** or **use** command.

3.4.167 –xsafe=mem

(SPARC) Allow the compiler to assume that no memory protection violations occur.

Using this option allows the compiler to assume no memory–based traps occur. It grants permission to use the speculative load instruction on the SPARC V9 platforms.

This option is effective only when used with optimization level **-O5**.

Caution – Because non-faulting loads do not cause a trap when a fault such as address misalignment or segmentation violation occurs, you should use this option only for programs in which such faults cannot occur. Because few programs incur memory-based traps, you can safely use this option for most programs. Do not use this option with programs that explicitly depend on memory-based traps to handle exceptional conditions.

3.4.168 –xsb

(Obsolete) Synonym for **-sb**.

3.4.169 –xsbfast

(Obsolete) Synonym for **-sbfast**.

3.4.170 –xspace

Do no optimizations that increase the code size.

Example: Do not unroll or parallelize loops if it increases code size.

3.4.171 –xtarget=*t*

Specify the target platform for the instruction set and optimization.

t must be one of: **native**, **native64**, **generic**, **generic64**, *platform–name*.

The **-xtarget** option permits a quick and easy specification of the **-xarch**, **-xchip**, and **-xcache** combinations that occur on real platforms. The only meaning of **-xtarget** is in its expansion.

The performance of some programs may benefit by providing the compiler with an accurate description of the target computer hardware. When program performance is critical, the proper specification of the target hardware could be very important. This is especially true when running on the newer SPARC processors. However, for most programs and older SPARC processors, the performance gain is negligible and a **generic** specification is sufficient.

The actual expansion of **-xtarget** values can change from release to release. You can always determine the expansion that the compiler will use with the **-dryrun** flag:

```
demo% f95 -dryrun -xtarget=ultra4plus
###     command line files and options (expanded):
### -dryrun -xarch=sparcvis
    -xcache=64/32/4/1:2048/64/4/2:32768/64/4/2 -xchip=ultra4plus
```

Note that the **–xtarget** expansion for a particular named platform might not be the same as **–xtarget=native** on that same platform.

3.4.171.1 Generic and Native Platforms

native	Optimize performance for the host platform (32–bits). Expands to **–m32 –xarch=native –xchip=native –xcache=native**
native64	Obsolete. Use **–xtarget=native –m64** instead.
generic	Get the best performance for most 32–bit platforms. This is the default and expands to: **-m32 -xarch=generic -xchip=generic -xcache=generic**
generic64	Obsolete. Use **-xtarget=generic -m64** instead.
platform–name	Get the best performance for the specified platform listed below.

3.4.171.2 SPARC Platforms

The following table gives a list of the commonly used system platform names accepted by the compiler.

TABLE 3–16 Expansions of Commonly Used **-xtarget** System Platforms

-xtarget= *platform-name*	-xarch	-xchip	-xcache
sparc64vi	sparcfmaf	sparc64vi	128/64/2:5120/64/10
sparc64vii	sparcima	sparc64vii	64/64/2:5120/256/10
ultra	sparcvis	ultra	16/32/1:512/64/1
ultra1/140	sparcvis	ultra	16/32/1:512/64/1
ultra1/170	sparcvis	ultra	16/32/1:512/64/1
ultra1/200	sparcvis	ultra	16/32/1:512/64/1
ultra2	sparcvis	ultra2	16/32/1:512/64/1
ultra2/1170	sparcvis	ultra	16/32/1:512/64/1
ultra2/1200	sparcvis	ultra	16/32/1:1024/64/1
ultra2/1300	sparcvis	ultra2	16/32/1:2048/64/1
ultra2/2170	sparcvis	ultra	16/32/1:512/64/1
ultra2/2200	sparcvis	ultra	16/32/1:1024/64/1
ultra2/2300	sparcvis	ultra2	16/32/1:2048/64/1
ultra2e	sparcvis	ultra2e	16/32/1:256/64/4
ultra2i	sparcvis	ultra2i	16/32/1:512/64/1
ultra3	sparcvis	ultra3	64/32/4:8192/512/1
ultra3cu	sparcvis	ultra3cu	64/32/4:8192/512/2
ultra3i	sparcvis	ultra3i	64/32/4:1024/64/4
ultra4	sparcvis	ultra4	64/32/4:8192/128/2
ultra4plus	sparcvis	ultra4plus	64/32/4/1:2048/64/4/2:32768/64/4/2
ultraT1	sparc	ultraT1	8/16/4/4:3072/64/12/32
ultraT2	sparcvis2	ultraT2	8/16/4:4096/64/16
ultraT2plus	sparcvis2	ultraT2plus	8/16/4:4096/64/16

Compiling for a 64-bit Solaris OS on 64–bit enabled platforms is indicated by the **-m64** flag. If **-xtarget** is specified, **-m64** must appear after the **-xtarget** flag, as in:

```
-xtarget=ultra2   ...   -m64
```

otherwise the default 32–bit memory model will be used.

3.4.171.3 x86 Platforms

The valid **-xtarget** platform names for x86 systems are:

generic, native, pentium, pentium_pro, pentium3, pentium4, **woodcrest, penryn, nehalem, barcelona**, and **opteron.**

TABLE 3–17 -xtarget Values on x86 Platforms

-xtarget=	-xarch	-xchip	-xcache
generic	generic	generic	generic
opteron	sse2	opteron	64/64/2:1024/64/16
pentium	386	pentium	generic
pentium_pro	pentium_pro	pentium_pro	generic
pentium3	sse	pentium3	16/32/4:256/32/4
pentium4	sse2	pentium4	8/64/4:256/128/8
nehalem	sse4_2	nehalem	32/64/8:256/64/8: 8192/64/16
penryn	sse4_1	penryn	2/64/8:4096/64/16
woodcrest	ssse3	core2	32/64/8:4096/64/16
barcelona	amdsse4a	amdfam10	64/64/2:512/64/16

Compiling for 64-bit Solaris OS on 64-bit enabled x86 platform is indicated by the **-m64** flag. For example, compiling with **-xtarget=opteron** is not necessary or sufficient. If **-xtarget** is specified, the **-m64** option must appear after the **-xtarget** flag, as in:

```
-xtarget=opteron -m64
```

otherwise the compilation will be 32-bit x86.

3.4.172 –xtime

Synonym for **-time**.

3.4.173 –xtypemap=*spec*

Specify default data mappings.

This option provides a flexible way to specify the byte sizes for default data types. This option applies to both default-size variables and constants.

The specification string *spec* may contain any or all of the following in a comma-delimited list:

real:*size***double:***size***integer:***size*

The allowable combinations on each platform are:

- **real:32**
- **real:64**
- **double:64**
- **double:128**
- **integer:16**
- **integer:32**
- **integer:64**

For example:

- **–xtypemap=real:64,double:64,integer:64**

maps both default **REAL** and **DOUBLE** to 8 bytes.

This option applies to all variables declared with default specifications (without explicit byte sizes), as in **REAL XYZ** (resulting in a 64-bit **XYZ**). Also, all single-precision **REAL** constants are promoted to **REAL*8**.

Note that **INTEGER** and **LOGICAL** are treated the same, and **COMPLEX** is mapped as two **REAL**s. Also, **DOUBLE COMPLEX** will be treated the way **DOUBLE** is mapped.

3.4.174 –xunroll=*n*

Synonym for **-unroll=***n*.

3.4.175 –xvector[=[[no%]lib,[no%]simd,%none]]

Enable automatic generation of calls to the vector library functions.

This option requires compiling with default rounding mode **-fround=nearest** when compiling with **-xvector**.

-xvector=lib (Solaris platforms only) enables the compiler to transform math library calls within loops into single calls to the equivalent vector math routines when such transformations are possible. This could result in a performance improvement for loops with large loop counts. **-xvector=no%lib** disables this feature.

-xvector=simd enables the compiler to use the native x86 SSE SIMD instructions to improve performance of certain loops. The compiler can only accept this switch if the target architecture supports SIMD instructions. For example, you must specify **-xarch=sse2 -m64** or **-xarch=generic64**. You must also specify an optimization level of **-xO3** or above as well as **-xdepend** with **-xvector=simd**. **-xvector=no%simd** disables this feature.

You will get better performance if you specify both **-xvector=simd** and **-fsimple=2** than with **-xvector=simd** alone. However, your floating point results can be slightly different because **-fsimple=2** allows reordering of floating-point operations.

The default is **-xvector=%none**. If you specify **-xvector**, but do not provide a sub-option, the compiler assumes **-xvector=lib**.

The compiler includes the libmvec libraries in the load step. If you specify **-xvector=lib** at compile time, you must also specify it at link time.

This option overrides previous instances so **-xvector=%none** overrides a previously specified **-xvector=lib**.

3.4.176 –ztext

Generate only pure libraries with no relocations.

The general purpose of **-ztext** is to verify that a generated library is pure text; instructions are all position–independent code. Therefore, it is generally used with both **-G** and **-pic**.

With **-ztext**, if **ld** finds an incomplete relocation in the *text* segment, then it does not build the library. If it finds one in the *data* segment, then it generally builds the library anyway; the data segment is writable.

Without **-ztext**, **ld** builds the library, relocations or not.

A typical use is to make a library from both source files and object files, where you do not know if the object files were made with **-pic**.

Example: Make library from both source and object files:

```
demo% f95 -G -pic -ztext -o MyLib -hMyLib a.f b.f x.o y.o
```

An alternate use is to ask if the code is position–independent already: compile without **-pic**, but ask if it is pure text.

Example: Ask if it is pure text already—even without **-pic**:

```
demo% f95 -G -ztext -o MyLib -hMyLib a.f b.f x.o y.o
```

The options **-ztext** and **-xprofile=collect** should not be used together. While **-ztext** prohibits position-dependent symbol relocations in read-only storage, **-xprofile=collect** generates statically initialized, position-dependent symbol relocations in writable storage.

If you compile with **-ztext** and **ld** does not build the library, then you can recompile without **-ztext**, and **ld** will build the library. The failure to build with **-ztext** means that one or more components of the library cannot be shared; however, maybe some of the other components can be shared. This raises questions of performance that are best left to you, the programmer.

◆ ◆ ◆ CHAPTER 4

Sun Studio Fortran Features and Differences

This appendix shows some of the major features differences between standard Fortran and the Sun Fortran compiler, **f95**.

4.1 Source Language Features

The **f95** compiler provides the following source language features and extensions to the Fortran standard.

4.1.1 Continuation Line Limits

f95 allows 999 continuation lines (1 initial and 999 continuation lines). Standard Fortran 95 allows 19 for fixed-form and 39 for free-form.

4.1.2 Fixed-Form Source Lines

In fixed-form source, lines can be longer than 72 characters, but everything beyond column 73 is ignored. Standard Fortran 95 only allows 72-character lines.

4.1.3 Tab Form

The **f95** fixed-format source text is defined as follows:

- A tab in any of columns 1 through 6 makes the line as a tab form source line.
- A comment indicator or a statement number may precede the tab.
- If a tab is the first nonblank character, then:
  - If the character after the tab is anything other than a nonzero digit, then the text following the tab is an initial line.

- If there is a nonzero digit after the first tab, the line is a continuation line. The text following the nonzero digit is the next part of the statement.

The **f95** default maximum line length is 72 columns for fixed form and 132 for free form. Use the **-e** compiler option to extend the lines in fixed-format source to 132 columns.

Example: The tab form source on the left is treated as shown on the right.

```
!^IUses of tabs                              !       Uses of tabs
^ICHARACTER *3 A = 'A'                               CHARACTER *3 A = 'A'
^IINTEGER B = 2                                      INTEGER B = 2
^IREAL C = 3.0                                       REAL C = 3.0
^IWRITE(*,9) A, B, C                                 WRITE(*,9) A, B, C
9^IFORMAT(1X, A3,                            9       FORMAT(1X, A3,
^I1 I3,                                             1 I3,
^I2 F9.1 )                                          2 F9.1 )
^IEND                                                END
```

In the example above, "**^I**" stands for the tab character, and the line starting with "1" and "2" are continuation lines. The coding is shown to illustrate various tab situations, and not to advocate any one style.

Tabs in **f95** force the rest of the line to be padded out to column 72. This may cause unexpected results if the tab appears within a character string that is continued onto the next line:

Source file:

```
^Iprint *, "Tab on next line
^I1this  continuation line starts with a tab."
^Iend
```

Running the code:

```
Tab on next line                                          this  continuation
 line starts with a tab.
```

Tab formatting is also permitted with the **–f77** option.

4.1.4 Source Form Assumed

The source form assumed by **f95** depends on options, directives, and suffixes.

Files with a **.f** or **.F** suffix are assumed to be in fixed format. Files with a **.f90**, **.f95**, **.F90**, or **.F95** suffix are assumed to be in free format.

TABLE 4–1 F95 Source Form Command-line Options

Option	Action
-fixed	Interpret all source files as Fortran *fixed* form
-free	Interpret all source files as Fortran *free* form

If the **-free** or **-fixed** option is used, it overrides the file name suffix. If either a **!DIR$ FREE** or **!DIR$ FIXED** directive is used, it overrides the option and file name suffix.

4.1.4.1 Mixing Forms

Some mixing of source forms is allowed.

- In the same **f95** command, some source files can be fixed form, some free.
- In the same file, free form *can* be mixed with fixed form by using **!DIR$ FREE** and **!DIR$ FIXED** directives.
- In the same program unit, tab form *can* be mixed with free or fixed form.

4.1.4.2 Case

Sun Fortran 95 is case insensitive by default. That means that a variable **AbcDeF** is treated as if it were spelled **abcdef**. Compile with the **-U** option to have the compiler treat upper and lower case as unique.

4.1.5 Limits and Defaults

- A single Fortran program unit can define up to 65,535 derived types and 16,777,215 distinct constants.
- Names of variables and other objects can be up to 127 characters long. 31 is standard.

4.2 Data Types

This section describes features and extensions to the Fortran data types.

4.2.1 Boolean Type

f95 supports constants and expressions of Boolean type. However, there are no Boolean variables or arrays, and there is no Boolean type statement.

4.2.1.1 Rules Governing Boolean Type

- For masking operations, a bitwise logical expression has a Boolean result; each of its bits is the result of one or more logical operations on the corresponding bits of the operands.
- For binary arithmetic operators, and for relational operators:
  - If one operand is Boolean, the operation is performed with no conversion.
  - If both operands are Boolean, the operation is performed as if they were integers.
- No user-specified function can generate a Boolean result, although some (nonstandard) intrinsics can.
- Boolean and logical types differ as follows:
  - Variables, arrays, and functions can be of logical type, but they cannot be Boolean type.
  - There is a **`LOGICAL`** statement, but no **`BOOLEAN`** statement.
  - A logical variable, constant, or expression represents only two values, **`.TRUE.`** or **`.FALSE.`** A Boolean variable, constant, or expression can represent any binary value.
  - Logical entities are invalid in arithmetic, relational, or bitwise logical expressions. Boolean entities are valid in all three.

4.2.1.2 Alternate Forms of Boolean Constants

`f95` allows a Boolean constant (octal, hexadecimal, or Hollerith) in the following alternate forms (no binary). Variables cannot be declared Boolean. Standard Fortran does not allow these forms.

Octal

*dddddd***`B`**, where *d* is any octal digit

- You can use the letter **`B`** or **`b`**.
- There can be 1 to 11 octal digits (0 through 7).
- 11 octal digits represent a full 32-bit word, with the leftmost digit allowed to be 0, 1, 2, or 3.
- Each octal digit specifies three bit values.
- The last (right most) digit specifies the content of the right most three bit positions (bits 29, 30, and 31).
- If less than 11 digits are present, the value is right-justified—it represents the right most bits of a word: bits n through 31. The other bits are 0.
- Blanks are ignored.

Within an I/O format specification, the letter **`B`** indicates *binary* digits; elsewhere it indicates *octal* digits.

Hexadecimal

X'*ddd***'** or **X"***ddd***"**, where *d* is any hexadecimal digit

- There can be 1 to 8 hexadecimal digits (0 through 9, **A**-**F**).
- Any of the letters can be uppercase or lowercase (**X**, **x**, **A**-**F**, **a**-**f**).
- The digits must be enclosed in either apostrophes or quotes.
- Blanks are ignored.
- The hexadecimal digits may be preceded by a + or - sign.
- 8 hexadecimal digits represent a full 32-bit word and the binary equivalents correspond to the contents of each bit position in the 32-bit word.
- If less than 8 digits are present, the value is right-justified—it represents the right most bits of a word: bits n through 31. The other bits are 0.

Hollerith

Accepted forms for Hollerith data are:

*n***H**…	**'**…**'H**	**"**…**"H**
*n***L**…	**'**…**'L**	**"**…**"L**
*n***R**…	**'**…**'R**	**"**…**"R**

Above, "…" is a string of characters and *n* is the character count.

- A Hollerith constant is type Boolean.
- If any character constant is in a bitwise logical expression, the expression is evaluated as Hollerith.
- A Hollerith constant can have 1 to 4 characters.

Examples: Octal and hexadecimal constants.

Boolean Constant	Internal Octal for 32-bit Word
0B	**00000000000**
77740B	**00000077740**
X"ABE"	**00000005276**
X"-340"	**37777776300**
X'1 2 3'	**00000000443**

Boolean Constant	Internal Octal for 32-bit Word
X'FFFFFFFFFFFFFFFF'	**37777777777**

Examples: Octal and hexadecimal in assignment statements.

```
i = 1357B
j = X"28FF"
k = X'-5A'
```

Use of an octal or hexadecimal constant in an arithmetic expression can produce undefined results and do not generate syntax errors.

4.2.1.3 Alternate Contexts of Boolean Constants

f95 allows BOZ constants in the places other than **DATA** statements.

B'*bbb***'**	**O'***ooo***'**	**Z'***zzz***'**
B"*bbb***"**	**O"***ooo***"**	**Z"***zzz***"**

If these are assigned to a real variable, no type conversion occurs.

Standard Fortran allows these only in **DATA** statements.

4.2.2 Abbreviated Size Notation for Numeric Data Types

f95 allows the following nonstandard type declaration forms in declaration statements, function statements, and **IMPLICIT** statements. The form in column one is nonstandard Fortran, though in common use. The kind numbers in column two can vary by vendor.

TABLE 4–2 Size Notation for Numeric Data Types

Nonstandard	Declarator	Short Form	Meaning
INTEGER*1	**INTEGER(KIND=1)**	**INTEGER(1)**	One-byte signed integers
INTEGER*2	**INTEGER(KIND=2)**	**INTEGER(2)**	Two-byte signed integers
INTEGER*4	**INTEGER(KIND=4)**	**INTEGER(4)**	Four-byte signed integers
LOGICAL*1	**LOGICAL(KIND=1)**	**LOGICAL(1)**	One-byte logicals
LOGICAL*2	**LOGICAL(KIND=2)**	**LOGICAL(2)**	Two-byte logicals

TABLE 4–2 Size Notation for Numeric Data Types *(Continued)*

Nonstandard	Declarator	Short Form	Meaning
`LOGICAL*4`	`LOGICAL(KIND=4)`	`LOGICAL(4)`	Four-byte logicals
`REAL*4`	`REAL(KIND=4)`	`REAL(4)`	IEEE single-precision four-byte floating-point
`REAL*8`	`REAL(KIND=8)`	`REAL(8)`	IEEE double-precision eight-byte floating-point
`REAL*16`	`REAL(KIND=16)`	`REAL(16)`	IEEE quad-precision sixteen-byte floating-point
`COMPLEX*8`	`COMPLEX(KIND=4)`	`COMPLEX(4)`	Single-precision complex (four bytes each part)
`COMPLEX*16`	`COMPLEX(KIND=8)`	`COMPLEX(8)`	Double-precision complex (eight bytes each part)
`COMPLEX*32`	`COMPLEX(KIND=16)`	`COMPLEX(16)`	Quad-precision complex (sixteen bytes each part)

4.2.3 Size and Alignment of Data Types

Storage and alignment are always given in bytes. Values that can fit into a single byte are byte-aligned.

The size and alignment of types depends on various compiler options and platforms, and how variables are declared. The default maximum alignment in COMMON blocks is to 4-byte boundaries.

Default data alignment and storage allocation can be changed by compiling with special options, such as **`-aligncommon`**, **`-f`**, **`-dalign`**, **`-dbl_align_all`**,**`- xmemalign`**,, and**`- xtypemap`**. The default descriptions in this manual assume that these options are not in force.

There is additional information in the *Fortran Programming Guide* regarding special cases of data types and alignment on certain platforms.

The following table summarizes the default size and alignment, ignoring other aspects of types and options.

TABLE 4–3 Default Data Sizes and Alignments (in Bytes)

Fortran Data Type	Size	DefaultAlignment	Alignment inCOMMON
BYTE X	1	1	1
CHARACTER X	1	1	1
CHARACTER* *n* **X**	n	1	1
COMPLEX X	8	4	4
COMPLEX*8 X	8	4	4
DOUBLE COMPLEX X	16	8	4
COMPLEX*16 X	16	8	4
COMPLEX*32 X	32	8/16	4
DOUBLE PRECISION X	8	8	4
REAL X	4	4	4
REAL*4 X	4	4	4
REAL*8 X	8	8	4
REAL*16 X	16	8/16	4
INTEGER X	4	4	4
INTEGER*2 X	2	2	2
INTEGER*4 X	4	4	4
INTEGER*8 X	8	8	4
LOGICAL X	4	4	4
LOGICAL*1 X	1	1	1
LOGICAL*2 X	2	2	2
LOGICAL*4 X	4	4	4
LOGICAL*8 X	8	8	4

Note the following:

- **REAL*16** and **COMPLEX*32**: in 64-bit environments (compiling with **-m64**) the default alignment is on 16-byte (rather than 8-byte) boundaries, as indicated by 8/16 in the table. This data type is often referred to as *quad precision*.
- Arrays and structures align according to their elements or fields. An array aligns the same as the array element. A structure aligns the same as the field with the widest alignment.

Options **-f** or **-dalign** force alignment of all 8, 16, or 32-byte data onto 8-byte boundaries. Option **-dbl_align_all** causes all data to be aligned on 8-byte boundaries. Programs that depend on the use of these options may not be portable.

4.3 Cray Pointers

A *Cray pointer* is a variable whose value is the address of another entity, called the *pointee*.

f95 supports Cray pointers; Standard Fortran 95 does not.

4.3.1 Syntax

The Cray **POINTER** statement has the following format:

```
POINTER  ( pointer_name, pointee_name [array_spec] ), ...
```

Where *pointer_name*, *pointee_name*, and *array_spec* are as follows:

pointer_name	Pointer to the corresponding *pointee_name*.
	pointer_name contains the address of *pointee_name*.Must be a scalar variable name (but not a derived type).Cannot be: a constant, a name of a structure, an array, or a function.
pointee_name	Pointee of the corresponding *pointer_name*
	Must be: a variable name, array declarator, or array name
array_spec	If *array_spec* is present, it must be explicit shape, (constant or non-constant bounds), or assumed-size.

For example, we can declare Cray pointers to two pointees:

```
    POINTER ( p, b ),  ( q, c )
```

The above example declares Cray pointer **p** and its pointee **b**, and Cray pointer **q** and its pointee **c**.

We can also declare a Cray pointer to an array:

```
     POINTER ( ix, x(n, 0:m) )
```

The above example declares Cray pointer **ix** and its pointee **x**; and declares **x** to be an array of dimensions **n** by **m+1**.

4.3.2 Purpose of Cray Pointers

You can use pointers to access user-managed storage by dynamically associating variables to particular locations in a block of storage.

Cray pointers allow accessing absolute memory locations.

4.3.3 Declaring Cray Pointers and Fortran 95 Pointers

Cray pointers are declared as follows:

POINTER (*pointer_name*, *pointee_name* [*array_spec*] **)**

Fortran 95 pointers are declared as follows:

POINTER *object_name*

The two kinds of pointers cannot be mixed.

4.3.4 Features of Cray Pointers

- Whenever the pointee is referenced, **f95** uses the current value of the pointer as the address of the pointee.
- The Cray pointer type statement declares both the pointer and the pointee.
- The Cray pointer is of type Cray pointer.
- The value of a Cray pointer occupies one storage unit on 32-bit processors, and two storage units on 64-bit processors.
- The Cray pointer can appear in a **COMMON** list or as a dummy argument.
- The Cray pointee has no address until the value of the Cray pointer is defined.
- If an array is named as a pointee, it is called a *pointee array*.

  Its array declarator can appear in:

  - A separate type statement
  - A separate **DIMENSION** statement
  - The pointer statement itself

  If the array declarator is in a subprogram, the dimensioning can refer to:

  - Variables in a common block, or
  - Variables that are dummy arguments

The size of each dimension is evaluated on entrance to the subprogram, not when the pointee is referenced.

4.3.5 Restrictions on Cray Pointers

- *pointee_name* must not be a variable typed **CHARACTER*(*)**.
- If *pointee_name* is an array declarator, it must be explicit shape, (constant or non-constant bounds), or assumed-size.
- An array of Cray pointers is not allowed.
- A Cray pointer cannot be:
  - Pointed to by another Cray pointer or by a Fortran pointer.
  - A component of a structure.
  - Declared to be any other data type.

  A Cray pointer cannot appear in:
  - A **PARAMETER** statement or in a type declaration statement that includes the **PARAMETER** attribute.
  - A **DATA** statement.

4.3.6 Restrictions on Cray Pointees

- A Cray pointee cannot appear in a **SAVE**, **DATA**, **EQUIVALENCE**, **COMMON**, or **PARAMETER** statement.
- A Cray pointee cannot be a dummy argument.
- A Cray pointee cannot be a function value.
- A Cray pointee cannot be a structure or a structure component.
- A Cray pointee cannot be of a derived type.

4.3.7 Usage of Cray Pointers

Cray pointers can be assigned values as follows:

- Set to an absolute address

  Example: **q = 0**
- Assigned to or from integer variables, plus or minus expressions

  Example: **p = q + 100**

- Cray pointers are not integers. You cannot assign them to a real variable.
- The **LOC** function (nonstandard) can be used to define a Cray pointer.

  Example: **p = LOC(x)**

Example: Use Cray pointers as described above.

```
SUBROUTINE  sub ( n )
COMMON pool(100000)
INTEGER blk(128), word64
REAL a(1000), b(n), c(100000-n-1000)
POINTER ( pblk, blk ), (ia, a ), ( ib, b ), &
        ( ic, c ), ( address, word64 )
DATA address / 64 /
pblk = 0
ia = LOC( pool )
ib = ia + 4000
ic = ib + n
...
```

Remarks about the above example:

- **word64** refers to the contents of absolute address 64
- **blk** is an array that occupies the first 128 words of memory
- **a** is an array of length 1000 located in blank common
- **b** follows **a** and is of length **n**
- **c** follows **b**
- **a**, **b**, and **c** are associated with **pool**
- **word64** is the same as **blk(17)** because Cray pointers are byte address and the integer elements of **blk** are each 4 bytes long

4.4 STRUCTURE and UNION (VAX Fortran)

To aid the migration of programs from **f77**, **f95** accepts VAX Fortran **STRUCTURE** and **UNION** statements, a precursor to the "derived types" in Fortran 95. For syntax details see the *FORTRAN 77 Language Reference* manual.

The field declarations within a **STRUCTURE** can be one of the following:

- A substructure— either another **STRUCTURE** declaration, or a record that has been previously defined.
- A **UNION** declaration.
- A **TYPE** declaration, which can include initial values.

- A derived type having the **SEQUENCE** attribute. (This is particular to **f95** only.)

As with **f77**, a **POINTER** statement cannot be used as a field declaration.

f95 also allows:

- Either "**.**' or "**%**' can be used as a structure field dereference symbol:**struct.field** or **struct%field**.
- Structures can appear in a formatted I/O statement.
- Structures can be initialized in a **PARAMETER** statement; the format is the same as a derived type initialization.
- Structures can appear as components in a derived type, but the derived type must be declared with the **SEQUENCE** attribute.

4.5 Unsigned Integers

The Fortran compiler accepts a new data type, **UNSIGNED**, as an extension to the language. Four **KIND** parameter values are accepted with **UNSIGNED**: 1, 2, 4, and 8, corresponding to 1-, 2-, 4-, and 8-byte unsigned integers, respectively.

The form of an unsigned integer constant is a digit-string followed by the upper or lower case letter **U**, optionally followed by an underscore and kind parameter. The following examples show the maximum values for unsigned integer constants:

```
255u_1
65535u_2
4294967295U_4
18446744073709551615U_8
```

Expressed without a kind parameter (**12345U**), the default is the same as for default integer. This is **U_4** but can be changed by the **-xtypemap** option, which will change the kind type for default unsigned integers.

Declare an unsigned integer variable or array with the **UNSIGNED** type specifier:

```
UNSIGNED U
UNSIGNED(KIND=2) :: A
UNSIGNED*8 :: B
```

4.5.1 Arithmetic Expressions

- Binary operations, such as **+ - * /** cannot mix signed and unsigned operands. That is, **U*N** is illegal if **U** is declared **UNSIGNED**, and **N** is a signed **INTEGER**.
  - Use the **UNSIGNED** intrinsic function to combine mixed operands in a binary operation, as in **U*UNSIGNED(N)**
  - An exception is when one operand is an unsigned integer and the other is a signed integer constant expression with positive or zero value; the result is an unsigned integer.
  - The kind of the result of such a mixed expression is the largest kind of the operands.

  Exponentiation of a signed value is signed while exponentiation of an unsigned value is unsigned.
- Unary minus of an unsigned value is unsigned.
- Unsigned operands may mix freely with real, complex operands. (Unsigned operands cannot be mixed with interval operands.)

4.5.2 Relational Expressions

Signed and unsigned integer operands may be compared using intrinsic relational operations. The result is based on the unaltered value of the operands.

4.5.3 Control Constructs

- The CASE construct accepts unsigned integers as case-expressions.
- Unsigned integers are not permitted as DO loop control variables, or in arithmetic IF control expressions.

4.5.4 Input/Output Constructs

- Unsigned integers can be read and written using the I, B, O, and Z edit descriptors.
- They can also be read and written using list-directed and namelist I/O. The written form of an unsigned integer under list-directed or namelist I/O is the same as is used for positive signed integers.
- Unsigned integers can also be read or written using unformatted I/O.

4.5.5 Intrinsic Functions

- Unsigned integers are allowed in intrinsic functions, except for **SIGN** and **ABS**.
- A new intrinsic function, **UNSIGNED**, is analogous to **INT** but produces a result of unsigned type. The form is

  UNSIGNED(*v* [**,***kind*] **)**.
- Another new intrinsic function, **SELECTED_UNSIGNED_KIND(** *var***)**, returns the kind parameter for *var*.
- Intrinsic functions do not allow both signed and unsigned integer operands, except for the **MAX** and **MIN** functions, which allow both signed and unsigned integer operands only if there is at least one operand of **REAL** type.
- Unsigned arrays cannot appear as arguments to array intrinsic functions.

4.6 Fortran 2003 Features

A number of new features in the Fortran 2003 standard appear in this release of the **f95** compiler. For details, refer to the Fortran 2003 standard.

4.6.1 Interoperability with C Functions

The new standard for Fortran provides:

- a means of referencing C language procedures and, conversely, a means of specifying that a Fortran subprogram can be referenced from a C function, and
- a means of declaring global variables that are linked with external C variables

The **ISO_C_BINDING** module provides access to named constants that are kind type parameters representing data that is compatible with C types.

The standard also introduces the **BIND(C)** attribute. A Fortran derived type is interoperable with C if it has the **BIND** attribute.

This release of the Fortran compiler implements these features as described in the chapter 15 of the standard. Fortran also provides facilities for defining derived types and enumerations that correspond to C types, as described in chapter 4 of the standard.

4.6.2 IEEE Floating-Point Exception Handling

New intrinsic modules **IEEE_ARITHMETIC**, and **IEEE_FEATURES** provide support for exceptions and IEEE arithmetic in the Fortran language. Full support of these features is provided by:

```
USE, INTRINSIC :: IEEE_ARITHMETIC

USE, INTRINSIC :: IEEE_FEATURES
```

The **INTRINSIC** keyword is new in Fortran 2003.These modules define a set of derived types, constants, rounding modes, inquiry functions, elemental functions, kind functions, and elemental and non-elemental subroutines. The details are contained in Chapter 14 of the Fortran 2003 standard.

4.6.3 Command-Line Argument Intrinsics

The Fortran 2003 standard introduces three new intrinsics for processing command-line arguments and environment variables. These are:

- **GET_COMMAND(***command, length, status***)**

  Returns in *command* the entire command line that invoked the program.
- **GET_COMMAND_ARGUMENT(***number, value, length, status***)**

  Returns a command-line argument in *value*.
- **GET_ENVIRONMENT_VARIABLE(***name, value, length, status, trim_name***)**

  Return the value of an environment variable.

4.6.4 PROTECTED Attribute

The Fortran compiler now accepts the Fortran 2003 **PROTECTED** attribute. **PROTECTED** imposes limitations on the usage of module entities. Objects with the **PROTECTED** attribute are only definable within the module that declares them.

4.6.5 Fortran 2003 Asynchronous I/O

The compiler recognizes the **ASYNCHRONOUS** specifier on I/O statements:

```
ASYNCHRONOUS=['YES' | 'NO']
```

This syntax is as proposed in the Fortran 2003 standard, Chapter 9. In combination with the **WAIT** statement it allows the programmer to specify I/O processes that may be overlapped with

computation. While the compiler recognizes **ASYNCHRONOUS='YES'**, the standard does not require actual asynchronous I/O. In this release of the compiler, I/O is always synchronous.

4.6.6 Extended ALLOCATABLE Attribute

Fortran 2003 extends the data entities allowed for the **ALLOCATABLE** attribute. Previously this attribute was limited to locally stored array variables. It is now allowed with:

- array components of structures
- dummy arrays
- array function results

Allocatable entities remain forbidden in all places where they may be storage-associated: **COMMON** blocks and **EQUIVALENCE** statements. Allocatable array components may appear in **SEQUENCE** types, but objects of such types are then prohibited from **COMMON** and **EQUIVALENCE**.

4.6.7 VALUE Attribute

The **f95** compiler accepts the Fortran 2003 **VALUE** type declaration attribute.

Specifying a subprogram dummy input argument with this attribute indicates that the actual argument is passed "by value". The following example demonstrates the use of the **VALUE** attribute with a C main program calling a Fortran subprogram with a literal value as an argument:

C code:

```
#include <stdlib.h>
int main(int ac, char *av[])
{
    to_fortran(2);
}
```

Fortran code:

```
       subroutine to_fortran(i)
       integer, value :: i
       print *, i
       end
```

4.6.8 Fortran 2003 Stream I/O

The Fortran 2003 standard defines a new "stream" I/O scheme. Stream I/O access treats a data file as a continuous sequence of bytes, addressable by a positive integer starting from 1. The data file can be connected for either formatted or unformatted access.

Declare a stream I/O file with the **ACCESS='STREAM'** specifier on the **OPEN** statement. File positioning to a byte address requires a **POS=***scalar_integer_expression* specifier on a **READ** or **WRITE** statement. The **INQUIRE** statement accepts **ACCESS='STREAM'**, a specifier **STREAM=***scalar_character_variable*, and **POS=***scalar_integer_variable*.

4.6.9 Fortran 2003 Formatted I/O Features

Three new Fortran 2003 formatted I/O specifiers have been implemented in **f95**. They may appear on **OPEN**, **READ**, **WRITE**, **PRINT**, and **INQUIRE** statements:

- **DECIMAL=**[**'POINT'**|**'COMMA'**]

  Change the default decimal editing mode. The default uses a period to separate the whole number and decimal parts of a floating-point number formatted with **D**, **E**, **EN**, **ES**, **F**, and **G** editing. **'COMMA'** changes the default to use comma instead of a period, to print, for example, **123,456**. The default is **'POINT'**, which uses a period, to print, for example, **123.456**.

- **ROUND=**[**'PROCESSOR_DEFINED'** | **'COMPATIBLE'**]

  Set the default rounding mode for formatted I/O **D**, **E**, **EN**, **ES**, **F**, and **G** editing. With **'COMPATIBLE'**, the value resulting from data conversion is the one closer to the two nearest represetnations, or the value away from zero if the value is halfway between them. With **'PROCESSOR_DEFINED'**, the rounding mode is dependent on the processor's default mode, and is the compiler default if **ROUND** is not specified.

  As an example, **WRITE(*,'(f11.4)') 0.11115** prints **0.1111** in default mode, and **0.1112** in **'COMPATIBLE'** mode.

- **IOMSG=***character-variable*

  Returns an error message as a string in the specified character variable. This is the same error message that would appear on standard output. Users should allocate a character buffer large enough to hold the longest message. (**CHARACTER*256** should be sufficient.)

When used in **INQUIRE** statements, these specifiers declare a character variable for returning the current values.

New edit descriptors **DP**, **DC**, **RP**, and **RC** change the defaults within a single **FORMAT** statement to decimal point, decimal comma, processor-defined rounding, and compatible rounding respectively. For example:

```
WRITE(*,'(I5,DC,F10.3)') N, W
```

prints a comma instead of a period in the **F10.3** output item.

See also the **-iorounding** compiler command-line option for changing the floating-point rounding modes on formatted I/O. ("3.4.46 **–iorounding**[={**compatible**|**processor-defined**}]" on page 72.)

4.6.10 Fortran 2003 IMPORT Statement

The **IMPORT** statement specified entities in the host scoping unit that are accessible by host association. It is allowed only in an interface body.

4.6.11 Fortran 2003 FLUSH I/O Statement

The **f95** compiler accepts the Fortran 2003 **FLUSH** statement. The **FLUSH** statement makes data written to an external file available to other processes, or causes data placed in an external file by means other than Fortran to be available to a **READ** statement.

4.7 Additional I/O Extensions

The section describes extensions to Fortran 95 Input/Output handling that are accepted by the **f95** compiler that are not part of the Fortran 2003 standard. Some are I/O extensions that appeared in the Fortran 77 compiler, **f77**, and are now part of the Fortran compiler.

4.7.1 I/O Error Handling Routines

Two new functions enable the user to specify their own error handling routine for formatted input on a logical unit. When a formatting error is detected, the runtime I/O library calls the specified user-supplied handler routine with data pointing at the character in the input line causing the error. The handler routine can supply a new character and allow the I/O operation to continue at the point where the error was detected using the new character; or take the default Fortran error handling.

The new routines, **SET_IO_ERR_HANDLER(**3f**)** and **GET_IO_ERR_HANDLER(**3f**)**, are module subroutines and require **USE SUN_IO_HANDLERS** in the routine that calls them. See the man pages for these routines for details.

4.7.2 Variable Format Expressions

Fortran 77 allowed any integer constant in a format to be replaced by an arbitrary expression enclosed in angle brackets:

1 FORMAT(… **<** *expr* **>** … **)**

Variable format expressions cannot appear as the *n* in an *n*H… edit descriptor, in a **FORMAT** statement that is referenced by an **ASSIGN** statement, or in a **FORMAT** statement within a parallel region.

This feature is enabled natively in **f95**, and does not require the **-f77** compatibility option flag.

4.7.3 NAMELIST Input Format

- The group name may be preceded by **$** or **&** on input. The **&** is the only form accepted by the Fortran 95 standard, and is what is written by **NAMELIST** output.
- Accepts **$** as the symbol terminating input except if the last data item in the group is **CHARACTER** data, in which case the **$** is treated as input data.
- Allows **NAMELIST** input to start in the first column of a record.

4.7.4 Binary Unformatted I/O

Opening a file with **FORM='BINARY'** has roughly the same effect as **FORM='UNFORMATTED'**, except that no record lengths are embedded in the file. Without this data, there is no way to tell where one record begins, or ends. Thus, it is impossible to **BACKSPACE** a **FORM='BINARY'** file, because there is no way of telling where to backspace to. A **READ** on a **'BINARY'** file will read as much data as needed to fill the variables on the input list.

- **WRITE** statement: Data is written to the file in binary, with as many bytes transferred as specified by the output list.
- **READ** statement: Data is read into the variables on the input list, transferring as many bytes as required by the list. Because there are no record marks on the file, there will be no "end-of-record" error detection. The only errors detected are "end-of-file" or abnormal system errors.
- **INQUIRE** statement: **INQUIRE** on a file opened with **FORM="BINARY"** returns:

  FORM="BINARY"ACCESS="SEQUENTIAL"DIRECT="NO"FORMATTED="NO"UNFORMATTED="YES"RECL= AND NEXTREC= are undefined
- **BACKSPACE** statement: Not allowed—returns an error.
- **ENDFILE** statement: Truncates file at current position, as usual.

- **REWIND** statement: Repositions file to beginning of data, as usual.

4.7.5 Miscellaneous I/O Extensions

- Recursive I/O possible on different units (this is because the **f95** I/O library is "MT-Warm").
- **RECL=2147483646** (2^{31}-2) is the default record length on sequential formatted, list directed, and namelist output.
- **ENCODE** and **DECODE** are recognized and implemented as described in the *FORTRAN 77 Language Reference Manual.*
- Non-advancing I/O is enabled with **ADVANCE='NO'**, as in:

```
write(*,'(a)',ADVANCE='NO') 'n= ' read(*,*) n
```

4.8 Directives

A compiler *directive* directs the compiler to do some special action. Directives are also called *pragmas*.

A compiler directive is inserted into the source program as one or more lines of text. Each line looks like a comment, but has additional characters that identify it as more than a comment for this compiler. For most other compilers, it is treated as a comment, so there is some code portability.

A complete summary of Fortran directives appears in Table C–1.

4.8.1 Form of Special `f95` Directive Lines

f95 recognizes its own special directives in addition to those described in "1.9 Command-Line Help" on page 21. These have the following syntax:

```
!DIR$ d1, d2, ...
```

4.8.1.1 Fixed-Form Source

- Put **CDIR$** or **!DIR$** in columns 1 through 5.
- Directives are listed in columns 7 and beyond.
- Columns beyond 72 are ignored.
- An *initial* directive line has a blank in column 6.
- A *continuation* directive line has a nonblank in column 6.

4.8.1.2 Free-Form Source

- Put **!DIR$** followed by a space anywhere in the line.

  The **!DIR$** characters are the first nonblank characters in the line (actually, non-whitespace).
- Directives are listed after the space.
- An *initial* directive line has a blank, tab, or newline in the position immediately after the **!DIR$**.
- A *continuation* directive line has a character other than a blank, tab, or newline in the position immediately after the **!DIR$**.

Thus, **!DIR$** in columns 1 through 5 works for both free-form source and fixed-form source.

4.8.2 FIXED and FREE Directives

These directives specify the source form of lines following the directive line.

4.8.2.1 Scope

They apply to the rest of the *file* in which they appear, or until the next **FREE** or **FIXED** directive is encountered.

4.8.2.2 Uses

- They allow you to switch source forms within a source file.
- They allow you to switch source forms for an **INCLUDE** file. You insert the directive at the start of the **INCLUDE** file. After the **INCLUDE** file has been processed, the source form reverts back to the form being used prior to processing the **INCLUDE** file.

4.8.2.3 Restrictions

The **FREE/FIXED** directives:

- Each must appear alone on a compiler directive line (not continued).
- Each can appear anywhere in your source code. Other directives must appear within the program unit they affect.

Example: A **FREE** directive.

```
!DIR$ FREE
    DO i = 1, n
```

```
        a(i) = b(i) * c(i)
    END DO
```

4.8.3 Parallelization Directives

A *parallelization* directive is a special comment that directs the compiler to attempt to parallelize the next DO loop. These are summarized in Appendix D and described in the chapter on parallelization in the *Fortran Programming Guide*. Both Sun and Cray style parallelization directives are now deprecated as obsolete., The OpenMP Fortran API directives and parallelization model is preferred. OpenMP parallelization is described in the *OpenMP API User's Guide*.

4.9 Module Files

Compiling a file containing a Fortran 95 **MODULE** generates a module interface file (**.mod** file) for every **MODULE** encountered in the source. The file name is derived from the name of the **MODULE**; file **xyz.mod** (all lowercase) will be created for **MODULE xyz**.

Compilation also generates a **.o** module implementation object file for the source file containing the **MODULE** statements. Link with the module implementation object file along with the all other object files to create an executable.

The compiler creates module interface files and implementation object files in the directory specified by the **-moddir=***dir* flag or the **MODDIR** evironment variable. If not specified, the compiler writes **.mod** files in the current working directory.

The compiler looks in the current working directory for the interface files when compiling **USE** *modulename* statements. The**- M***path* option allows you to give the compiler an additional path to search. Module implementation object files must be listed explicitly on the command line for the link step.

Typically, programmers define one **MODULE** per file and assign the same name to the **MODULE** and the source file containing it. However, this is not a requirement.

In this example, all the files are compiled at once. The module source files appear first before their use in the main program.

```
demo% cat mod_one.f90
 MODULE one
    ...
 END MODULE
demo% cat mod_two.f90
 MODULE two
```

```
    ...
 END MODULE
demo% cat main.f90
 USE one
 USE two
   ...
 END
demo% f95 -o main mod_one.f90 mod_two.f90 main.f90
```

Compilation creates the files:

```
mainmain.oone.modmod_one.otwo.modmod_two.o
```

The next example compiles each unit separately and links them together.

```
demo% f95 -c mod_one.f90 mod_two.f90
demo% f95 -c main.f90
demo% f95 -o main main.o mod_one.o mod_two.o
```

When compiling **main.f90**, the compiler searches the current directory for **one.mod** and **two.mod**. These must be compiled before compiling any files that reference the modules on **USE** statements. The link step requires the module implementation object files **mod_one.o** and **mod_two.o** appear along with all other object files to create the executable.

4.9.1 Searching for Modules

With the release of the version 7.0 of the Fortran compiler, **.mod** files can be stored into an archive (**.a**) file. An archive must be explicitly specified in a **-M***path* flag on the command line for it to be searched for modules. The compiler does not search archive files by default.

Only **.mod** files with the same names that appear on **USE** statements will be searched. For example, the Fortran statement **USE mymod** causes the compiler to search for the module file **mymod.mod** by default.

While searching, the compiler gives higher priority to the directory where the module files are being written. This can be controlled by the **-moddir=***dir* option flag and the **MODDIR** environment variable. This implies that if only the **-M***path* option is specified, the current directory will be searched for modules first, before the directories and files listed on the **-M** flag.

4.9.2 The -use=*list* Option Flag

The **-use=***list* flag forces one or more implicit **USE** statements into each subprogram or module subprogram compiled with this flag. By using the flag, it is not necessary to modify source programs when a module or module file is required for some feature of a library or application.

Compiling with **-use=***module_name* has the effect of adding a **USE** *module_name* to each subprogram or module being compiled. Compiling with **-use=***module_file_name* has the effect of adding a **USE** *module_name* for each of the modules contained in the *module_file_name* file.

4.9.3 The `fdumpmod` Command

Use the **fdumpmod**(1) command to display information about the contents of a compiled module information file.

```
demo% fdumpmod x.mod group.mod
x 1.0 v8,i4,r4,d8,n16,a4 x.mod
group 1.0 v8,i4,r4,d8,n16,a4 group.mod
```

The **fdumpmod** command will display information about modules in a single **.mod** file, files formed by concatenating **.mod** files, and in **.a** archives of **.mod** files. The display includes the name of the module, a version number, the target architecture, and flags indicating compilation options with which the module is compatible. See the **fdumpmod**(1) man page for details.

4.10 Intrinsics

f95 supports some intrinsic procedures that are extensions beyond the standard.

TABLE 4–4 Nonstandard Intrinsics

Name	Definition	Function Type	Argument Types	Arguments	Notes
COT	Cotangent	real	real	**([X=]***x***)**	P, E
DDIM	Positive difference	double precision	double precision	**([X=]***x***,[Y=]***y***)**	P, E
LEADZ	Get the number of leading 0 bits	integer	Boolean, integer, real, or pointer	**([I=]***i***)**	NP, I
POPCNT	Get the number of set bits	integer	Boolean, integer, real, or pointer	**([I=]***i***)**	NP, I
POPPAR	Calculate bit population parity	integer	Boolean, integer, real, or pointer	**([X=]***x***)**	NP, I

Notes:P: The name can be passed as an argument. NP: The name cannot be passed as an argument. E: External code for the intrinsic is called at run time. I: **f95** generates inline code for the intrinsic procedure.

See the *Fortran Library Reference* for a more complete discussion of intrinsics, including those from Fortran 77 that are recognized by the Fortran compiler.

4.11 Forward Compatibility

Future releases of **f95** are intended to be source code compatible with this release.

Module information files generated by this release of **f95** are not guaranteed to be compatible with future releases.

4.12 Mixing Languages

Routines written in C can be combined with Fortran programs, since these languages have common calling conventions. See the C/Fortran Interface chapter in the *Fortran Programming Guide* for details on how to interoperate between C and Fortran routines.

◆ ◆ ◆ CHAPTER 5

FORTRAN 77 Compatibility: Migrating to Sun Studio Fortran

The Fortran compiler, **f95**, will compile most legacy FORTRAN 77 programs, including programs utilizing non-standard extensions previously compiled by the **f77** compiler.

f95 will accept many of these FORTRAN 77 features directly. Others require compiling in FORTRAN 77 compatibility mode (**f95 -f77**).

This chapter describes the FORTRAN 77 features accepted by **f95**, and lists those **f77** features that are incompatible with **f95**. For details on any of the non-standard FORTRAN 77 extensions that were accepted by the **f77** compiler, see the *FORTRAN 77 Language Reference* manual at `http://docs.sun.com/source/806-3594/index.html`.

See Chapter Chapter 4, "Sun Studio Fortran Features and Differences," for other extensions to the Fortran language accepted by the **f95** compiler.

f95 will compile standard-conforming FORTRAN 77 programs. To ensure continued portability, programs utilizing non-standard FORTRAN 77 features should migrate to standard-conforming Fortran 95/2003. Compiling with the **-ansi** option will flag all non-standard usages in your program.

5.1 Compatible f77 Features

f95 accepts the following non-standard features of the FORTRAN 77 compiler, **f77,** either directly or when compiling in **-f77** compatibility mode:

Source Format

- Continuation lines can start with "**&**' in column 1. [**-f77=misc**]
- The first line in an include file can be a continuation line. [**-f77=misc**]
- Use **f77** tab-format. [**-f77=tab**]
- Tab-formatting can extend source lines beyond column 72. [**-f77=tab]**

- **f95** tab-formatting will not pad character strings to column 72 if they extend over a continuation line. [**-f77]**

I/O:

- You can open a file with **ACCESS='APPEND'** in Fortran 95.
- List-directed output uses formats similar to the **f77** compiler. [**-f77=output**]
- **f95** allows **BACKSPACE** on a direct-access file, but not **ENDFILE**.
- **f95** allows implicit field-width specifications in format edit descriptors. For example, **FORMAT(I)** is allowed.
- **f95** will recognize **f77** escape sequences (for example, **\n \t \'**) in output formats. [**-f77=backslash**.]
- **f95** recognizes **FILEOPT=** in **OPEN** statements.
- **f95** allows **SCRATCH** files to be closed with **STATUS='KEEP'** [**-f77]**. When the program exits, the scratch file is not deleted. **SCRATCH** files can also be opened with **FILE=***name* when compiled with **-f77**.
- Direct I/O is permitted on internal files. [**-f77**]
- **f95** recognizes FORTRAN 77 format edit descriptors **A**, **$**, and **SU**. [**-f77**]
- **FORM='PRINT'** can appear on **OPEN** statements. [**-f77]**
- **f95** recognizes the legacy FORTRAN input/output statements **ACCEPT** and **TYPE**.
- Compile with **-f77=output** to write FORTRAN 77 style **NAMELIST** output.
- A **READ** with only **ERR=** specified (no **IOSTAT=** or **END=** branches) treats the **ERR=** branch as an **END=** when an EOF is detected. [**-f77]**
- VMS Fortran **NAME='***filename***'** is accepted on **OPEN** statements. [**-f77]**
- **f95** accepts an extra comma after **READ()** or **WRITE()**. [**-f77]**
- **END=** branch can appear on direct access **READ** with **REC=**. [**-f77=input]**
- Allow format edit descriptor **E***w***.***d***.***e* and treat it as **E***w***.***d***.E***e*. [**-f77]**
- Character strings can be used in the FORMAT of an input statement. [**-f77=input]**
- **IOSTAT=** specifier can appear in **ENCODE/DECODE** statements.
- List-directed I/O is allowed with **ENCODE/DECODE** statements.
- Asterisk (*****) can be used to stand in for **STDIN** and **STDOUT** when used as a logical unit in an I/O statement.
- Arrays can appear in the **FMT=** specifier. [**-f77=misc]**
- **PRINT** statement accepts namelist group names. [**-f77=output]**
- The compiler accepts redundant commas in **FORMAT** statements.
- While performing **NAMELIST** input, entering a question mark (**?**) responds with the name of the namelist group being read. [**-f77=input]**

Data Types, Declarations, and Usage:

- In a program unit, the **IMPLICIT** statement may follow any other declarative statement in the unit.
- **f95** accepts the **IMPLICIT UNDEFINED** statement.
- **f95** accepts the **AUTOMATIC** statement, a FORTRAN 77 extension.
- **f95** accepts the **STATIC** statement and treats it like a **SAVE** statement.
- **f95** accepts VAX **STRUCTURE**, **UNION**, and **MAP** statements.(See "4.4 **STRUCTURE** and **UNION** (VAX Fortran)" on page 152)
- **LOGICAL** and **INTEGER** variables can be used interchangeably. [**-f77=logical**]
- **INTEGER** variables can appear in conditional expressions, such as **DO WHILE**. [**-f77=logical]**
- Cray pointers can appear in calls to intrinsic functions.
- **f95** will accept data initializations using slashes on type declarations. For example: **REAL MHW/100.101/, ICOMX/32.223/**
- **f95** allows assigning Cray character pointers to non-pointer variables and to other Cray pointers that are not character pointers.
- **f95** allows the same Cray pointer to point to items of different type sizes (for example, **REAL*8** and **INTEGER*4**).
- A Cray pointer can be declared **INTEGER** in the same program unit where it is declared as a **POINTER**. The **INTEGER** declaration is ignored. [**-f77=misc]**
- A Cray pointer can be used in division and multiplication operations. [**-f77=misc]**
- Variables in an **ASSIGN** statement can be of type **INTEGER*2**. [**-f77=misc]**
- Expressions in alternate **RETURN** statements can be non-integer type. [**-f77=misc]**
- Variables with the **SAVE** attribute can be equivalenced to an element of a **COMMON** block.
- Initializers for the same array can be of different types. Example:**REAL*8 ARR(5) /12.3 1, 3, 5.D0, 9/**
- Type declarations for namelist items can follow the **NAMELIST** statement.
- **f95** accepts the **BYTE** data type.
- **f95** allows non-integers to be used as array subscripts. [**-f77=subscript]**
- **f95** allows relational operators **.EQ.** and **.NE.** to be used with logical operands. [**-f77=logical**]
- **f95** will accept the legacy **f77 VIRTUAL** statement, and treats it as a **DIMENSION** statement.
- Different data structures can be equivalenced in a manner that is compatible with the **f77** compiler. [**-f77=misc]**
- Like the **f77** compiler, **f95** allows many intrinsics to appear in initialization expressions on **PARAMETER** statements.
- **f95** allows assignment of an integer value to **CHARACTER*1** variables. [**-f77=misc]**

- BOZ constants can be used as exponents. [**-f77=misc]**
- BOZ constants can be assigned to character variables. For example: **character*8 ch ch ="12345678"X**
- BOZ constants can be used as arguments to intrinsic function calls. [**-f77=misc]**
- A character variable can be initialized with an integer value in a **DATA** statement. The first character in the variable is set to the integer value and the rest of the string, if longer than one character, is blank-filled.
- **A**n integer array of hollerith characters can be used as a format descriptor. [**-f77]**.
- Constant folding will not be done at compile time if it results in a floating-point exception. [**-f77=misc]**
- When compiling with **-f77=misc**, **f95** will automatically promote a **REAL** constant to the appropriate kind (**REAL*8** or **REAL*16**) in assignments, data, and parameter statements, in the manner of the **f77** compiler. [**-f77=misc]**
- Equivalenced variables are allowed on an assigned GOTO. [**-f77]**
- Non-constant character expressions can be assigned to numeric variables.
- Compiling with **-f77=misc** allows ***kind** after the variable name in type declarations. [**-f77=misc].** For example **REAL Y*4, X*8(21)) INTEGER FUNCTION FOO*8(J)**
- A character substring may appear as an implied-DO target in a **DATA** statement. [**-f77=misc**]For example: **DATA (a(i:i), i=1,n) /n*'+'/**
- Integer expressions within parentheses can appear as a type size. For example: **PARAMETER (N=2) INTEGER*(N+2) K**

Programs, Subroutines, Functions, and Executable Statements:

- **f95** does not require a **PROGRAM** statement to have a *name*.
- Functions can be called by a **CALL** statement as if they were subroutines. [**-f77]**
- Functions do not have to have their return value defined. [**-f77]**
- An alternate return specifier (***label** or **&***label*) can appear in the actual parameter list and in different positions. [**-f77=misc]**
- **%VAL** can be used with an argument of type **COMPLEX**. [**-f77=misc]**
- **%REF** and **%LOC** are available. [**-f77=misc]**
- A subroutine can call itself recursively without declaring itself with a **RECURSIVE** keyword. [**-f77=misc]** However, programs that perform indirect recursion (routine A calls routine B which then calls routine A) should also be compiled with the **-xrecursive** flag to work correctly.
- A subroutine with alternate returns can be called even when the dummy argument list does not have an alternate return list.

- Compiling with **-f77=misc** allows statement functions to be defined with arguments typed other than **INTEGER** or **REAL**, and actual arguments will be converted to the type defined by the statement function. [**-f77=misc]**
- Allow null actual arguments. For example: **CALL FOO(I,,J)** has two null arguments between the first **I** and the final **J** argument.
- **f95** treats a call to the function **%LOC()** as a call to **LOC()**. [**-f77=misc]**
- Allow unary plus and unary minus after another operator such as ** or *.
- Allow a second argument with the **CMPLX()** intrinsic function even when the first argument is a **COMPLEX** type. In this case, the real part of the first argument is used. [**-f77=misc]**
- Allow the argument to the **CHAR()** intrinsic function to exceed 255 with only a warning, not an error. [**-f77=misc]**
- Allow negative shift counts with only a warning, not an error.
- Search for an **INCLUDE** file in the current directory as well as those specified in the **-I** option. [**-f77=misc]**
- Allow consecutive **.NOT.** operations, such as **.NOT..NOT..NOT.(I.EQ.J)**. [**-f77=misc]**

Miscellaneous

- The **f95** compiler normally does not issue progress messages to standard out. The **f77** compiler did issue progress messages, displaying the names of the routines it was compiling. This convention is retained when compiling with the **-f77** compatibility flag.
- Programs compiled by the **f77** compiler did not trap on arithmetic exceptions, and automatically called **ieee_retrospective** on exit to report on any exceptions that may have occured during execution. Compiling with the **-f77** flag mimics this behavior of the **f77** compiler. By default, the **f95** compiler traps on the first arithmetic exception encountered and does not call **ieee_retrospective**.
- The **f77** compiler treated a **REAL*4** constant as if it had higher precision in contexts where higher precision was needed. When compiling with the **-f77** flag, the **f95** compiler allows a **REAL*4** constant to have double or quad precision when the constant is used with a double or quad precision operand, respectively.
- Allow the DO loop variable to be redefined within the loop. [**-f77=misc]**
- Display the names of program units being compiled. [**-f77=misc]**
- Allow the types of the variables used in a **DIMENSION** statement to be declared after the **DIMENSION** statement. Example:

```
SUBROUTINE FOO(ARR,G)
DIMENSION ARR(G)
INTEGER G
RETURN
END
```

For details on the syntax and semantics of non-standard language extensions, see the *FORTRAN 77 Language Reference* at `http://docs.sun.com/source/806-3594/index.html`.

5.2 Incompatibility Issues

The following lists known incompatibilities that arise when compiling and testing legacy **f77** programs with this release of **f95**. These are due to either missing comparable features in **f95**, or differences in behavior. These items are non-standard extensions to Fortran 77 supported in **f77** but not in **f95**.

Source Format

- An ANSI warning is given for names longer than 6 characters when the **-f77** option is specified.

I/O:

- **f95** does not allow **ENDFILE** on a direct-access file.
- **f95** does not recognize the *'n* form for specifying a record number in direct access I/O: **READ (2 '13) X,Y,Z**
- **f95** does not recognize the legacy **f77** "**R**" format edit descriptor.
- **f95** does not allow the **DISP=** specifier in a **CLOSE** statement.
- Bit constants are not allowed on a **WRITE** statement.
- Fortran 95 **NAMELIST** does not allow arrays and character strings with variable lengths.
- Opening a direct access file with **RECL=1** cannot be used as a "stream" file. Use **FORMAT='STREAM'** instead.
- Fortran 95 reports illegal I/O specifiers as errors. **f77** gave only warnings.

Data Types, Declarations, and Usage:

- **f95** allows only 7 array subscripts; **f77** allowed 20.
- **f95** does not allow non-constants in **PARAMETER** statements.
- Integer values cannot be used in the initializer of a **CHARACTER** type declaration.
- The **REAL()** intrinsic returns the real part of a complex argument instead of converting the argument to **REAL*4**. This gives different results when the argument is **DOUBLE COMPLEX** or **COMPLEX*32**
- Fortran 95 will not allow array elements in boundary expressions before the array is declared. For example:

```
subroutine s(i1,i2)
integer i1(i2(1):10)
dimension i2(10)
```

```
...ERROR: "I2" has been used as a function,
therefore it must not be declared with the explicit-shape DIMENSION attribute.


end
```

Programs, Subroutines, Functions, Statements:

- The maximum length for names is 127 characters.

Command-line Options:

- **f95** does not recognize the **f77** compiler options **-dbl -oldstruct -i2 -i4** and some suboptions of **-vax**.

f77 Library Routines Not Supported by f95:

- The POSIX library.
- The **IOINIT()** library routine.
- The tape I/O routines **topen, tclose, twrite, tread, trewin, tskipf, tstate**.
- **start_iostats** and **end_iostats** library routines.
- **f77_init()** function.
- **f95** does not allow the **IEEE_RETROSPECTIVE** subroutine to be bypassed by defining the user's own routine with the same name.

5.3 Linking With f77-Compiled Routines

- To mix **f77** and **f95** object binaries, link with **f95** compile with the **-xlang=f77** option. Perform the link step with **f95** even if the main program is an **f77** program
- Example: Compiling an **f95** main program with an **f77** object file.

```
demo% cat m.f95
CHARACTER*74 :: c = 'This is a test.'
   CALL echo1( c )
END
demo% f95 -xlang=f77 m.f95 sub77.o
demo% a.out
 This is a test.
demo%
```

- The FORTRAN 77 library and intrinsics are available to **f95** programs and are listed in the *Fortran Library Reference Manual*.

  Example: **f95** main calls a routine from the FORTRAN 77 library.

```
demo% cat tdtime.f95
        REAL e, dtime, t(2)
```

```
        e = dtime( t )
        DO i = 1, 100000
           as = as + cos(sqrt(float(i)))
        END DO
        e = dtime( t )
        PRINT *, 'elapsed:', e, ', user:', t(1), ', sys:', t(2)
        END
demo% f95 tdtime.f95
demo% a.out
elapsed: 0.14 , user: 0.14 , sys: 0.0E+0
demo%
```

See **dtime**(3F).

5.3.1 Fortran Intrinsics

The Fortran standard supports intrinsic functions that FORTRAN 77 did not have. The full set of Fortran intrinsics, including non-standard intrinsics, appears in the *Fortran Library Reference* manual.

If you use any of the intrinsic names listed in the *Fortran Library Reference* as a function name in your program, you must add an **EXTERNAL** statement for **f95** to use your routine rather than the intrinsic one.

The *Fortran Library Reference* also lists all the intrinsics recognized by earlier releases of the **f77** compiler. The **f95** compiler recognizes these names as intrinsics as well.

Compiling with **-f77=intrinsics** limits the compiler's recognition of intrinsic functions to just those that were known to the **f77** compiler, ignoring the Fortran intrinsics.

5.4 Additional Notes About Migrating to the f95 Compiler

- The **floatingpoint.h** header file replaces **f77_floatingpoint.h**, and should be used in source programs as follows:

  ```
  #include "floatingpoint.h"
  ```

- Header file references of the form **f77/***filename* should be changed to remove the **f77/** directory path.
- Some programs utilizing non-standard aliasing techniques (by overindexing arrays, or by overlapping Cray or Fortran pointers) may benefit by compiling with the appropriate **-xalias** flag. See "3.4.108 **–xalias**[=*keywords*]" on page 93. This is discussed with examples in the chapter on porting "dusty deck" programs in the *Fortran Programming Guide*.

◆ ◆ ◆ APPENDIX A

Runtime Error Messages

This appendix describes the error messages generated by the Fortran runtime I/O library and operating system.

A.1 Operating System Error Messages

Operating system error messages include system call failures, C library errors, and shell diagnostics. The system call error messages are found in **intro**(2). System calls made through the `Fortran` library do not produce error messages directly. The following system routine in the `Fortran` library calls C library routines which produce an error message:

```
integer system, status
status = system("cp  afile bfile")
print*, "status = ", status
end
```

The following message is displayed:

```
cp: cannot access afile
 status =  512
```

A.2 `f95` Runtime I/O Error Messages

The **f95** I/O library issues diagnostic messages when errors are detected at runtime. Here is an example, compiled and run with **f95**:

```
demo% cat wf.f
      WRITE( 6 ) 1
      END
demo% f95 -o wf wf.f
```

```
demo% wf

 ******  FORTRAN RUN-TIME SYSTEM  ******
 Error 1003:  unformatted I/O on formatted unit
 Location:  the WRITE statement at line 1 of "wf.f"
 Unit:  6
 File:  standard output
Abort
```

Because the **f95** message contains references to the originating source code filename and line number, application developers should consider using the **ERR=** clause in I/O statements to softly trap runtime I/O errors.

Table A–1 lists the runtime I/O messages issued by **f95**.

TABLE A–1 **f95** Runtime I/O Messages

Error	Message
1000	**format error**
1001	**illegal unit number**
1002	**formatted I/O on unformatted unit**
1003	**unformatted I/O on formatted unit**
1004	**direct-access I/O on sequential-access unit**
1005	**sequential-access I/O on direct-access unit**
1006	**device does not support BACKSPACE**
1007	**off beginning of record**
1008	**can't stat file**
1009	**no * after repeat count**
1010	**record too long**
1011	**truncation failed**
1012	**incomprehensible list input**
1013	**out of free space**
1014	**unit not connected**
1015	**read unexpected character**
1016	**illegal logical input field**
1017	**'new' file exists**

TABLE A–1 f95 Runtime I/O Messages *(Continued)*

Error	Message
1018	can't find 'old' file
1019	unknown system error
1020	requires seek ability
1021	illegal argument
1022	negative repeat count
1023	illegal operation for channel or device
1024	reentrant I/O
1025	incompatible specifiers in open
1026	illegal input for namelist
1027	error in FILEOPT parameter
1028	writing not allowed
1029	reading not allowed
1030	integer overflow on input
1031	floating-point overflow on input
1032	floating-point underflow on input
1051	default input unit closed
1052	default output unit closed
1053	direct-access READ from unconnected unit
1054	direct-access WRITE to unconnected unit
1055	unassociated internal unit
1056	null reference to internal unit
1057	empty internal file
1058	list-directed I/O on unformatted unit
1059	namelist I/O on unformatted unit
1060	tried to write past end of internal file
1061	unassociated ADVANCE specifier
1062	ADVANCE specifier is not 'YES' or 'NO'
1063	EOR specifier present for advancing input

TABLE A–1 f95 Runtime I/O Messages *(Continued)*

Error	Message
1064	SIZE specifier present for advancing input
1065	negative or zero record number
1066	record not in file
1067	corrupted format
1068	unassociated input variable
1069	more I/O-list items than data edit descriptors
1070	zero stride in subscript triplet
1071	zero step in implied DO-loop
1072	negative field width
1073	zero-width field
1074	character string edit descriptor reached on input
1075	Hollerith edit descriptor reached on input
1076	no digits found in digit string
1077	no digits found in exponent
1078	scale factor out of range
1079	digit equals or exceeds radix
1080	unexpected character in integer field
1081	unexpected character in real field
1082	unexpected character in logical field
1083	unexpected character in integer value
1084	unexpected character in real value
1085	unexpected character in complex value
1086	unexpected character in logical value
1087	unexpected character in character value
1088	unexpected character before NAMELIST group name
1089	NAMELIST group name does not match the name in the program
1090	unexpected character in NAMELIST item
1091	unmatched parenthesis in NAMELIST item name

TABLE A–1 f95 Runtime I/O Messages *(Continued)*

Error	Message
1092	variable not in NAMELIST group
1093	too many subscripts in NAMELIST object name
1094	not enough subscripts in NAMELIST object name
1095	zero stride in NAMELIST object name
1096	empty section subscript in NAMELIST object name
1097	subscript out of bounds in NAMELIST object name
1098	empty substring in NAMELIST object name
1099	substring out of range in NAMELIST object name
1100	unexpected component name in NAMELIST object name
1111	unassociated ACCESS specifier
1112	unassociated ACTION specifier
1113	unassociated BINARY specifier
1114	unassociated BLANK specifier
1115	unassociated DELIM specifier
1116	unassociated DIRECT specifier
1117	unassociated FILE specifier
1118	unassociated FMT specifier
1119	unassociated FORM specifier
1120	unassociated FORMATTED specifier
1121	unassociated NAME specifier
1122	unassociated PAD specifier
1123	unassociated POSITION specifier
1124	unassociated READ specifier
1125	unassociated READWRITE specifier
1126	unassociated SEQUENTIAL specifier
1127	unassociated STATUS specifier
1128	unassociated UNFORMATTED specifier
1129	unassociated WRITE specifier

TABLE A–1 f95 Runtime I/O Messages *(Continued)*

Error	Message
1130	zero length file name
1131	ACCESS specifier is not 'SEQUENTIAL' or 'DIRECT'
1132	ACTION specifier is not 'READ', 'WRITE' or 'READWRITE'
1133	BLANK specifier is not 'ZERO' or 'NULL'
1134	DELIM specifier is not 'APOSTROPHE', 'QUOTE', or 'NONE'
1135	unexpected FORM specifier
1136	PAD specifier is not 'YES' or 'NO'
1137	POSITION specifier is not 'APPEND', 'ASIS', or 'REWIND'
1138	RECL specifier is zero or negative
1139	no record length specified for direct-access file
1140	unexpected STATUS specifier
1141	status is specified and not 'OLD' for connected unit
1142	STATUS specifier is not 'KEEP' or 'DELETE'
1143	status 'KEEP' specified for a scratch file
1144	impossible status value
1145	a file name has been specified for a scratch file
1146	attempting to open a unit that is being read from or written to
1147	attempting to close a unit that is being read from or written to
1148	attempting to open a directory
1149	status is 'OLD' and the file is a dangling symbolic link
1150	status is 'NEW' and the file is a symbolic link
1151	no free scratch file names
1152	specifier ACCESS='STREAM' for default unit
1153	stream-access to default unit
1161	device does not support REWIND
1162	read permission required for BACKSPACE
1163	BACKSPACE on direct-access unit
1164	BACKSPACE on binary unit

TABLE A–1 f95 Runtime I/O Messages *(Continued)*

Error	Message
1165	end-of-file seen while backspacing
1166	write permission required for ENDFILE
1167	ENDFILE on direct-access unit
1168	stream-access to sequential or direct-access unit
1169	stream-access to unconnected unit
1170	direct-access to stream-access unit
1171	incorrect value of POS specifier
1172	unassociated ASYNCHRONOUS specifier
1173	unassociated DECIMAL specifier
1174	unassociated IOMSG specifier
1175	unassociated ROUND specifier
1176	unassociated STREAM specifier
1177	ASYNCHRONOUS specifier is not 'YES' or 'NO'
1178	ROUND specifier is not 'UP', 'DOWN', 'ZERO', 'NEAREST', 'COMPATIBLE' or 'PROCESSOR-DEFINED'
1179	DECIMAL specifier is not 'POINT' or 'COMMA'
1180	RECL specifier is not allowed in OPEN statement for stream-access unit
1181	attempting to allocate an allocated array
1182	deallocating an unassociated pointer
1183	deallocating an unallocated allocatable array
1184	deallocating an allocatable array through a pointer
1185	deallocating an object not allocated by an ALLOCATE statement
1186	deallocating a part of an object
1187	deallocating a larger object than was allocated
1191	unallocated array passed to array intrinsic function
1192	illegal rank
1193	small source size
1194	zero array size

TABLE A–1 **f95** Runtime I/O Messages *(Continued)*

Error	Message
1195	**negative elements in shape**
1196	**illegal kind**
1197	**nonconformable array**
1213	**asynchronous I/O on unconnected unit**
1214	**asynchronous I/O on synchronous unit**
1215	**a data edit descriptor and I/O list item type are incompatible**
1216	**current I/O list item doesn't match with any data edit descriptor**
1217	**illegal CORR_ACCTION value**
1218	**infinite loop occurred due to I/O handler enabled**
1220	**the number of requested bytes is greater than is supported on the target platform**
1221	**data in a UNION cannot be read from or written to an incompatible file type**
2001	**invalid constant, structure, or component name**
2002	**handle not created**
2003	**character argument too short**
2004	**array argument too long or too short**
2005	**end of file, record, or directory stream**
2021	**lock not initialized** (OpenMP)
2022	**deadlock in using lock variabl**e (OpenMP)
2023	**lock not set** (OpenMP)

◆ ◆ ◆ APPENDIX B

Features Release History

This Appendix lists the new and changed features in this release and previous releases of the Fortran compiler.

The Sun Studio Fortran compiler, version 8.4, is a component of the Sun Studio 12 Update 1 software release.

B.1 Sun Studio 12 Update 1 Fortran Release

- Object files created by the compilers on the Solaris OS on x86 platforms or the Linux OS are incompatible with previous compiler versions if the application code contains functions with parameters or return values using _m128/_m64 data types. Users with .il inline function files, assembler code, or asm inline statements calling these functions also need to be aware of this incompatibility.
- New x86 **–xtarget** values **woodcrest, penryn, nehalem**.
- New SPARC **–xtarget** values **ultraT2plus** and **sparc64vii**.
- New x86 **–xarch** and **–xchip** values **ssse3, sse4_1, sse4_2, core2, penryn, nehalem, barcelona**.
- New SPARC **–xarch** and **–xchip** values **sparcima, sparc64vii**, and **ultraT2plus**.
- The **-xprofile=collect** and **-xprofile=use** options provide improved support for profiling multi-threaded, dynamically linked applications.
- The **-xcrossfile=1** option becomes an alias of the **-xipo=1** option.
- On Solaris platforms, the **-xpec**[=**yes|no**] option generates a PEC binary that is recompilable for use with the Automatic Tuning System (ATS).
- On SPARC. platforms, the **-xdepend** option is now implicitly enabled for optimization levels **-x03** or higher, and is no longer included in the expansion of the **-fast** option.
- Support for OpenMP 3.0 tasking..

- **-xannotate**[=**yes**|**no**] (SPARC platforms only) instructs the compiler to create binaries that can be transformed later by binary modification tools like **binopt**(1).
- Quad precision (REAL*16) is implemented on x86 platforms. REAL*16 is 128-bit IEEE floating point.
- The compiler normally creates temporary files in the **/tmp** directory. You can specify another directory by setting the **TMPDIR** environment variable.
- The behavior of the **cpu_time**() Fortran intrinsic routine is different between Solaris and Linux platforms.
- The Fortran 2003 **IMPORT** statement is implemented.

B.2 Sun Studio 12 Fortran Release

- The Fortran compiler is now available on the following Linux (x86 and x64) distibutions: SuSe Linux Enterprise Server 9 with Service Pack 3 (or later), Red Hat Enterprise Linux 4, and other Linux distributions based on the 2.6 kernel (although these are not officially supported).
- Use -**m64** to create 64-bit executables and shared libraries.
- New flags for **-xarch** replace obsolete flags.
- New values for **-xtarget** and **-xchip** provide code generation for the UltraSPARC T2 and SPARC64vi processors.
- New flag **-fma=fused** to enable generation of fused multiply-add instructions on processors that support them.
- New flag **-xhwcprof** enables compiler support for dataspace profiling.
- New flag **-xinstrument** to enable performance analysis by the Thread Analyzer
- **-xregs=frameptr** added to **-fast** on x86.
- Support for interval arithmetic on Solaris x86 platform with the **-xarch=sse2** and **-xia** options.
- Explicit prefetch directives accepted on x86 platforms as well as SPARC platforms. (**–xprefetch=explicit**)
- Default format for debugging information has changed from the "stabs" standard to the "dwarf" standard format. (**-xdebugformat=dwarf**).

B.3 Sun Studio 11 Fortran Release

- **New `-xmodel` option:**The new -xmodel option lets you specify the kernel, small, or medium memory models on the 64-bit AMD architecture. If the size of your global and static variables exceeds two gigabytes, specify **`-xmodel=medium`**. Otherwise, use the default **`-xmodel=small`** setting. See "3.4.144 **`–xmodel=`**[**`small`** | **`kernel`** | **`medium`**]" on page 122.
- **The `-xvector` option extended for x86 SSE2 platforms:**The **`-xvector`** option enables automatic generation of calls to the vector library functions and/or the generation of the SIMD (Single Instruction Multiple Data) instructions. This option now offers the expanded syntax on x86 SSE2 platforms. See "3.4.175 **`–xvector`**[**`=`** [[**`no%`**]**`lib`**, [**`no%`**]**`simd`**, **`%none`**]]" on page 138.
- **`STACKSIZE` environment variable enhanced**:The syntax of the **`STACKSIZE`** environment variable has been enhanced to include a units keyword.
- **`-xpagesize` options available on x86 platforms:**Options **`-xpagesize`**, **`-xpagesize_heap`**, and **`-xpagesize_stack`** are now enabled on x86 platforms as well as SPARC. See "3.4.151 **`–xpagesize=`***size*" on page 124.
- **New UltraSPARC T1 and UltraSPARC IV+ targets enabled:**Values for **`-xarch`**, **`-xchip`**, **`-xcache`**, and **`-xtarget`** support new UltraSPARC processors. See "3.4.171 **`–xtarget=`***t*" on page 135.

B.4 Sun Studio 10 Fortran Release:

- **Compiling for AMD-64 Processors**

  This release introduces **`-xarch=amd64`** and **`-xtarget=opteron`** for compiling applications to run on 64-bit x86 platforms.
- **File sharing between big-endian and little-endian platforms**

  The new compiler flag **`-xfilebyteorder`** provides cross-platform support of binary I/O files.
- **OpenMP available on Solaris OS x86 platforms**

  With this release of Sun Studio, the OpenMP API for shared-memory parallelism is available on Solaris x86 platforms as well as Solaris SPARC platforms. The same functionality is now enabled on both platforms.
- **OpenMP option `-openmp=stubs` no longer supported**

  An OpenMP "stubs" library is provided for user's convenience. To compile an OpenMP program that calls OpenMP library functions but ignores the OpenMP pragmas, compile the program with the -openmp option and link the object files with the libompstubs.a library. For example: **`% f95 omp_ignore.c -lompstubs`**

  Linking with both **`libompstubs.a`** and the OpenMP runtime library **`libmtsk.so`** is unsupported and may result in unexpected behavior.

B.5 Sun Studio 9 Fortran Release:

- **Fortran 95 compiler released on x86 Solaris platforms:**

  This release of Sun Studio makes the Fortran compiler available on Solaris OS x86 platforms. Compile with **-xtarget** values **generic**, **native**, **386**, **486**, **pentium**, **pentium_pro**, **pentium3**, or **pentium4**, to generate executables on Solaris x86 platforms. The default on x86 platforms is **-xtarget=generic.**

  The following **f95** features are not yet implemented on x86 platforms and are only available on SPARC platforms:

  - Interval Arithmetic (compiler options **-xia** and **-xinterval**)
  - Quad (128-bit) Arithmetic (for example, REAL*16)
  - IEEE Intrinsic modules IEEE_EXCEPTIONS, IEEE_ARITHMETIC, and IEEE_FEATURES
  - The **sun_io_handler** module
  - Parallelization options such as **-autopar** and **-openmp**.

    The following **f95** command-line options are only available on x86 platforms and not on SPARC platforms: **-fprecision**, **-fstore**, **-nofstore**

    The following **f95** command-line options are only available on SPARC platforms and not on x86 platforms: **-xcode**, **-xmemalign**, **-xprefetch**, **-xcheck**, **-xia**, -**xinterval**, **-xipo**, **-xjobs**, **-xlang**, **-xlinkopt**, **-xloopinfo**, **-xpagesize**, **-xprofile_ircache**, **-xreduction**, **-xvector**, **-depend**, **-openmp**, **-autopar**, **-vpara**, **-XlistMP**. Also, on x86 platforms **-fast** adds **-nofstore**.

  Improved Runtime Performance:

  Runtime performance for most applications should improve significantly with this release. For best results, compile with high optimization levels **-xO4** or **-xO5**. At these levels the compiler may now inline contained procedures, and those with assumed-shape, allocatable, or pointer arguments.

- **Fortran 2003 Command-Line Intrinsics:**

  The Fortran 2003 standard introduces three new intrinsics for processing command-line arguments and environment variables. These have been implemented in this release of the **f95** compiler. The new intrinsics are:

  - **GET_COMMAND(***command, length, status***)**

    Returns in command the entire command line that invoked the program.

  - **GET_COMMAND_ARGUMENT(***number, value, length, status***)**

    Returns a command-line argument in value.

  - **GET_ENVIRONMENT_VARIABLE(***name, value, length, status, trim_name***)**

    Return the value of an environment variable.

New and Changed Command-Line Options:

The following **f95** command-line options are new in this release. See the Chapter 3 for details.

- **-xipo_archive=**{ **none** | **readonly** | **writeback** }

  Allow crossfile optimization to include archive (**.a**) libraries. (SPARC only)

- **-xprefetch_auto_type=**[**no%**]**indirect_array_access**

  Generate indirect prefetches for a data arrays accessed indirectly. (SPARC only)

- **-xprofile_pathmap=***collect_prefix***:***use_prefix*

  Set path mapping for profile data files. Use the **-xprofile_pathmap** option with the **-xprofile=use** option when profiling into a directory that is not the directory used when previously compiling with **-xprofile=collect**.

  The following command-line option defaults have changed with this release of **f95**.

- The default for **-xprefetch** is **-xprefetch=no%auto,explicit**.
- The default for **-xmemalign** is **-xmemalign=8i**; when compiling with one of the **-xarch=v9** options the default is **-xmemalign=8f**.
- The default for -xcode when compiling with one of the **-xarch=v9** options is **abs44**.

  To compile with the defaults used in previous compiler releases, specify the following options explicitly:

  -xarch=v8 -**xmemalign=4s** -x**prefetch=no** for 32-bit compilation **-xcode=abs64** **-xprefetch=no** for 64-bit compilation

Default SPARC Architecture is V8PLUS:

The default SPARC architecture is no longer V7. Support for **-xarch=v7** is limited in this Sun Studio 9 release. The new default is V8PLUS (UltraSPARC). Compiling with **-xarch=v7** is treated as **-xarch=v8** because the Solaris 8 OS only supports **-xarch=v8** or better.

To deploy on SPARC V8 systems (for example, SPARCStation 10), compile with **-xarch=v8** explicitly. The provided system libraries run on SPARC V8 architectures.

To deploy on SPARC V7 systems (for example, SPARCStation 1), compile with **-xarch=v7** explicitly. The provided system libraries use the SPARC V8 instruction set. For the Sun Studio 9 release, only the Solaris 8 OS supports the SPARC V7 architecture. When a SPARC V8 instruction is encountered, the OS interprets the instruction in software. The program will run, but performance will be degraded.

- **OpenMP: Maximum Number of Threads Increased:**

  The maximum number of threads for **OMP_NUM_THREADS** and the multitasking library has increased from 128 to 256.

- **OpenMP: Automatic Scoping of Variables:**

This release of the Fortran compiler's implementation of the OpenMP API for shared-memory parallel programming features automatic scoping of variables in parallel regions. See the OpenMP API User's Guide for details. (OpenMP is only implemented on SPARC platforms for this release.)

B.6 Sun Studio 8 Fortran Release:

- **Enhanced `-openmp` option:**

  The **`-openmp`** option flag has been enhanced to facilitate debugging OpenMP programs. To use **`dbx`** to debug your OpenMP application, compile with

  ```
  -openmp=noopt -g
  ```

  You will then be able to use **`dbx`** to breakpoint within parallel regions and display contents of variables. .

- **Multi-process compilation:**

  Specify **`-xjobs=`***n* with **`-xipo`** and the interprocedural optimizer will invoke at most *n* code generator instances to compile the files listed on the command line. This option can greatly reduce the build time of large applications on a multi-cpu machine. See "3.4.133 **`–xjobs=`***n* on page 116.

- **Making assertions with `PRAGMA ASSUME`:**

  The **`ASSUME`** pragma is a new feature in this release of the compiler. This pragma gives hints to the compiler about conditions the programmer knows are true at some point in a procedure. This may help the compiler to do a better job optimizing the code. The programmer can also use the assertions to check the validity of the program during execution. See "2.3.1.8 The **`ASSUME`** Directives" on page 34, and "3.4.111 **`–xassume_control`**[=*keywords*]" on page 99.

- **More Fortran 2003 features:**

  The following features appearing in the Fortran 2003 standard have been implemented in this release of Fortran compiler. These are described in Chapter 4.

  - Exceptions and IEEE Arithmetic:

    New intrinsic modules IEEE_ARITHMETIC, and IEEE_FEATURES provide support for exceptions and IEEE arithmetic in the Fortran language. See "4.6.2 IEEE Floating-Point Exception Handling" on page 156.

  - Interoperability with C:

    The Fortran standard provides a means of referencing C language procedures and, conversely, a means of specifying that a Fortran subprogram can be referenced from a C function. It also provides a means of declaring global variables that are linked with external C variables. See "4.6.1 Interoperability with C Functions" on page 155.

  - **`PROTECTED`** Attribute

The Fortran compiler now accepts the Fortran 2003 **PROTECTED** attribute. **PROTECTED** imposes limitations on the usage of module entities. Objects with the **PROTECTED** attribute are only definable within the module that declares them. "4.6.4 **PROTECTED** Attribute" on page 156.

- **ASYNCHRONOUS** I/O Specifier

  The compiler recognizes the **ASYNCHRONOUS** specifier on I/O statements:

  ASYNCHRONOUS=[**'YES'** | **'NO'**]

  See "4.6.5 Fortran 2003 Asynchronous I/O" on page 156.

Enhanced compatibility with legacy `f77`:

A number of new features enhance the Fortran compiler's compatibility with legacy Fortran 77 compiler, **f77**. These include variable format expressions (VFE's), long identifiers, **-arg=local** , and the **-vax** compiler option. See Chapter 3 and Chapter 4.

- **I/O error handlers:**

  Two new functions enable the user to specify their own error handling routine for formatted input on a logical unit. These routines are described in "4.7.1 I/O Error Handling Routines" on page 159, and in man pages and the *Fortran Library Reference*.

- **Unsigned integers:**

  With this release, the Fortran compiler accepts a new data type, **UNSIGNED**, as an extension to the language. See "4.5 Unsigned Integers" on page 153.

- **Set preferred stack/heap page size:**

  A new command-line option, **-xpagesize**, enables the running program to set the preferred stack and heap page size at program startup. See "3.4.151 **–xpagesize=***size*" on page 124.

- **Faster and enhanced profiling:**

  This release introduces the new command-line option **-xprofile_ircache=** *path*, to speed up the "use" compilation phase during profile feedback. See "3.4.161 **–xprofile_ircache**[**=***path*]" on page 131. See also "3.4.162 **–xprofile_pathmap=***collect_prefix***:***use_prefix*" on page 132.

- **Enhanced "known libraries":**

  The **-xknown_lib** option has been enhanced to include more routines from the Basic Linear Algebra library, BLAS. See "3.4.134 **–xknown_lib=***library_list*" on page 117.

- **Link-time Optimization:**

  Compile and link with the new **-xlinkop**t flag to invoke a post-optimizer to apply a number of advanced performance optimizations on the generated binary object code at link time. See "3.4.140 **–xlinkopt**[**=**{**1**|**2**|**0**}]" on page 119.

- **Initialization of local variables:**

A new extension to the **-xcheck** option flag enables special initialization of local variables. Compiling with **-xcheck=init_local** initializes local variables to a value that is likely to cause an arithmetic exception if it is used before it is assigned by the program. See "3.4.115 **–xcheck=***keyword*" on page 102

B.7 Sun ONE Studio 7, Compiler Collection (Forte Developer 7) Release:

- **Fortran 77 Functionality Absorbed Into Fortran 95 Compiler**

  This release of the Forte Developer software replaces the **f77** compiler with added functionality in the **f95** compiler. The **f77** command is a script that calls the **f95** compiler:

the command:
`f77` *options files libraries*
becomes a call to the `f95` *compiler::*
`f95 -f77=%all -ftrap=%none` *options files* `-lf77compat` *libraries*

See "4.12 Mixing Languages" on page 166 for details on Fortran 77 compatibilities and incompatibilities.

- **Fortran 77 Compatibility Mode:**

  The new **-f77** flag selects various compatibility features that enable the compiler to accept many Fortran 77 constructs and conventions that are normally incompatible with Fortran 95. See "3.4.24 **–f77**[=*list*]" on page 60, and "4.12 Mixing Languages" on page 166.

- **Compiling "Dusty Deck" Programs That Employ Non-Standard Aliasing:**

  The **f95** compiler must assume that programs it compiles adhere to the Fortran 95 standard regarding aliasing of variables through subprogram calls, global variables, pointers, and overindexing. Many "dusty deck" legacy programs intentionally utilized aliasing techniques to get around shortcomings in early versions of the Fortran language. Use the new **-xalias** flag to advise the compiler about how far the program deviates from the standard and what kind of aliasing syndromes it should expect. In some cases the compiler generates correct code only when the proper **-xalias** suboption is specified. Programs that conform strictly to the standard will find some performance improvement by advising the compiler to be unconcerned about aliasing. See "3.4.108 **–xalias**[=*keywords*]" on page 93, and the chapter on Porting in the *Fortran Programming Guide*.

- **Enhanced MODULE Features:**
  - New flag **-use=***list* forces one or more implicit **USE** statements into each subprogram. See "3.4.99 **–use=***list*" on page 89.
  - New flag **-moddir=***path* controls where the compiler writes compiled **MODULE** subprograms (**.mod** files). See "3.4.55 **–moddir=***path*" on page 75. A new environment variable, **MODDIR**, also controls where .mod files are written.

- The -M*path* flag will now accept directory paths, archive (**.a**) files, or module (**.mod**) files to search for **MODULE** subprograms. The compiler determines the type of the file by examining its contents; the actual file name extension is ignored. See "3.4.53 **–M***path*" on page 74.
- When searching for modules, the compiler now looks first in the directory where module files are being written.

  See "4.9 Module Files" on page 163 for details.

Enhanced Global Program Analysis With -Xlist:

This release of the **f95** compiler adds a number of new checks to the global program analysis provided by the **-Xlist** flag. The new **-XlistMP** suboption opens a new domain of static program analysis, verification of OpenMP parallelization directives. See "3.4.105 **–Xlist**[*x*] on page 91, the Forte Developer *OpenMP API User's Guide*, and the chapter on Program Analysis and Debugging in the *Fortran Programming Guide* for details.

- **Identifying Known Libraries With -xknown_lib=library:**

  A new option, **-xknown_lib=***library*, directs the compiler to treat references to certain known libraries as intrinsics, ignoring any user-supplied versions. This enables the compiler to perform optimizations over library calls based on its special knowledge of the library. In this release, the known library names are limited to **blas**, for a subset of the BLAS routines in the Sun Performance Library, and **intrinsics**, for ignoring explicit **EXTERNAL** declarations for Fortran 95 standard intrinsics and any user-supplied versions of these routines. See "3.4.134 **–xknown_lib=***library_list*" on page 117.

- **Ignoring Dummy Argument Type in Interfaces:**

  A new directive, **!$PRAGMA IGNORE_TKR** {*list_of_variables*}, causes the compiler to ignore the type, kind, and rank for the specified dummy argument names appearing in a generic procedure interface when resolving a specific call. Using this directive greatly simplifies writing generic interfaces for wrappers that call specific library routines based on argument type, kind, and rank. See "2.3.1.2 The **IGNORE_TKR** Directive" on page 31 for details.

- **Enhanced -C Runtime Array Checking:**

  In this **f95** compiler release, runtime array subscript range checking with the **-C** option has been enhanced to include array conformance checking. A runtime error is produced when an array syntax statement is executed where the array sections are not conformable. See "3.4.7 **–C**" on page 53.

- **Introducing Fortran 2003 Features:**

  Some new formatted I/O features proposed for the next Fortran standard have been implemented in this release of **f95**. These are the **DECIMAL=**, **ROUND=**, and I**OMSG=** specifiers, and they may appear in **OPEN**, **READ**, **WRITE**, **PRINT**, and **INQUIRE** statements. Also implemented are the **DP**, **DC**, **RP**, and **RC** edit descriptors. See "4.6.9 Fortran 2003 Formatted I/O Features" on page 158 for details.

- **Rounding in Formatted I/O:**

A new option flag, **-iorounding**, sets the default rounding mode for formatted I/O. The modes, processor-defined or compatible, correspond to the **ROUND=** specifier implemented as part of the Fortran 2003 features. See "3.4.46 **–iorounding**[={**compatible**|**processor-defined**}]" on page 72.

- **Obsolete Flags Removed:**

  The following flags have been removed from the **f95** command line:

  -db -dbl

  The following **f77** compiler flags have not been implemented in the **f95** compiler and are also considered obsolete:

  -arg=local -i2 -i4 -misalign -oldldo -r8 -vax-xl -xvpara -xtypemap=integer:mixed

- **Checking for Stack Overflow:**

  Compiling with the new **-xcheck=stkovf** flag adds a runtime check for stack overflow conditions on entry to subprograms. If a stack overflow is detected, a **SIGSEGV** segment fault is raised. Stack overflows in multithreaded applications with large arrays allocated on the stack can cause silent data corruption in neighboring thread stacks. Compile all routines with **-xcheck=stkovf** if stack overflow is suspected. See "3.4.115 **–xcheck=***keyword*" on page 102.

- **New Default Thread Stack Size:**

  With this release, the default slave thread stack size has been increased to 4 Megabytes on SPARC V8 platforms, and 8 Megabytes on SPARC V9 platforms. See the discussion of stacks and stack sizes in the Parallelization chapter of the *Fortran Programming Guide* for details.

- **Enhanced Interprocedural Optimizations:**

  With **-xipo=1** the compiler does inlining across all source files. This release adds **-xipo=2** for enhanced interprocedural aliasing analysis and memory allocation and layout optimizations to imporve cache performance. See "3.4.131 **–xipo**[={**0**|**1**|**2**}]" on page 113.

- **Control Prefetch Instructions With -xprefetch_level=n:**

  Use the new flag **-xprefetch_level=***n* to control the automatic insertion of prefetch instructions with **-xprefetch=auto**. Use requires an optimization level of **-xO3** or greater and a target platform that supports prefetch (**-xarch** platforms **v8plus**, **v8plusa**, **v8plusb**, **v9**, **v9a**, **v9b**, **generic64**, or **native64**). See "3.4.159 **-xprefetch_level=**{**1**|**2**|**3**}" on page 129.

Feature histories for releases prior to Forte Developer 7 can be found in the documentation sets for those earlier releases on the `http://docs.sun.com` web site.

◆ ◆ ◆ APPENDIX C

Legacy **-xtarget** Platform Expansions

This Appendix details legacy **-xtarget** option platform system names and their expansions. They appear here for reference purposes. The current values for UltraSPARC platforms are given under the **-xtarget** option description in Chapter 3. Some of the system platforms listed here may no longer be supported by recent releases of the Solaris operating environment or the Sun Studio compilers.

Each specific value for **-xtarget** expands into a specific set of values for the **-xarch**, **-xchip**, and **-xcache** options, as shown in the following table.

For example:

–xtarget=sun4/15

means

–xarch=v8a -xchip=micro -xcache=2/16/1

TABLE C–1 Legacy **-xtarget** Expansions

-xtarget=	-xarch	-xchip	-xcache
cs6400	**v8**	**super**	**16/32/4:2048/64/1**
sc2000	**v8**	**super**	**16/32/4:2048/64/1**
solb5	**v7**	**old**	**128/32/1**
solb6	**v8**	**super**	**16/32/4:1024/32/1**
ss1	**v7**	**old**	**64/16/1**
ss10	**v8**	**super**	**16/32/4**
ss10/20	**v8**	**super**	**16/32/4**

TABLE C–1 Legacy **-xtarget** Expansions *(Continued)*

-xtarget=	-xarch	-xchip	-xcache
ss10/30	v8	super	16/32/4
ss10/40	v8	super	16/32/4
ss10/402	v8	super	16/32/4
ss10/41	v8	super	16/32/4:1024/32/1
ss10/412	v8	super	16/32/4:1024/32/1
ss10/50	v8	super	16/32/4
ss10/51	v8	super	16/32/4:1024/32/1
ss10/512	v8	super	16/32/4:1024/32/1
ss10/514	v8	super	16/32/4:1024/32/1
ss10/61	v8	super	16/32/4:1024/32/1
ss10/612	v8	super	16/32/4:1024/32/1
ss10/71	v8	super2	16/32/4:1024/32/1
ss10/712	v8	super2	16/32/4:1024/32/1
ss10/hs11	v8	hyper	256/64/1
ss10/hs12	v8	hyper	256/64/1
ss10/hs14	v8	hyper	256/64/1
ss10/hs21	v8	hyper	256/64/1
ss10/hs22	v8	hyper	256/64/1
ss1000	v8	super	16/32/4:1024/32/1
ss1plus	v7	old	64/16/1
ss2	v7	old	64/32/1
ss20	v8	super	16/32/4:1024/32/1
ss20/151	v8	hyper	512/64/1
ss20/152	v8	hyper	512/64/1
ss20/50	v8	super	16/32/4
ss20/502	v8	super	16/32/4
ss20/51	v8	super	16/32/4:1024/32/1
ss20/512	v8	super	16/32/4:1024/32/1

TABLE C–1 Legacy **-xtarget** Expansions *(Continued)*

-xtarget=	-xarch	-xchip	-xcache
ss20/514	v8	super	16/32/4:1024/32/1
ss20/61	v8	super	16/32/4:1024/32/1
ss20/612	v8	super	16/32/4:1024/32/1
ss20/71	v8	super2	16/32/4:1024/32/1
ss20/712	v8	super2	16/32/4:1024/32/1
ss20/hs11	v8	hyper	256/64/1
ss20/hs12	v8	hyper	256/64/1
ss20/hs14	v8	hyper	256/64/1
ss20/hs21	v8	hyper	256/64/1
ss20/hs22	v8	hyper	256/64/1
ss2p	v7	powerup	64/32/1
ss4	v8a	micro2	8/16/1
ss4/110	v8a	micro2	8/16/1
ss4/85	v8a	micro2	8/16/1
ss5	v8a	micro2	8/16/1
ss5/110	v8a	micro2	8/16/1
ss5/85	v8a	micro2	8/16/1
ss600/120	v7	old	64/32/1
ss600/140	v7	old	64/32/1
ss600/41	v8	super	16/32/4:1024/32/1
ss600/412	v8	super	16/32/4:1024/32/1
ss600/51	v8	super	16/32/4:1024/32/1
ss600/512	v8	super	16/32/4:1024/32/1
ss600/514	v8	super	16/32/4:1024/32/1
ss600/61	v8	super	16/32/4:1024/32/1
ss600/612	v8	super	16/32/4:1024/32/1
sselc	v7	old	64/32/1
ssipc	v7	old	64/16/1

TABLE C–1 Legacy **-xtarget** Expansions *(Continued)*

-xtarget=	-xarch	-xchip	-xcache
ssipx	v7	old	64/32/1
sslc	v8a	micro	2/16/1
sslt	v7	old	64/32/1
sslx	v8a	micro	2/16/1
sslx2	v8a	micro2	8/16/1
ssslc	v7	old	64/16/1
ssvyger	v8a	micro2	8/16/1
sun4/110	v7	old	2/16/1
sun4/15	v8a	micro	2/16/1
sun4/150	v7	old	2/16/1
sun4/20	v7	old	64/16/1
sun4/25	v7	old	64/32/1
sun4/260	v7	old	128/16/1
sun4/280	v7	old	128/16/1
sun4/30	v8a	micro	2/16/1
sun4/330	v7	old	128/16/1
sun4/370	v7	old	128/16/1
sun4/390	v7	old	128/16/1
sun4/40	v7	old	64/16/1
sun4/470	v7	old	128/32/1
sun4/490	v7	old	128/32/1
sun4/50	v7	old	64/32/1
sun4/60	v7	old	64/16/1
sun4/630	v7	old	64/32/1
sun4/65	v7	old	64/16/1
sun4/670	v7	old	64/32/1
sun4/690	v7	old	64/32/1

◆ ◆ ◆ APPENDIX D

Fortran Directives Summary

This appendix summarizes the directives recognized by **f95** Fortran compiler:

- General Fortran Directives
- Sun Parallelization Directives
- Cray Parallelization Directives
- OpenMP Fortran 95 Directives, Library Routines, and Environment

D.1 General Fortran Directives

General directives accepted by **f95** are described in "2.3 Directives" on page 29.

TABLE D–1 Summary of General Fortran Directives

Format	
C$PRAGMA *keyword* **(** *a* **[, ** *a* **] …)** *[, keyword (a [, a] …)] ,…*	
C$PRAGMA SUN *keyword* **(** *a* **[, ** *a* **] …)** *[, keyword (a [, a] …)] ,…*	
C$PRAGMA SPARC *keyword* **(** *a* **[, ** *a* **] …)** *[, keyword (a [, a] …)] ,…*	
Comment-indicator in column 1 may be **c**, **C**, **!**, or ***.** (We use **C** in these examples. **f95** free-format must use **!**.)	
C *Directive*	**C$PRAGMA C(***list***)** Declares a list of names of external functions as C language routines.
IGNORE_TKR *Directive*	**C$PRAGMA IGNORE_TKR** {*name* {, *name*} ...} The compiler ignores the type, kind, and rank of the specified dummy argument names appearing in a generic procedure interface when resolving a specific call.

TABLE D–1 Summary of General Fortran Directives *(Continued)*

UNROLL *Directive*	**C$PRAGMA SUN UNROLL=***n* Advises the compiler that the following loop can be unrolled to a length *n*.
WEAK *Directive*	**C$PRAGMA WEAK(***name*[**=***name2*]**)** Declares *name* to be a weak symbol, or an alias for *name2*.
OPT *Directive*	**C$PRAGMA SUN OPT=***n* Set optimization level for a subprogram to *n*.
PIPELOOP *Directive*	**C$PRAGMA SUN PIPELOOP**[**=***n*] Assert dependency in loop between iterations *n* apart.
PREFETCH *Directives*	**C$PRAGMA SUN_PREFETCH_READ_ONCE (***name***)** **C$PRAGMA SUN_PREFETCH_READ_MANY (***name***)** **C$PRAGMA SUN_PREFETCH_WRITE_ONCE (***name***)** **C$PRAGMA SUN_PREFETCH_WRITE_MANY (***name***)** Request compiler generate prefetch instructions for references to name. (Requires **-xprefetch** option, which is enabled by default. Prefetch directives can be disabled by compiling with **–xprefetch=no**. Target architecture must also support prefetch instructions, and the compiler optimization level must be set greater than **–xO2**.)
ASSUME *Directives*	**C$PRAGMA** [**BEGIN**} **ASSUME (***expression* [**,***probability*]**)** **C$PRAGMA END ASSUME** Make assertions about conditions at certain points in the program that the compiler can assume are true.

D.2 Special Fortran Directives

The following directives are only available with **f95**. See "4.8.2 **FIXED** and **FREE** Directives" on page 162 for details.

TABLE D–2 Special Fortran Directives

Format	**!DIR$** *directive* : initial line **!DIR$&** ... : continuation line With fixed-format source, **C** is also accepted as a directive-indicator: **CDIR$** *directive*... The line must start in column 1. With free-format source, the line may be preceded by blanks.
FIXED/FREE *Directives*	**!DIR$ FREE!DIR$ FIXED** These directives specify the source format of the lines following the directive. They apply to the rest of the source file in which they appear, up to the next **FREE** or **FIXED** directive.

D.3 Fortran OpenMP Directives

The Sun Studio Fortran compiler supports the OpenMP 3.0 Fortran API. The **-openmp** compiler flag enables these directives. (See "3.4.149 **–xopenmp**[={**parallel**|**noopt**|**none**}]" on page 123).

See the *OpenMP API User's Guide* for complete details.

D.4 Sun Parallelization Directives

Note – Legacy Sun and Cray parallelization directives are now deprecated and ignored. Use of the OpenMP API for parallelization on Solaris SPARC and x86 platforms is preferred. See the OpenMP API User's Guide for information on migrating legacy applications to OpenMP.

OpenMP parallelization is the preferred parallelization model with Fortran. Sun-style parallelization directives are described here for legacy applications.

TABLE D–3 Sun-Style Parallelization Directives Summary

Format	**C$PAR** *directive [optional_qualifiers]* : initial line **C$PAR&** *[more_qualifiers]* : continuation line Fixed format, the directive-indicator may be **C** (as shown), **c**, *****, or **!**. Separate multiple qualifiers with commas. Characters beyond column 72 ignored unless **-e** compiler option specified.

TABLE D–3 Sun-Style Parallelization Directives Summary *(Continued)*

TASKCOMMON *Directive*	**C$PAR TASKCOMMON** *block_name* Declares variables in common block *block_name* as thread-private: private to a thread, but global within the thread. Declaring a common block **TASKCOMMON** requires that this directive appear after *every* common declaration of that block.
DOALL *Directive*	**C$PAR DOALL** *[qualifiers]* Parallelize DO loop that follows. Qualifiers are: **PRIVATE**(*list*) declare names on list PRIVATE **SHARED**(*list*) declare names on list SHARED **MAXCPUS**(*n*) use no more than *n* threads **READONLY**(*list*) listed variables not modified in loop **SAVELAST** save last value of all private variables **STOREBACK**(*list*) save last value of listed variables **REDUCTION**(*list*) listed variables are reduction variables **SCHEDTYPE**(*type*) use scheduling type: (default is **STATIC**) **STATIC** **SELF**(*nchunk*) **FACTORING**[(*m*)] **GSS**[(*m*)]
DOSERIAL *Directive*	**C$PAR DOSERIAL** Disables parallelization of the loop that follows.
DOSERIAL* *Directive*	**C$PAR DOSERIAL*** Disables parallelization of the loop nest that follows.

D.5 Cray Parallelization Directives

Note – Legacy Sun and Cray parallelization directives are now deprecated and ignored. Use of the OpenMP API for parallelization on Solaris SPARC and x86 platforms is preferred. See the OpenMP API User's Guide for information on migrating legacy applications to OpenMP.

Cray-style parallelization directives are detailed in the chapter on parallelization in the *Fortran Programming Guide*. Requires **-mp=cray** compiler option.

TABLE D–4 Cray Parallelization Directives Summary

Format	**CMIC$** *directive qualifiers* : initial line **CMIC$&** *[more_qualifiers]* : continuation line Fixed format. Directive-indicator may be **C** (as shown here), **c**, *****, or **!**. With **f95** free-format, leading blanks can appear before **!MIC$**.
DOALL *Directive*	**CMIC$ DOALL SHARED**(*list*), **PRIVATE**(*list*) *[, more_qualifiers]* Parallelize loop that follows. Qualifiers are: Scoping qualifiers are required (unless *list* is empty)—all variables in the loop must appear in a **PRIVATE** or **SHARED** clause: **PRIVATE**(*list*) declare names on list PRIVATE **SHARED**(*list*) declare names on list SHARED **AUTOSCOPE** automatically determine scope of variables The following are optional: **MAXCPUS**(*n*) use no more than *n* threads **SAVELAST** save last value of all private variables. Only one scheduling qualifier may appear: **GUIDED** *equivalent to Sun-style* **GSS(64)** **SINGLE** *equivalent to Sun-style* **SELF(1)** **CHUNKSIZE**(*n*) *equivalent to Sun-style* **SELF(n)** **NUMCHUNKS**(*m*) *equivalent to Sun-style* **SELF(n/m)** The default scheduling is Sun-style **STATIC**, for which there is no Cray-style equivalent. Interpretations of these scheduling qualifiers differ between Sun and Cray style. Check the *Fortran Programming Guide* for details.
TASKCOMMON *Directive*	**CMIC$ TASKCOMMON** *block_name* Declares variables in the named common block as *thread-private*— private to a thread, but global within the thread. Declaring a common block **TASKCOMMON** requires that this directive appear immediately after *every* common declaration of that block.
DOSERIAL *Directive*	**CMIC$ DOSERIAL** Disables parallelization of the loop that follows.
DOSERIAL* *Directive*	**CMIC$ DOSERIAL*** Disables parallelization of the loop nest that follows.

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