Oracle® VM Server for SPARC 3.1 Administration Guide

Part No: E38406
September 2014

ORACLE

140915@25097

Contents

Preface

- **Overview** – Provides detailed information and procedures that describe the overview, security considerations, installation, configuration, modification, and execution of common tasks for the Oracle VM Server for SPARC 3.1 software on supported servers, blades, and server modules. See "Supported Platforms" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

  Note – The features that are described in this book can be used with all of the supported system software and hardware platforms that are listed in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*. However, some features are only available on a subset of the supported system software and hardware platforms. For information about these exceptions, see "What's New in This Release" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* and What's New in Oracle VM Server for SPARC Software (`http://www.oracle.com/technetwork/server-storage/vm/documentation/sparc-whatsnew-330281.html`).

- **Audience** – System administrators who manage virtualization on SPARC servers
- **Required knowledge** – System administrators on these servers must have a working knowledge of UNIX systems and the Oracle Solaris operating system (Oracle Solaris OS)

Product Documentation Library

Late-breaking information and known issues for this product are included in the documentation library at `http://www.oracle.com/pls/topic/lookup?ctx=product_intuitive_ID`.

Access to Oracle Support

Oracle customers have access to electronic support through My Oracle Support. For information, visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info or visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs if you are hearing impaired.

Feedback

Provide feedback about this documentation at http://www.oracle.com/goto/docfeedback.

PART I

Oracle VM Server for SPARC 3.1 Software

This part introduces the Oracle VM Server for SPARC 3.1 software, which provides highly efficient, enterprise-class virtualization capabilities for SPARC T-Series, SPARC M-Series, and Fujitsu M10 systems.

◆ ◆ ◆ CHAPTER 1

Overview of the Oracle VM Server for SPARC Software

This chapter provides an overview of the Oracle VM Server for SPARC software.

Oracle VM Server for SPARC provides highly efficient, enterprise-class virtualization capabilities for SPARC T-Series and SPARC M5 platforms, and Fujitsu M10 systems. Using the Oracle VM Server for SPARC software, you can create up to 128 virtual servers, called logical domains, on a single system. This kind of configuration enables you to take advantage of the massive thread scale offered by SPARC T-Series and SPARC M5 platforms, Fujitsu M10 systems and the Oracle Solaris OS.

This chapter covers the following topics:

About Oracle VM Server for SPARC and Oracle Solaris OS Versions

The Oracle VM Server for SPARC software depends on particular Oracle Solaris OS versions, required software patches, and particular versions of system firmware. For more information, see "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

The version of the Oracle Solaris OS that runs on a guest domain is *independent* of the Oracle Solaris OS version that runs on the `primary` domain. So, if you run the Oracle Solaris 10 OS in the `primary` domain, you can still run the Oracle Solaris 11 OS in a guest domain. Likewise, if you run the Oracle Solaris 11 OS in the `primary` domain, you can still run the Oracle Solaris 10 OS in a guest domain.

The only difference between running the Oracle Solaris 10 OS or the Oracle Solaris 11 OS on the `primary` domain is the feature differences in each OS.

Hypervisor and Logical Domains

This section provides an overview of the SPARC hypervisor, which supports logical domains.

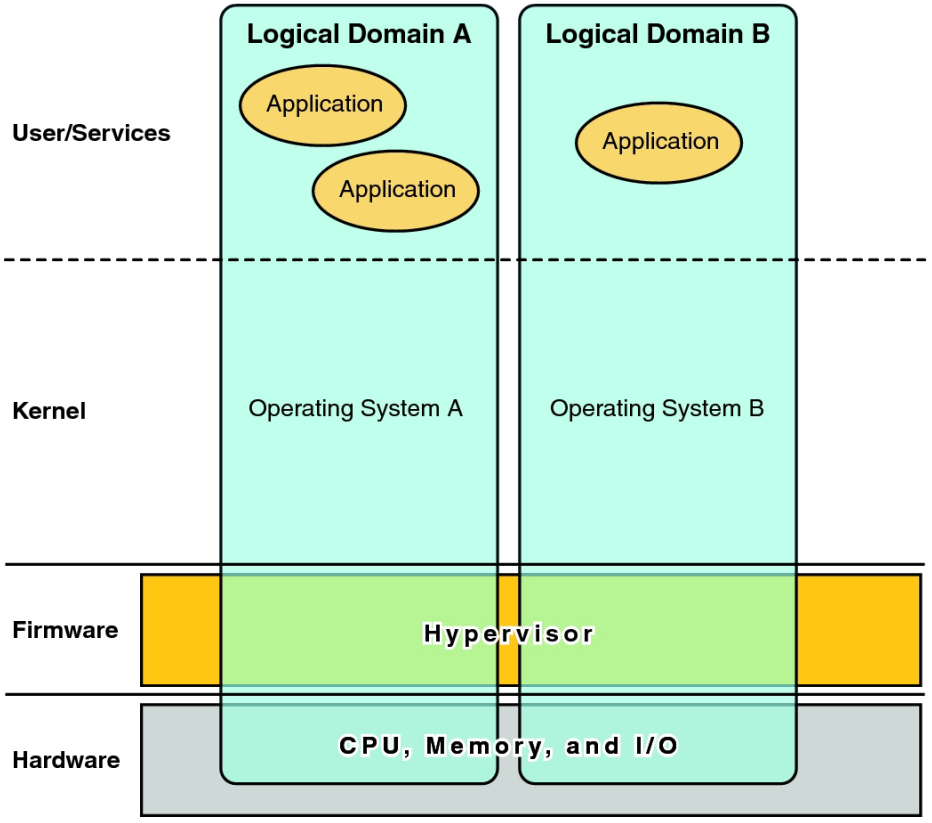
The SPARC *hypervisor* is a small firmware layer that provides a stable virtualized machine architecture to which an operating system can be written. SPARC servers that use the hypervisor provide hardware features to support the hypervisor's control over a logical operating system's activities.

A *logical domain* is a virtual machine comprised of a discrete logical grouping of resources. A logical domain has its own operating system and identity within a single computer system. Each logical domain can be created, destroyed, reconfigured, and rebooted independently, without requiring you to perform a power cycle of the server. You can run a variety of applications software in different logical domains and keep them independent for performance and security purposes.

Each logical domain is only permitted to observe and interact with those server resources that are made available to it by the hypervisor. The Logical Domains Manager enables you to specify what the hypervisor should do through the control domain. Thus, the hypervisor enforces the partitioning of the server's resources and provides limited subsets to multiple operating system environments. This partitioning and provisioning is the fundamental mechanism for creating logical domains. The following diagram shows the hypervisor supporting two logical domains. It also shows the following layers that make up the Oracle VM Server for SPARC functionality:

- User/services (applications)
- Kernel (operating systems)
- Firmware (hypervisor)
- Hardware, including CPU, memory, and I/O

FIGURE 1–1 Hypervisor Supporting Two Domains



The number and capabilities of each logical domain that a specific SPARC hypervisor supports are server-dependent features. The hypervisor can allocate subsets of the overall CPU, memory, and I/O resources of a server to a given logical domain. This capability enables support of multiple operating systems simultaneously, each within its own logical domain. Resources can be rearranged between separate logical domains with an arbitrary granularity. For example, CPUs are assignable to a logical domain with the granularity of a CPU thread.

Each logical domain can be managed as an entirely independent machine with its own resources, such as:

- Kernel, patches, and tuning parameters
- User accounts and administrators
- Disks
- Network interfaces, MAC addresses, and IP addresses

Each logical domain can be stopped, started, and rebooted independently of each other without requiring you to perform a power cycle of the server.

The hypervisor software is responsible for maintaining the separation between logical domains. The hypervisor software also provides logical domain channels (LDCs) that enable logical domains to communicate with each other. LDCs enable domains to provide services to each other, such as networking or disk services.

The service processor (SP), also known as the system controller (SC), monitors and runs the physical machine, but it does not manage the logical domains. The Logical Domains Manager manages the logical domains.

In addition to using the `ldm` command to manage the Oracle VM Server for SPARC software, you can now use Oracle VM Manager.

Oracle VM Manager is a web-based user interface that you can use to manage the Oracle VM environment. Earlier versions of this user interface only managed the Oracle VM Server x86 software, but starting with Oracle VM Manager 3.2 and Oracle VM Server for SPARC 3.0, you can also manage the Oracle VM Server for SPARC software. For more information about Oracle VM Manager, see Oracle VM Documentation (`http://www.oracle.com/technetwork/documentation/vm-096300.html`).

Logical Domains Manager

The Logical Domains Manager is used to create and manage logical domains, as well as to map logical domains to physical resources. Only one Logical Domains Manager can run on a server.

Roles for Domains

All logical domains are the same and can be distinguished from one another based on the roles that you specify for them. Logical domains can perform the following roles:

- **Control domain.** The Logical Domains Manager runs in this domain, which enables you to create and manage other logical domains, and to allocate virtual resources to other domains. You can have only one control domain per server. The control domain is the first domain created when you install the Oracle VM Server for SPARC software. The control domain is named `primary`.
- **Service domain.** A service domain provides virtual device services to other domains, such as a virtual switch, a virtual console concentrator, and a virtual disk server. You can have more than one service domain, and any domain can be configured as a service domain.
- **I/O domain.** An I/O domain has direct access to a physical I/O device, such as a network card in a PCI EXPRESS (PCIe) controller. An I/O domain can own the following:
  - A PCIe root complex.
  - A PCIe slot or on-board PCIe device by using the direct I/O (DIO) feature. See "Creating an I/O Domain by Assigning PCIe Endpoint Devices" on page 82.

- A PCIe SR-IOV virtual function. See "Creating an I/O Domain by Assigning PCIe SR-IOV Virtual Functions" on page 95.

An I/O domain can share physical I/O devices with other domains in the form of virtual devices when the I/O domain is also used as a service domain.

- **Root domain.** A root domain has a PCIe root complex assigned to it. This domain owns the PCIe fabric and provides all fabric-related services, such as fabric error handling. A root domain is also an I/O domain, as it owns and has direct access to physical I/O devices.

  The number of root domains that you can have depends on your platform architecture. For example, if you are using an Oracle Sun SPARC Enterprise T5440 server, you can have up to four root domains.

  The default root domain is the `primary` domain. Starting with the Oracle VM Server for SPARC 3.1 release, you can use non-`primary` domains to act as root domains.
- **Guest domain.** A guest domain is a non-I/O domain that consumes virtual device services that are provided by one or more service domains. A guest domain does not have any physical I/O devices but only has virtual I/O devices, such as virtual disks and virtual network interfaces.

You can install the Logical Domains Manager on an existing system that is not already configured with Oracle VM Server for SPARC. In this case, the current instance of the OS becomes the control domain. Also, the system is configured with only one domain, the control domain. After configuring the control domain, you can balance the load of applications across other domains to make the most efficient use of the entire system by adding domains and moving those applications from the control domain to the new domains.

Command-Line Interface

The Logical Domains Manager uses a command-line interface (CLI) to create and configure logical domains. The CLI is a single command, `ldm`, that has multiple subcommands. See the `ldm(1M)` man page.

The Logical Domains Manager daemon, `ldmd`, must be running to use the Logical Domains Manager CLI.

Virtual Input/Output

In an Oracle VM Server for SPARC environment, you can provision up to 128 domains on a system (up to 256 on a Fujitsu M10 system). Some servers, particularly single-processor and some dual-processor systems, have a limited number of I/O buses and physical I/O slots. As a result, you might be unable to provide exclusive access to a physical disk and network devices to all domains on these systems. You can assign a PCIe bus or endpoint device to a domain to provide it with access to a physical device. Note that this solution is insufficient to provide all

domains with exclusive device access. This limitation on the number of physical I/O devices that can be directly accessed is addressed by implementing a virtualized I/O model. See Chapter 6, "Setting Up I/O Domains."

Any logical domains that have no physical I/O access are configured with virtual I/O devices that communicate with a service domain. The service domain runs a virtual device service to provide access to a physical device or to its functions. In this client-server model, virtual I/O devices either communicate with each other or with a service counterpart through interdomain communication channels called logical domain channels (LDCs). The virtualized I/O functionality includes support for virtual networking, storage, and consoles.

Virtual Network

Oracle VM Server for SPARC uses the virtual network device and virtual network switch device to implement virtual networking. The virtual network (`vnet`) device emulates an Ethernet device and communicates with other `vnet` devices in the system by using a point-to-point channel. The virtual switch (`vsw`) device primarily functions as a multiplexor of all the virtual network's incoming and outgoing packets. The `vsw` device interfaces directly with a physical network adapter on a service domain, and sends and receives packets on behalf of a virtual network. The `vsw` device also functions as a simple layer-2 switch and switches packets between the `vnet` devices connected to it within the system.

Virtual Storage

The virtual storage infrastructure uses a client-server model to enable logical domains to access block-level storage that is not directly assigned to them. The model uses the following components:

- Virtual disk client (`vdc`), which exports a block device interface
- Virtual disk service (`vds`), which processes disk requests on behalf of the virtual disk client and submits them to the back-end storage that resides on the service domain

Although the virtual disks appear as regular disks on the client domain, most disk operations are forwarded to the virtual disk service and processed on the service domain.

Virtual Console

In an Oracle VM Server for SPARC environment, console I/O from the `primary` domain is directed to the service processor. The console I/O from all other domains is redirected to the service domain that is running the virtual console concentrator (`vcc`). The domain that runs the `vcc` is typically the `primary` domain. The virtual console concentrator service functions as a concentrator for console traffic for all domains, and interfaces with the virtual network terminal server daemon (`vntsd`) to provide access to each console through a UNIX socket.

Resource Configuration

A system that runs the Oracle VM Server for SPARC software can configure resources such as virtual CPUs, virtual I/O devices, cryptographic units, and memory. Some resources can be configured dynamically on a running domain, while others must be configured on a stopped domain. If a resource cannot be dynamically configured on the control domain, you must first initiate a delayed reconfiguration. The delayed reconfiguration postpones the configuration activities until after the control domain has been rebooted. For more information, see "Resource Reconfiguration" on page 251.

Persistent Configurations

You can use the `ldm` command to store the current configuration of a logical domain on the service processor. You can add a configuration, specify a configuration to be used, remove a configuration, and list the configurations. For details, see the `ldm(1M)` man page. You can also specify a configuration to boot from the SP, as described in "Using Oracle VM Server for SPARC With the Service Processor" on page 306.

For information about managing configurations, see "Managing Domain Configurations" on page 285.

Oracle VM Server for SPARC Physical-to-Virtual Conversion Tool

The Oracle VM Server for SPARC Physical-to-Virtual (P2V) Conversion tool automatically converts an existing physical system to a virtual system that runs the Oracle Solaris 10 OS in a logical domain on a chip multithreading (CMT) system. You can run the `ldmp2v` command from a control domain that runs the Oracle Solaris 10 OS or the Oracle Solaris 11 OS to convert one of the following source systems to a logical domain:

- Any `sun4u` SPARC based system that runs at least the Solaris 8, Solaris 9, or Oracle Solaris 10 OS
- Any `sun4v` system that runs the Oracle Solaris 10 OS but does not run the Oracle VM Server for SPARC software

---

Note – You cannot use the P2V tool to convert an Oracle Solaris 11 physical system to a virtual system.

For information about the tool and about installing it, see Chapter 14, "Oracle VM Server for SPARC Physical-to-Virtual Conversion Tool." For information about the `ldmp2v` command, see the `ldmp2v(1M)` man page.

Oracle VM Server for SPARC Configuration Assistant

The Oracle VM Server for SPARC Configuration Assistant leads you through the configuration of a logical domain by setting basic properties. It can be used to configure any system where the Oracle VM Server for SPARC software is installed but not already configured.

After gathering the configuration data, the Configuration Assistant creates a configuration that is suitable for booting as a logical domain. You can also use the default values selected by the Configuration Assistant to create a usable system configuration.

Note – The `ldmconfig` command is supported only on Oracle Solaris 10 systems.

The Configuration Assistant is a terminal-based tool.

For more information, see Chapter 15, "Oracle VM Server for SPARC Configuration Assistant (Oracle Solaris 10)" and the `ldmconfig`(1M) man page.

Oracle VM Server for SPARC Management Information Base

The Oracle VM Server for SPARC Management Information Base (MIB) enables third-party system management applications to perform remote monitoring of domains, and to start and stop logical domains (domains) by using the Simple Network Management Protocol (SNMP). For more information, see Chapter 17, "Using the Oracle VM Server for SPARC Management Information Base Software."

◆ ◆ ◆ CHAPTER 2

Installing and Enabling Software

This chapter describes how to install or upgrade the different software components required to enable the Oracle VM Server for SPARC 3.1 software.

This chapter covers the following topics:

Required Oracle VM Server for SPARC Software Components

Using the Oracle VM Server for SPARC software requires the following components:

- A supported platform. Refer to "Supported Platforms" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* for a list of supported platforms. For information about the supported firmware, see "Required Software to Enable the Latest Oracle VM Server for SPARC Features" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* and "Upgrading the System Firmware" on page 29.
- A control domain running an operating system equivalent to at least the Oracle Solaris 11 OS and the appropriate Support Repository Update (SRU), if applicable, or the Oracle Solaris 10 1/13 OS with any patches recommended in "Required Software and Patches" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*. See "Upgrading the Oracle Solaris OS" on page 34.
- Oracle VM Server for SPARC 3.1 software installed and enabled on the control domain. See "Installing the Logical Domains Manager" on page 30.
- (Optional) The Oracle VM Server for SPARC Management Information Base (MIB) software package. See Chapter 17, "Using the Oracle VM Server for SPARC Management Information Base Software."

The Oracle Solaris OS and the system firmware must be installed or upgraded on your server before you install or upgrade the Logical Domains Manager. If your system is already using Oracle VM Server for SPARC software, see "Upgrading a System That Is Already Using Oracle VM Server for SPARC" on page 33. Otherwise, see "Installing Oracle VM Server for SPARC Software on a New System" on page 28.

Installing Oracle VM Server for SPARC Software on a New System

SPARC platforms that support the Oracle VM Server for SPARC software are preinstalled with the Oracle Solaris 10 OS or the Oracle Solaris 11 OS. Initially, the platform appears as a single system hosting only one operating system. After the Oracle Solaris OS, system firmware, and Logical Domains Manager have been installed, the original system and instance of the Oracle Solaris OS become the control domain. That first domain of the platform is named `primary`, and you cannot change that name or destroy that domain. From there, the platform can be reconfigured with multiple domains hosting different instances of the Oracle Solaris OS.

Note – The version of the Oracle Solaris OS software that runs on a guest domain is *independent* of the Oracle Solaris OS version that runs on the `primary` domain. So, if you run the Oracle Solaris 10 OS in the `primary` domain, you can still run the Oracle Solaris 11 OS in any of the guest domains. Similarly, if you run the Oracle Solaris 11 OS in the `primary` domain, you can still run the Oracle Solaris 10 OS in any of the guest domains.

Base your decision about which Oracle Solaris OS version to run on the `primary` domain on your requirements and any potential feature differences between Oracle Solaris 10 and Oracle Solaris 11. See *Oracle Solaris 11.1 Release Notes* and *Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.1 Automated Installer*.

Updating the Oracle Solaris OS

On a new system, you might want to reinstall the factory-installed OS to conform to your installation policy. See "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*. For complete Oracle Solaris OS installation instructions, see the Oracle Solaris 10 8/11 Information Library (`http://docs.oracle.com/cd/E23823_01/`) and the Oracle Solaris 11.1 Information Library (`http://docs.oracle.com/cd/E23824_01/`). You can tailor the installation to the requirements of your system.

If your system is already installed with the Oracle Solaris OS, you must upgrade it to the OS version that is associated with the Oracle VM Server for SPARC 3.1 software. See "Required Software and Patches" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*. For complete Oracle Solaris OS upgrade instructions, see the Oracle Solaris 10 8/11 Information

Library (http://docs.oracle.com/cd/E23823_01/) and the Oracle Solaris 11.1 Information Library (http://docs.oracle.com/cd/E23824_01/).

Upgrading the System Firmware

Use the following resources when upgrading the system firmware on SPARC T-Series and SPARC M5 systems:

- For information about upgrading the system firmware by using the ILOM software, see "Update the Firmware" and "Updating ILOM Firmware" in *Oracle Integrated Lights Out Manager (ILOM) 3.0 CLI Procedures Guide*. For more information about using the ILOM software, see the documents for your specific platform at http://www.oracle.com/technetwork/documentation/sparc-tseries-servers-252697.html.
- System firmware for your platform is available at http://www.oracle.com/technetwork/systems/patches/firmware/index.html.
- For information about the required system firmware for the supported servers, see "Required System Firmware Patches" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- To upgrade the system firmware from the control domain, refer to your system firmware product notes, which are available at SPARC T-Series Servers Documentation (http://www.oracle.com/technetwork/documentation/sparc-tseries-servers-252697.html).
- Refer to the administration guides or product notes for the supported servers for more information about installing and upgrading the system firmware for these servers.
- To find out how to use the ILOM web interface to upgrade system firmware, see "Updating ILOM Firmware" in the *Oracle Integrated Lights Out Manager (ILOM) 3.0 Web Interface Procedures Guide*.

To upgrade Fujitsu M10 system firmware by using the eXtended System Control Facility (XSCF), see the following resources:

- *Fujitsu M10 Systems System Operation and Administration Guide*
- *Fujitsu M10 Systems XSCF Reference Manual*

Downloading the Logical Domains Manager

You can obtain the latest packages for both the Oracle Solaris 10 OS and the Oracle Solaris 11 OS. Note that the Oracle VM Server for SPARC software is included by default with the Oracle Solaris 11 OS.

- **Oracle Solaris 10 OS.** Download the `OVM_Server_SPARC-3_1.zip` package from My Oracle Support. See "How to Download the Logical Domains Manager Software (Oracle Solaris 10)" on page 30.
- **Oracle Solaris 11 OS.** Obtain the `ldomsmanager` package from the Oracle Solaris 11 Support Repository. See "How to Upgrade to the Oracle VM Server for SPARC 3.1 Software (Oracle Solaris 11)" on page 37.

▼ How to Download the Logical Domains Manager Software (Oracle Solaris 10)

1. **Download the `OVM_Server_SPARC-3_1.zip` zip file at `http://www.oracle.com/virtualization/index.html`.**

2. **Unzip the zip file.**

   ```
   $ unzip OVM_Server_SPARC-3_1.zip
   ```

   See "Location of the Oracle VM Server for SPARC Software" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* for details about the structure of the file and what it includes.

Installing the Logical Domains Manager

The methods of installing the Logical Domains Manager software are:

- **Oracle Solaris 10 only.** Using the installation script to install the packages and patches. This method automatically installs the Logical Domains Manager software. See "Automatically Installing the Logical Domains Manager Software (Oracle Solaris 10)" on page 31.
- **Oracle Solaris 10 only.** Using the Oracle Solaris JumpStart feature to install the packages as part of a network installation. See *Oracle Solaris 10 8/11 Installation Guide: Custom JumpStart and Advanced Installations* for information about configuring a JumpStart server. Also see *JumpStart Technology: Effective Use in the Solaris Operating Environment* for complete information about using this feature.
- **Oracle Solaris 11 only.** Using the Oracle Solaris 11 Automated Installer feature to install the packages as part of a network installation. See "How to Use the Automated Installer" in *Installing Oracle Solaris 11.1 Systems* and *Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.1 Automated Installer*.

- Installing the package manually. See "Manually Installing the Logical Domains Manager Software" on page 32.

Note – You must manually install the Oracle VM Server for SPARC MIB software package after you install the Oracle VM Server for SPARC packages. It is not automatically installed with the other packages. See Chapter 17, "Using the Oracle VM Server for SPARC Management Information Base Software," for more information about installing and using the Oracle VM Server for SPARC MIB.

Automatically Installing the Logical Domains Manager Software (Oracle Solaris 10)

The `install-ldm` installation script provides options to specify how you want the script to run. Each choice is described in the procedures that follow.

If you do not specify any options, the script does the following automatically:

- Checks that the Oracle Solaris OS release is the Oracle Solaris 10 OS
- Verifies that the package subdirectories `SUNWldm/` and `SUNWldmp2v/` and that the prerequisite Oracle VM Server for SPARC driver packages, `SUNWldomr` and `SUNWldomu`, are present
- Verifies that the `SUNWldm` and `SUNWldmp2v` packages have not been installed
- Installs the Oracle VM Server for SPARC 3.1 software
- Verifies that all packages are installed
- If the Solaris Security Toolkit (SST) package (`SUNWjass`) is already installed, you are prompted to harden the Oracle Solaris OS on the control domain.
- Determines whether to use the Oracle VM Server for SPARC Configuration Assistant (`ldmconfig`) to perform the installation.

To automatically run the Oracle VM Server for SPARC Configuration Assistant after the software is installed, specify the `-c`. To skip running this utility, specify the `-s`.

If the SST package is installed, you can issue the following options with the `install-ldm` script:

`-d` — Specifies an SST driver other than a driver ending with `-secure.driver`. This option hardens the Oracle Solaris OS on the control domain with the SST customized driver that you specify, for example, the `server-secure-myname.driver`.

`-d none` — Specifies that you do *not* want to harden the Oracle Solaris OS running on your control domain by using the SST. Bypassing the use of the SST is not suggested and should only be done when you intend to harden your control domain using an alternative process.

`-p` Specifies that you only want to perform the post-installation actions of enabling the Logical Domains Manager daemon (`ldmd`) and running the SST. For example, you would use this option if the `SUNWldm` and `SUNWjass` packages are preinstalled on your server.

Manually Installing the Logical Domains Manager Software

The following procedure guides you through manually installing the Oracle VM Server for SPARC 3.1 software on the Oracle Solaris 10 OS.

When you install the Oracle Solaris 11 OS, the Oracle VM Server for SPARC 2.1 software is installed by default. If you want to install the Oracle VM Server for SPARC 3.1 software, see "How to Upgrade to the Oracle VM Server for SPARC 3.1 Software (Oracle Solaris 11)" on page 37.

▼ How to Manually Install the Oracle VM Server for SPARC 3.1 Software (Oracle Solaris 10)

1. **Download the `OVM_Server_SPARC-3_1.zip` zip file at `http://www.oracle.com/virtualization/index.html`.**

2. **Unzip the zip file.**

   ```
   $ unzip OVM_Server_SPARC-3_1.zip
   ```

   See "Location of the Oracle VM Server for SPARC Software" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* for details about the structure of the file and what it includes.

3. **If you are already running an earlier version of the Oracle VM Server for SPARC software, save your configuration to the service processor (SP).**

   ```
   primary# ldm add-config config-name
   ```

4. **Install the `SUNWldm.v` and `SUNWldmp2v` packages.**

   ```
   # pkgadd -Gd . SUNWldm.v SUNWldmp2v
   ```

   Answer `y` for yes to all questions in the interactive prompts.

   The `-G` option installs the package in the global zone only. The `-d` option specifies the path to the directory that contains the `SUNWldm.v` and `SUNWldmp2v` packages.

   For more information, see the `pkgadd`(1M) man page.

5 **Verify that the `SUNWldm` and `SUNWldmp2v` packages are installed.**

The following revision (`REV`) information is an example:

```
# pkginfo -l SUNWldm | grep VERSION
VERSION=3.1.0.0.24,REV=2013.07.23.12.23
```

For more information, see the `pkginfo`(1) man page.

Enabling the Logical Domains Manager Daemon

The `install-ldm` installation script automatically enables the Logical Domains Manager daemon (`ldmd`). The `ldmd` daemon is also automatically enabled when the Oracle VM Server for SPARC software package is installed. Once the daemon is enabled, you can create, modify, and control the logical domains.

▼ How to Enable the Logical Domains Manager Daemon

Use this procedure to enable the `ldmd` daemon if it has been disabled.

1 **Use the `svcadm` command to enable the Logical Domains Manager daemon, `ldmd`.**

```
# svcadm enable ldmd
```

For more information about the `svcadm` command, see the `svcadm`(1M) man page.

2 **Verify that the Logical Domains Manager is running.**

The `ldm list` command should list all domains that are currently defined on the system. In particular, the `primary` domain should be listed and be in the `active` state. The following sample output shows that only the `primary` domain is defined on the system.

```
# /opt/SUNWldm/bin/ldm list
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   ---c-   SP      64    3264M    0.3%  19d 9m
```

Upgrading a System That Is Already Using Oracle VM Server for SPARC

This section describes the process of upgrading the Oracle Solaris OS, firmware, and Logical Domains Manager components on a system that is already using the Oracle VM Server for SPARC software. Upgrading the control domain and the existing domains enables the use of all the Oracle VM Server for SPARC 3.1 features on those domains.

Note – Before you upgrade the Oracle VM Server for SPARC software, perform the following steps:

- Upgrade the system with the required system firmware.

  See "Required Software to Enable the Latest Oracle VM Server for SPARC Features" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- Apply the required Oracle Solaris 10 OS patches or Oracle Solaris 11 OS SRU.

  See "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- Save the configurations to the SP.

Upgrading the Oracle Solaris OS

Refer to "Required Software and Patches" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* to find the Oracle Solaris 10 or Oracle Solaris 11 OS that you should use for this version of the Oracle VM Server for SPARC software, and the required and recommended patches for the different domains. Refer to the Oracle Solaris 10 and Oracle Solaris 11 installation guides for complete instructions on upgrading the Oracle Solaris OS.

When reinstalling the Oracle Solaris OS in the control domain, you must save and restore the domain autosave configuration data and the constraints database file, as described in this section.

Saving and Restoring Autosave Configuration Directories

You can save and restore autosave configuration directories prior to reinstalling the operating system on the control domain. Whenever you reinstall the operating system on the control domain, you must save and restore the domain autosave configuration data, which is found in the `/var/opt/SUNWldm/autosave-`*autosave-name* directories.

You can use the `tar` or `cpio` command to save and restore the entire contents of the directories.

Note – Each autosave directory includes a timestamp for the last SP configuration update for the related configuration. If you restore the autosave files, the timestamp might be out of sync. In this case, the restored autosave configurations are shown in their previous state, either `[newer]` or up to date.

For more information about autosave configurations, see "Managing Domain Configurations" on page 285.

How to Save and Restore Autosave Directories

1. **Save the autosave directories.**

```
# cd /
# tar -cvpf autosave.tar var/opt/SUNWldm/autosave-*
```

2. **(Optional) Remove the existing autosave directories to ensure a clean restore operation.**

   Sometimes an autosave directory might include extraneous files, perhaps left over from a previous configuration, that might corrupt the configuration that was downloaded to the SP. In such cases, clean the autosave directory prior to the restore operation as shown in this example:

```
# cd /
# rm -rf var/opt/SUNWldm/autosave-*
```

3. **Restore the autosave directories.**

   These commands restore the files and directories in the `/var/opt/SUNWldm` directory.

```
# cd /
# tar -xvpf autosave.tar
```

Saving and Restoring the Logical Domains Constraints Database File

Whenever you upgrade the operating system on the control domain, you must save and restore the `/var/opt/SUNWldm/ldom-db.xml` Logical Domains constraints database file.

Note – Also save and restore the `/var/opt/SUNWldm/ldom-db.xml` file when you perform any other operation that is destructive to the control domain's file data, such as a disk swap.

Preserving the Logical Domains Constraints Database File When Using the Oracle Solaris 10 Live Upgrade Feature

If you are using the Oracle Solaris 10 Live Upgrade feature on the control domain, consider adding the following line to the `/etc/lu/synclist` file. This line causes the database to be copied automatically from the active boot environment to the new boot environment when you switch boot environments.

```
/var/opt/SUNWldm/ldom-db.xml     OVERWRITE
```

For more information about `/etc/lu/synclist` and synchronizing files between boot environments, refer to "Synchronizing Files Between Boot Environments" in *Oracle Solaris 10 8/11 Installation Guide: Live Upgrade and Upgrade Planning*.

Upgrading the Logical Domains Manager and the System Firmware

This section describes how to upgrade to Oracle VM Server for SPARC 3.1 software.

First download the Logical Domains Manager to the control domain. See "Downloading the Logical Domains Manager" on page 30.

Then stop all domains (except the control domain) running on the platform:

▼ How to Stop All Domains Running on the Platform, Except the Control Domain

Perform this task only if you plan to perform a power cycle of the system or upgrade the firmware. Performing this task is not required if you are only upgrading the Logical Domains Manager software.

1. **Stop all domains.**

   ```
   primary# ldm stop-domain -a
   ```

2. **Issue the `unbind-domain` subcommand from the control domain for each domain.**

   ```
   primary# ldm unbind-domain ldom
   ```

Upgrading to Oracle VM Server for SPARC 3.1 Software

This section explains how to upgrade to the Oracle VM Server for SPARC 3.1 software.

▼ How to Upgrade to the Oracle VM Server for SPARC 3.1 Software (Oracle Solaris 10)

1. **Perform a flash upgrade of the system firmware.**

2. **Disable the Logical Domains Manager daemon (`ldmd`).**

   ```
   # svcadm disable ldmd
   ```

3. **Remove the old `SUNWldm` package.**

   ```
   # pkgrm SUNWldm
   ```

4. **Add the new `SUNWldm` package.**

   ```
   # pkgadd -Gd . SUNWldm.v
   ```

   Specifying the `-d` option indicates that the package is in the current directory.

Note – To obtain the latest features for this Oracle VM Server for SPARC release, you might need to apply a patch. For more information, see "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

5 Use the `ldm list` command to verify that the Logical Domains Manager is running.

The `ldm list` command should list all domains that are currently defined on the system. In particular, the `primary` domain should be listed and be in the `active` state. The following sample output shows that only the `primary` domain is defined on the system.

```
# ldm list
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   ---c-   SP      32    3264M    0.3%  19d 9m
```

How to Upgrade to the Oracle VM Server for SPARC 3.1 Software (Oracle Solaris 11)

1 Prepare your domain for a Logical Domains Manager upgrade.

Performing the following steps enables you to "roll back" to a boot environment (BE) that runs the previous release of the Oracle VM Server for SPARC software, if necessary.

a. Save your configuration to the SP.

```
# ldm add-config config-name
```

The following example saves the configuration called `ldoms-prev-config`:

```
# ldm add-config ldoms-prev-config
```

b. Create a snapshot of your existing BE.

```
# beadm create snapshot-name
```

The following example creates a snapshot called `S10811@ldoms-prev-backup`:

```
# beadm create S10811@ldoms-prev-backup
```

c. Create a backup BE based on the snapshot.

```
# beadm create -e snapshot-name  BE-name
```

The following example creates a new BE called `ldoms-prev-backup` from the snapshot called `S10811@ldoms-prev-backup`:

```
# beadm create -e S10811@ldoms-prev-backup ldoms-prev-backup
```

2 Register to use the online software repository.

See Certificate Generator Online Help (`https://pkg-register.oracle.com/help/#support`).

3 Install the Oracle VM Server for SPARC 3.1 version of the `ldomsmanager` package from the online software repository as part of an update to the latest SRU.

```
# pkg update
            Packages to update:         1
     Estimated space available: 430.14 GB
Estimated space to be consumed:  81.58 MB
       Create boot environment:        No
Create backup boot environment:       Yes
            Services to change:         1
          Rebuild boot archive:        No

Changed packages:
solaris
  system/ldoms/ldomsmanager
    3.0.0.4,5.11-0.175.1.9.0.4.0:20130628T214036Z ->
    3.1.0.0.24,5.11-0.175.2.0.0.20.0:20130723T192948Z
Services:
  restart_fmri:
    svc:/system/manifest-import:default
DOWNLOAD                                  PKGS         FILES    XFER (MB)   SPEED
Completed                                  1/1         44/44      1.9/1.9 79.8k/s

PHASE                                          ITEMS
Removing old actions                           11/11
Installing new actions                         16/16
Updating modified actions                      46/46
Updating package state database                 Done
Updating package cache                           1/1
Updating image state                            Done
Creating fast lookup database                working -Loading smf(5) services
Creating fast lookup database                working /
Creating fast lookup database                   Done
```

4 Verify that the package is installed.

```
# pkg info ldomsmanager
          Name: system/ldoms/ldomsmanager
       Summary: Logical Domains Manager
   Description: LDoms Manager - Virtualization for SPARC T-Series
      Category: System/Virtualization
         State: Installed
     Publisher: solaris
       Version: 3.1.0.0.24
 Build Release: 5.11
        Branch: 0.175.2.0.0.20.0
Packaging Date: Tue Jul 23 19:29:48 2013
          Size: 3.71 MB
          FMRI: pkg://solaris/system/ldoms/ldomsmanager@
                3.1.0.0.24,5.11-0.175.2.0.0.20.0:20130723T192948Z
```

5 Restart the `ldmd` service.

```
# svcadm restart ldmd
```

6 Verify that you are running the correct `ldm` version.

```
# ldm -V
```

7 **Save your configuration to the SP.**

```
# ldm add-config config-name
```

The following example saves the configuration called `ldoms-3.1-config`:

```
# ldm add-config ldoms-3.1-config
```

Factory Default Configuration and Disabling Domains

The initial configuration, in which the platform appears as a single system hosting only one operating system, is called the factory default configuration. If you want to disable logical domains, you probably also want to restore this configuration so that the system regains access to all resources (CPUs, memory, I/O) that might have been assigned to other domains.

This section describes how to remove all guest domains, remove all domain configurations, and revert the configuration to the factory default.

▼ How to Remove All Guest Domains

1 **Stop all domains.**

```
primary# ldm stop-domain -a
```

2 **Unbind all domains except for the `primary` domain.**

```
primary# ldm unbind-domain ldom
```

Note – You might be unable to unbind an I/O domain if it is providing services required by the control domain. In this situation, skip this step.

---

3 **Destroy all domains except for the `primary` domain.**

```
primary# ldm remove-domain -a
```

▼ How to Remove All Domain Configurations

1 **List all the domain configurations that are stored on the service processor (SP).**

```
primary# ldm list-config
```

2. **Remove all configurations (*config-name*) previously saved to the SP except for the `factory-default` configuration.**

   Use the following command for each such configuration:

   ```
   primary# ldm rm-config config-name
   ```

   After you remove all the configurations previously saved to the SP, the `factory-default` domain is the next domain to use when the control domain (`primary`) is rebooted.

How to Restore the Factory Default Configuration

1. **Select the factory default configuration.**

   ```
   primary# ldm set-config factory-default
   ```

2. **Stop the control domain.**

   ```
   primary# shutdown -i5 -g0 -y
   ```

3. **Perform a power cycle of the system to load the factory default configuration.**

   ```
   -> stop /SYS
   -> start /SYS
   ```

How to Disable the Logical Domains Manager

- **Disable the Logical Domains Manager from the control domain.**

  ```
  primary# svcadm disable ldmd
  ```

Note – Disabling the Logical Domains Manager does not stop any running domains, but does disable the ability to create a new domains, change the configuration of existing domains, or monitor the state of the domains.

Caution – If you disable the Logical Domains Manager, this disables some services, such as error reporting or power management. In the case of error reporting, if you are in the `factory-default` configuration, you can reboot the control domain to restore error reporting. However, you cannot re-enable power management. In addition, some system management or monitoring tools rely on the Logical Domains Manager.

How to Remove the Logical Domains Manager

After restoring the factory default configuration and disabling the Logical Domains Manager, you can remove the Logical Domains Manager software.

Note – If you remove the Logical Domains Manager before restoring the factory default configuration, you can restore the factory default configuration from the service processor as shown in the next procedure.

- **Remove the Logical Domains Manager software.**
  - **Remove the Oracle Solaris 10 `SUNWldm` and `SUNWldmp2v` packages.**

    ```
    primary# pkgrm SUNWldm SUNWldmp2v
    ```
  - **Remove the Oracle Solaris 11 `ldomsmanager` package.**

    ```
    primary# pkg uninstall ldomsmanager
    ```

How to Restore the Factory Default Configuration From the Service Processor

If you remove the Logical Domains Manager before restoring the factory default configuration, you can restore the factory default configuration from the service processor.

1. **Restore the factory default configuration from the service processor.**

   ```
   -> set /HOST/bootmode config=factory-default
   ```
2. **Perform a power cycle of the system to load the factory default configuration.**

   ```
   -> reset /SYS
   ```

◆ ◆ ◆ CHAPTER 3

Oracle VM Server for SPARC Security

This chapter describes some security features that you can enable on your Oracle VM Server for SPARC system.

This chapter covers the following topics:

Note – The examples in this book are shown as being performed by superuser. However, you can use profiles instead to have users acquire more fine-grained permissions to perform management tasks.

Delegating the Management of Logical Domains by Using Rights

The Logical Domains Manager package adds two predefined rights profiles to the local rights configuration. These rights profiles delegate administrative privileges to unprivileged users:

- The `LDoms Management` profile permits a user to use all `ldm` subcommands.
- The `LDoms Review` profile permits a user to use all list-related `ldm` subcommands.

These rights profiles can be assigned directly to users or to a role that is then assigned to users. When one of these profiles is assigned directly to a user, you must use the `pfexec` command or a profile shell, such as `pfbash` or `pfksh`, to successfully use the `ldm` command to manage your domains. Determine whether to use roles or rights profiles based on your rights configuration. See *System Administration Guide: Security Services* or Part III, "Roles, Rights Profiles, and Privileges," in *Oracle Solaris 11.1 Administration: Security Services*.

Users, authorizations, rights profiles, and roles can be configured in the following ways:

- Locally on the system by using files
- Centrally in a naming service, such as LDAP

Installing the Logical Domains Manager adds the necessary rights profiles to the local files. To configure profiles and roles in a naming service, see *System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP)*. For an overview of the authorizations and execution attributes delivered by the Logical Domains Manager package, see "Logical Domains Manager Rights Profile Contents" on page 46. All of the examples in this chapter assume that the rights configuration uses local files.

Using Rights Profiles and Roles

Caution – Be careful when using the `usermod` and `rolemod` commands to add authorizations, rights profiles, or roles.

- For the Oracle Solaris 10 OS, the `usermod` or `rolemod` command replaces any existing values.

  To add values instead of replacing them, specify a comma-separated list of existing values and the new values.
- For the Oracle Solaris 11 OS, add values by using the plus sign (+) for each authorization you add.

  For example, the `usermod -A +`*auth username* command grants the *auth* authorization to the *username* user; similarly for the `rolemod` command.

Managing User Rights Profiles

The following procedures show how to manage user rights profiles on the system by using local files. To manage user profiles in a naming service, see *System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP)*.

▼ How to Assign a Rights Profile to a User

Users who have been directly assigned the `LDoms Management` profile *must* invoke a profile shell to run the `ldm` command with security attributes. For more information, see *System Administration Guide: Security Services* or Part III, "Roles, Rights Profiles, and Privileges," in *Oracle Solaris 11.1 Administration: Security Services*.

1 Become an administrator.

- **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in *System Administration Guide: Security Services*.**

- **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in** *Oracle Solaris 11.1 Administration: Security Services***.**

2 **Assign an administrative profile to a local user account.**

You can assign either the `LDoms Review` profile or the `LDoms Management` profile to a user account.

```
# usermod -P "profile-name" username
```

The following command assigns the `LDoms Management` profile to user `sam`:

```
# usermod -P "LDoms Management" sam
```

Assigning Roles to Users

The following procedure shows how to create a role and assign it to a user by using local files. To manage roles in a naming service, see *System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP)*.

The advantage of using this procedure is that only a user who has been assigned a specific role can assume that role. When assuming a role, a password is required if the role has been assigned a password. These two layers of security prevent a user who has not been assigned a role from assuming that role even though he has the password.

▼ How to Create a Role and Assign the Role to a User

1 **Become an administrator.**

- **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in** *System Administration Guide: Security Services***.**
- **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in** *Oracle Solaris 11.1 Administration: Security Services***.**

2 **Create a role.**

```
# roleadd -P "profile-name" role-name
```

3 **Assign a password to the role.**

You will be prompted to specify and then verify a new password.

```
# passwd role-name
```

4 **Assign the role to a user.**

```
# useradd -R role-name username
```

5 **Assign a password to the user.**

You will be prompted to specify and then verify a new password.

```
# passwd username
```

6 **Become the user and provide the password, if necessary.**

```
# su username
```

7 **Verify that the user has access to the assigned role.**

```
$ id
uid=nn(username) gid=nn(group-name)
$ roles
role-name
```

8 **Assume the role and provide the password, if necessary.**

```
$ su role-name
```

9 **Verify that the user has assumed the role.**

```
$ id
uid=nn(role-name) gid=nn(group-name)
```

Example 3–1 Creating a Role and Assigning the Role to a User

This example shows how to create the `ldm_read` role, assign the role to the `user_1` user, become the `user_1` user, and assume the `ldm_read` role.

```
# roleadd -P "LDoms Review" ldm_read
# passwd ldm_read
New Password: ldm_read-password
Re-enter new Password: ldm_read-password
passwd: password successfully changed for ldm_read
# useradd -R ldm_read user_1
# passwd user_1
New Password: user_1-password
Re-enter new Password: user_1-password
passwd: password successfully changed for user_1
# su user_1
Password: user_1-password
$ id
uid=95555(user_1) gid=10(staff)
$ roles
ldm_read
$ su ldm_read
Password: ldm_read-password
$ id
uid=99667(ldm_read) gid=14(sysadmin)
```

Logical Domains Manager Rights Profile Contents

The Logical Domains Manager package adds the following rights profiles to the local rights profile description database:

```
LDoms Power Mgmt Observability:::View LDoms Power Consumption:auths=solaris.ldoms.ldmpower
LDoms Review:::Review LDoms configuration:profiles=LDoms Power Mgmt Observability;auths=solaris.ldoms.read
LDoms Management:::Manage LDoms domains:profiles=LDoms Power Mgmt Observability;auths=solaris.ldoms.*
```

The Logical Domains Manager package also adds the following execution attribute that is associated with the `LDoms Management` profile and the `LDoms Power Mgmt Observability` profile to the local execution profiles database:

```
LDoms Management:suser:cmd:::/usr/sbin/ldm:privs=file_dac_read,file_dac_search
LDoms Power Mgmt Observability:suser:cmd:::/usr/sbin/ldmpower:privs=file_dac_search
```

The following table lists the `ldm` subcommands with the corresponding user authorization that is needed to perform the commands.

TABLE 3–1 `ldm` Subcommands and User Authorizations

ldm Subcommand[1]	User Authorization
`add-*`	`solaris.ldoms.write`
`bind-domain`	`solaris.ldoms.write`
`list`	`solaris.ldoms.read`
`list-*`	`solaris.ldoms.read`
`panic-domain`	`solaris.ldoms.write`
`remove-*`	`solaris.ldoms.write`
`set-*`	`solaris.ldoms.write`
`start-domain`	`solaris.ldoms.write`
`stop-domain`	`solaris.ldoms.write`
`unbind-domain`	`solaris.ldoms.write`

[1] Refers to all the resources you can add, list, remove, or set.

Controlling Access to a Domain Console by Using Rights

By default, any user can access all domain consoles. To control access to a domain console, configure the `vntsd` daemon to perform authorization checking. The `vntsd` daemon provides a Service Management Facility (SMF) property named `vntsd/authorization`. This property can be configured to enable authorization checking of users and roles for a domain console or a console group. To enable authorization checking, use the `svccfg` command to set the value of this property to `true`. While this option is enabled, `vntsd` listens and accepts connections only on `localhost`. If the `listen_addr` property specifies an alternative IP address when `vntsd/authorization` is enabled, `vntsd` ignores the alternative IP address and continues to listen only on `localhost`.

Caution – Do *not* configure the `vntsd` service to use a host other than `localhost`.

If you specify a host other than `localhost`, you are no longer restricted from connecting to guest domain consoles from the control domain. If you use the `telnet` command to remotely connect to a guest domain, the login credentials are passed as clear text over the network.

By default, an authorization to access all guest consoles is present in the local authorization description database.

```
solaris.vntsd.consoles:::Access All LDoms Guest Consoles::
```

Use the `usermod` command to assign the required authorizations to users or roles in local files. This command permits only the user or role who has the required authorizations to access a given domain console or console group. To assign authorizations to users or roles in a naming service, see *System Administration Guide: Naming and Directory Services (DNS, NIS, and LDAP)*.

You can control the access to all domain consoles or to a single domain console.

- To control the access to all domain consoles, see "How to Control Access to All Domain Consoles by Using Roles" on page 48 and "How to Control Access to All Domain Consoles by Using Rights Profiles" on page 50.
- To control access to a single domain console, see "How to Control Access to a Single Console by Using Roles" on page 52 and "How to Control Access to a Single Console by Using Rights Profiles" on page 53.

▼ How to Control Access to All Domain Consoles by Using Roles

1 Restrict access to a domain console by enabling console authorization checking.

```
primary# svccfg -s vntsd setprop vntsd/authorization = true
primary# svcadm refresh vntsd
primary# svcadm restart vntsd
```

2 Create a role that has the `solaris.vntsd.consoles` authorization, which permits access to all domain consoles.

```
primary# roleadd -A solaris.vntsd.consoles role-name
primary# passwd all_cons
```

3 Assign the new role to a user.

```
primary# usermod -R role-name username
```

Example 3–2 Controlling Access to All Domain Consoles by Using Roles

First, enable console authorization checking to restrict access to a domain console.

```
primary# svccfg -s vntsd setprop vntsd/authorization = true
primary# svcadm refresh vntsd
primary# svcadm restart vntsd
primary# ldm ls
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  UART    8     16G      0.2%  47m
ldg1             active     -n--v-  5000    2     1G       0.1%  17h 50m
ldg2             active     -t----  5001    4     2G        25%  11s
```

The following example shows how to create the `all_cons` role with the `solaris.vntsd.consoles` authorization, which permits access to all domain consoles.

```
primary# roleadd -A solaris.vntsd.consoles all_cons
primary# passwd all_cons
New Password:
Re-enter new Password:
passwd: password successfully changed for all_cons
```

This command assigns the `all_cons` role to the `sam` user.

```
primary# usermod -R all_cons sam
```

User `sam` assumes the `all_cons` role and can access any console. For example:

```
$ id
uid=700299(sam) gid=1(other)
$ su all_cons
Password:
$ telnet localhost 5000
Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.

Connecting to console "ldg1" in group "ldg1" ....
Press ~? for control options ..

$ telnet localhost 5001
Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.

Connecting to console "ldg2" in group "ldg2" ....
Press ~? for control options ..
```

This example shows what happens when an unauthorized user, `dana`, attempts to access a domain console:

```
$ id
uid=702048(dana) gid=1(other)
$ telnet localhost 5000
Trying 0.0.0.0...
```

```
Connected to 0.
Escape character is '^]'.
Connection to 0 closed by foreign host.
```

How to Control Access to All Domain Consoles by Using Rights Profiles

1. **Restrict access to a domain console by enabling console authorization checking.**

   ```
   primary# svccfg -s vntsd setprop vntsd/authorization = true
   primary# svcadm refresh vntsd
   primary# svcadm restart vntsd
   ```

2. **Create a rights profile with the `solaris.vntsd.consoles` authorization.**

   - **Oracle Solaris 10 OS: Edit the `/etc/security/prof_attr` file.**

     Include the following entry:

     ```
     LDoms Consoles:::Access LDoms Consoles:auths=solaris.vntsd.consoles
     ```

   - **Oracle Solaris 11 OS: Use the `profiles` command to create a new profile.**

     ```
     primary# profiles -p "LDoms Consoles" \
     'set desc="Access LDoms Consoles"; set auths=solaris.vntsd.consoles'
     ```

3. **Assign the rights profile to a user.**

   - **Oracle Solaris 10 OS: Assign the rights profile to a user.**

     ```
     primary# usermod -P "All,Basic Solaris User,LDoms Consoles" username
     ```

     Be careful to specify any pre-existing profiles when adding the `LDoms Consoles` profile. The previous command shows that the user already had the `All` and `Basic Solaris User` profiles.

   - **Oracle Solaris 11 OS: Assign the rights profile to a user.**

     ```
     primary# usermod -P +"LDoms Consoles" username
     ```

4. **Connect to the domain console as the user.**

   ```
   $ telnet localhost 5000
   ```

Example 3–3 Controlling Access to All Domain Consoles by Using Rights Profiles

The following examples show how to use rights profiles to control access to all domain consoles:

- **Oracle Solaris 10:** Create a rights profile with the `solaris.vntsd.consoles` authorization by adding the following entry to the `/etc/security/prof_attr` file:

  ```
  LDoms Consoles:::Access LDoms Consoles:auths=solaris.vntsd.consoles
  ```

Assign the rights profile to *username*.

```
primary# usermod -P "All,Basic Solaris User,LDoms Consoles" username
```

The following commands show how to verify that the user is `sam` and that the `All`, `Basic Solaris User`, and `LDoms Consoles` rights profiles are in effect. The `telnet` command shows how to access the `ldg1` domain console.

```
$ id
uid=702048(sam) gid=1(other)
$ profiles
All
Basic Solaris User
LDoms Consoles
$ telnet localhost 5000
Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.

Connecting to console "ldg1" in group "ldg1" ....
Press ~? for control options ..
```

- **Oracle Solaris 11:** Use the `profiles` command to create a rights profile with the `solaris.vntsd.consoles` authorization in the rights profile description database.

  ```
  primary# profiles -p "LDoms Consoles" \
  'set desc="Access LDoms Consoles"; set auths=solaris.vntsd.consoles'
  ```

  Assign the rights profile to a user.

  ```
  primary# usermod -P +"LDoms Consoles" sam
  ```

  The following commands show how to verify that the user is `sam` and that the `All`, `Basic Solaris User`, and `LDoms Consoles` rights profiles are in effect. The `telnet` command shows how to access the `ldg1` domain console.

  ```
  $ id
  uid=702048(sam) gid=1(other)
  $ profiles
  All
  Basic Solaris User
  LDoms Consoles
  $ telnet localhost 5000
  Trying 0.0.0.0...
  Connected to 0.
  Escape character is '^]'.

  Connecting to console "ldg1" in group "ldg1" ....
  Press ~? for control options ..
  ```

▼ How to Control Access to a Single Console by Using Roles

1. **Restrict access to a domain console by enabling console authorization checking.**

```
primary# svccfg -s vntsd setprop vntsd/authorization = true
primary# svcadm refresh vntsd
primary# svcadm restart vntsd
```

2. **Add an authorization for a single domain to the authorization description database.**

   The authorization name is derived from the name of the domain and has the form `solaris.vntsd.console-`*domain-name*:

```
solaris.vntsd.console-domain-name:::Access domain-name Console::
```

3. **Create a role with the new authorization to permit access only to the console of the domain.**

```
primary# roleadd -A solaris.vntsd.console-domain-name role-name
primary# passwd role-name
New Password:
Re-enter new Password:
passwd: password successfully changed for role-name
```

4. **Assign the *role-name* role to a user.**

```
primary# usermod -R role-name username
```

Example 3–4 Accessing a Single Domain Console

This example shows how user `terry` assumes the `ldg1cons` role and accesses the `ldg1` domain console.

First, add an authorization for a single domain, `ldg1`, to the authorization description database.

```
solaris.vntsd.console-ldg1:::Access ldg1 Console::
```

Then, create a role with the new authorization to permit access only to the console of the domain.

```
primary# roleadd -A solaris.vntsd.console-ldg1 ldg1cons
primary# passwd ldg1cons
New Password:
Re-enter new Password:
passwd: password successfully changed for ldg1cons
```

Assign the `ldg1cons` role to user `terry`, assume the `ldg1cons` role, and access the domain console.

```
primary# usermod -R ldg1cons terry
primary# su terry
Password:
```

```
$ id
uid=700300(terry) gid=1(other)
$ su ldg1cons
Password:
$ id
uid=700303(ldg1cons) gid=1(other)
$ telnet localhost 5000
Trying 0.0.0.0...
Escape character is '^]'.

Connecting to console "ldg1" in group "ldg1" ....
Press ~? for control options ..
```

The following example shows that the user `terry` cannot access the `ldg2` domain console:

```
$ telnet localhost 5001
Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.
Connection to 0 closed by foreign host.
```

How to Control Access to a Single Console by Using Rights Profiles

1 Restrict access to a domain console by enabling console authorization checking.

```
primary# svccfg -s vntsd setprop vntsd/authorization = true
primary# svcadm refresh vntsd
primary# svcadm restart vntsd
```

2 Add an authorization for a single domain to the authorization description database.

The following example entry adds the authorization for a domain console:

`solaris.vntsd.console-`*domain-name*`:::Access` *domain-name* `Console::`

3 Create a rights profile with an authorization to access a specific domain console.

- **Oracle Solaris 10 OS: Edit the `/etc/security/prof_attr` file.**

  domain-name `Console:::Access` *domain-name*
  `Console:auths=solaris.vntsd.console-`*domain-name*

  This entry must be on a single line.

- **Oracle Solaris 11 OS: Use the `profiles` command to create a new profile.**

  ```
  primary# profiles -p "domain-name Console" \
  'set desc="Access domain-name Console";
  set auths=solaris.vntsd.console-domain-name'
  ```

4 **Assign the rights profile to a user.**

The following commands assign the profile to a user:

- **Oracle Solaris 10 OS: Assign the rights profile.**

  ```
  primary# usermod -P "All,Basic Solaris User,domain-name Console" username
  ```

  Note that the `All` and `Basic Solaris User` profiles are required.

- **Oracle Solaris 11 OS: Assign the rights profile.**

  ```
  primary# usermod -P +"domain-name Console" username
  ```

Enabling and Using Auditing

The Logical Domains Manager uses the Oracle Solaris OS auditing feature to examine the history of actions and events that have occurred on your control domain. The history is kept in a log that tracks what was done, when it was done, by whom, and what was affected.

You can enable and disable the auditing feature based on the version of the Oracle Solaris OS that runs on your system, as follows:

- **Oracle Solaris 10 OS:** Use the `bsmconv` and `bsmunconv` commands. See the `bsmconv`(1M) and `bsmunconv`(1M) man pages, and Part VII, "Auditing in Oracle Solaris," in *System Administration Guide: Security Services*.
- **Oracle Solaris 11 OS:** Use the `audit` command. See the `audit`(1M) man page and Part VII, "Auditing in Oracle Solaris," in *Oracle Solaris 11.1 Administration: Security Services*.

▼ How to Enable Auditing

You must configure and enable the Oracle Solaris auditing feature on your system. Oracle Solaris 11 auditing is enabled by default, but you must still perform some configuration steps.

Note – Pre-existing processes are *not* audited for the virtualization software (`vs`) class. Ensure that you perform this step *before* regular users log in to the system.

---

1 **Add customizations to the `/etc/security/audit_event` and `/etc/security/audit_class` files.**

These customizations are preserved across Oracle Solaris upgrades, but should be re-added after a fresh Oracle Solaris installation.

a. **Add the following entry to the `audit_event` file if not already present:**

```
40700:AUE_ldoms:ldoms administration:vs
```

b. Add the following entry to the `audit_class` file if not already present:

```
0x10000000:vs:virtualization_software
```

2 (Oracle Solaris 10) Add the `vs` class to the `/etc/security/audit_control` file.

The following example `/etc/security/audit_control` fragment shows how you might specify the `vs` class:

```
dir:/var/audit
flags:lo,vs
minfree:20
naflags:lo,na
```

3 (Oracle Solaris 10) Enable the auditing feature.

a. Run the `bsmconv` command.

```
# /etc/security/bsmconv
```

b. Reboot the system.

4 (Oracle Solaris 11) Preselect the `vs` audit class.

a. Determine which auditing classes are already selected.

Ensure that any audit classes that have already been selected are part of the updated set of classes. The following example shows that the `lo` class is already selected:

```
# auditconfig -getflags
active user default audit flags = lo(0x1000,0x1000)
configured user default audit flags = lo(0x1000,0x1000)
```

b. Add the `vs` auditing class.

```
# auditconfig -setflags [class],vs
```

class is zero or more audit classes, separated by commas. You can see the list of audit classes in the `/etc/security/audit_class` file. Be sure to include the `vs` class on your Oracle VM Server for SPARC system.

For example, the following command selects both the `lo` and `vs` classes:

```
# auditconfig -setflags lo,vs
```

c. (Optional) Log out of the system if you want to audit your processes, either as the administrator or as the configurer.

If you do not want to log out, see "How to Update the Preselection Mask of Logged In Users" in *Oracle Solaris 11.1 Administration: Security Services*.

5 Verify that the auditing software is running.

```
# auditconfig -getcond
```

If the auditing software is running, `audit condition = auditing` appears in the output.

How to Disable Auditing

- **Disable the auditing feature.**
  - **Oracle Solaris 10 OS:**
    a. **Run the `bsmunconv` command.**

```
# /etc/security/bsmunconv
Are you sure you want to continue? [y/n] y
This script is used to disable the Basic Security Module (BSM).
Shall we continue the reversion to a non-BSM system now? [y/n] y
bsmunconv: INFO: removing c2audit:audit_load from /etc/system.
bsmunconv: INFO: stopping the cron daemon.

The Basic Security Module has been disabled.
Reboot this system now to come up without BSM.
```

    b. **Reboot the system.**
  - **Oracle Solaris 11 OS:**
    a. **Run the `audit -t` command.**

```
# audit -t
```

    b. **Verify that the auditing software is no longer running.**

```
# auditconfig -getcond
audit condition = noaudit
```

How to Review Audit Records

- **Use one of the following methods to review `vs` audit output:**
  - **Use the `auditreduce` and `praudit` commands to review audit output.**

```
# auditreduce -c vs | praudit
# auditreduce -c vs -a 20060502000000 | praudit
```

  - **Use the `praudit -x` command to print audit records in XML form.**

How to Rotate Audit Logs

- **Use the `audit -n` command to rotate audit logs.**

  Rotating the audit logs closes the current audit file and opens a new one in the current audit directory.

Using Domain Console Logging

In an Oracle VM Server for SPARC environment, console I/O from the `primary` domain is directed to the service processor (SP). The console I/O from all other domains is redirected to the service domain that runs the virtual console concentrator, `vcc`. If the service domain runs the Oracle Solaris 11 OS, the guest domain console output can be logged to a file.

Service domains support console logging for logical domains. While the service domain must run the Oracle Solaris 11 OS, the guest domain being logged can run either the Oracle Solaris 10 OS or the Oracle Solaris 11 OS.

The domain console log is saved to a file on the service domain called `/var/log/vntsd/`*domain-name*`/console-log` that provides the `vcc` service. You can rotate console log files by using the `logadm` command. See the `logadm`(1M) and `logadm.conf`(4) man pages.

The Oracle VM Server for SPARC software enables you to selectively enable and disable console logging for each logical domain. Console logging is enabled by default.

▼ How to Enable or Disable Console Logging

You must enable or disable console logging for each individual logical domain even if the domains belong to the same console group.

1 List the current console settings for the domain.

```
primary# ldm list -o console domain
```

2 Stop and unbind the domain.

The domain must be in an inactive and unbound state before you modify the console settings.

```
primary# ldm stop domain
primary# ldm unbind domain
```

3 Enable or disable console logging.

- **To enable console logging.**

  ```
  primary# ldm set-vcons log=on domain
  ```

- **To disable console logging.**

  ```
  primary# ldm set-vcons log=off domain
  ```

Service Domain Requirements for Domain Console Logging

A domain that is attached to a service domain that runs an OS version older than Oracle Solaris 11.1 *cannot* be logged.

Note – Even if you enable console logging for a domain, the domain's virtual console is not logged if the required support is not available on the service domain.

◆ ◆ ◆ CHAPTER 4

Setting Up Services and the Control Domain

This chapter describes the procedures necessary to set up default services and your control domain.

You can also use the Oracle VM Server for SPARC Configuration Assistant to configure logical domains and services. See Chapter 15, "Oracle VM Server for SPARC Configuration Assistant (Oracle Solaris 10)."

This chapter covers the following topics:

Output Messages

If a resource cannot be dynamically configured on the control domain, the recommended practice is to first initiate a delayed reconfiguration. The delayed reconfiguration postpones the configuration activities until after the control domain has been rebooted.

You receive the following message when you initiate a delayed reconfiguration on the `primary` domain:

```
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the
primary domain reboots, at which time the new configuration for the
primary domain also takes effect.
```

You receive the following notice after every subsequent operation on the `primary` domain until reboot:

```
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
```

Creating Default Services

The following virtual device services must be created to use the control domain as a service domain and to create virtual devices for other domains:

- `vcc` – Virtual console concentrator service
- `vds` – Virtual disk server
- `vsw` – Virtual switch service

▼ How to Create Default Services

1 **Create a virtual console concentrator (`vcc`) service for use by the virtual network terminal server daemon (`vntsd`) and as a concentrator for all logical domain consoles.**

For example, the following command would add a virtual console concentrator service (`primary-vcc0`) with a port range from 5000 to 5100 to the control domain (`primary`).

```
primary# ldm add-vcc port-range=5000-5100 primary-vcc0 primary
```

2 **Create a virtual disk server (`vds`) to allow importing virtual disks into a logical domain.**

For example, the following command adds a virtual disk server (`primary-vds0`) to the control domain (`primary`).

```
primary# ldm add-vds primary-vds0 primary
```

3 **Create a virtual switch service (`vsw`) to enable networking between virtual network (`vnet`) devices in logical domains.**

Assign a GLDv3-compliant network adapter to the virtual switch if each logical domain must communicate outside the box through the virtual switch.

- In Oracle Solaris 10, add a virtual switch service on network adapter driver to the control domain.

  ```
  primary# ldm add-vsw net-dev=net-driver vsw-service primary
  ```

  For example, the following command adds a virtual switch service (`primary-vsw0`) on network adapter driver `nxge0` to the control domain (`primary`):

  ```
  primary# ldm add-vsw net-dev=nxge0 primary-vsw0 primary
  ```

- In Oracle Solaris 11, add a virtual switch service (`primary-vsw0`) on network adapter driver `net0` to the control domain (`primary`):

  ```
  primary# ldm add-vsw net-dev=net-driver vsw-service primary
  ```

  For example, the following command adds a virtual switch service (`primary-vsw0`) on network adapter driver `net0` to the control domain (`primary`):

```
primary# ldm add-vsw net-dev=net0 primary-vsw0 primary
```

- The following process applies to the Oracle Solaris 10 OS only and should *not* be performed on an Oracle Solaris 11 system.

  This command automatically allocates a MAC address to the virtual switch. You can specify your own MAC address as an option to the `ldm add-vsw` command. However, in that case, you are responsible for ensuring that the MAC address specified does not conflict with an already existing MAC address.

  If the virtual switch being added replaces the underlying physical adapter as the primary network interface, it must be assigned the MAC address of the physical adapter so that the Dynamic Host Configuration Protocol (DHCP) server assigns the domain the same IP address. See "Enabling Networking Between the Control/Service Domain and Other Domains" on page 63.

  ```
  primary# ldm add-vsw mac-addr=2:04:4f:fb:9f:0d net-dev=nxge0 primary-vsw0 primary
  ```

4 Verify the services have been created by using the `list-services` subcommand.

Your output should look similar to the following:

```
primary# ldm list-services primary
VDS
    NAME             VOLUME         OPTIONS          DEVICE
    primary-vds0

VCC
    NAME             PORT-RANGE
    primary-vcc0     5000-5100

VSW
    NAME             MAC               NET-DEV   DEVICE     MODE
    primary-vsw0     02:04:4f:fb:9f:0d nxge0     switch@0   prog,promisc
```

Initial Configuration of the Control Domain

Initially, all system resources are allocated to the control domain. To allow the creation of other logical domains, you must release some of these resources.

Do *not* attempt to use memory dynamic reconfiguration (DR) to perform the initial configuration of the control domain. Although you can use memory DR to perform this configuration without needing a reboot, the memory DR approach might take a very long time (longer than a reboot) and could even potentially fail. Instead, use the `ldm start-reconf` command to place the control domain in delayed reconfiguration mode before you change the memory configuration. Then, you can reboot the control domain after you complete all the configuration steps.

▼ How to Configure the Control Domain

Note – This procedure contains examples of resources to set for your control domain. These numbers are examples only, and the values used might not be appropriate for your control domain.

1. **Determine whether you have cryptographic devices in the control domain.**

   Note that only UltraSPARC T2, UltraSPARC T2 Plus, and SPARC T3 platforms have cryptographic devices (MAUs). Because newer platforms such as SPARC T4 systems and Fujitsu M10 systems do not have separate cryptographic units, you do not need to assign a cryptographic accelerator on these platforms.

   ```
   primary# ldm list -o crypto primary
   ```

2. **Assign cryptographic resources to the control domain, if applicable.**

   The following example would assign one cryptographic resource to the control domain, `primary`. This setup leaves the remainder of the cryptographic resources available to a guest domain.

   ```
   primary# ldm set-mau 1 primary
   ```

3. **Assign virtual CPUs to the control domain.**

   For example, the following command would assign eight virtual CPUs to the control domain, `primary`. This setup leaves the remainder of the virtual CPUs available to a guest domain.

   ```
   primary# ldm set-vcpu 8 primary
   ```

4. **Initiate a delayed reconfiguration on the control domain.**

   ```
   primary# ldm start-reconf primary
   ```

5. **Assign memory to the control domain.**

   For example, the following command would assign 4 Gbytes of memory to the control domain, `primary`. This setup leaves the remainder of the memory available to a guest domain.

   ```
   primary# ldm set-memory 4G primary
   ```

6. **Add a logical domain machine configuration to the service processor (SP).**

   For example, the following command would add a configuration called `initial`.

   ```
   primary# ldm add-config initial
   ```

7. **Verify that the configuration is ready to be used at the next reboot.**

   ```
   primary# ldm list-config
   factory-default
   initial [current]
   ```

   This `ldm list-config` command shows that the `initial` configuration set will be used after you perform a power cycle.

Rebooting to Use Domains

You must reboot the control domain for the configuration changes to take effect and for the resources to be released for other logical domains to use.

▼ How to Reboot

- **Shut down and reboot the control domain.**

```
primary# shutdown -y -g0 -i6
```

Note – Either a reboot or power cycle instantiates the new configuration. Only a power cycle actually boots the configuration saved to the service processor (SP), which is then reflected in the `list-config` output.

Enabling Networking Between the Control/Service Domain and Other Domains

Caution – This section applies only to an Oracle Solaris 10 system. Do *not* configure the `vsw` interface on an Oracle Solaris 11 system.

By default, networking between the control domain and other domains in the system is disabled. To enable networking, the virtual switch device should be configured as a network device. The virtual switch can either replace the underlying physical device (`nxge0` in this example) as the primary interface or be configured as an additional network interface in the domain.

Guest domains can automatically communicate with the control domain or service domain as long as the corresponding network back-end device is configured in the same virtual LAN or virtual network.

How to Configure the Virtual Switch as the Primary Interface

Note – Perform the following procedure from the control domain's console, as the procedure could temporarily disrupt network connectivity to the domain.

If necessary, you can configure the virtual switch as well as the physical network device. In this case, create the virtual switch as in Step 2, and do not delete the physical device (skip Step 3). You must then configure the virtual switch with either a static IP address or a dynamic IP address. You can obtain a dynamic IP address from a DHCP server. For additional information and an example of this case, see "Configuring a Virtual Switch and the Service Domain for NAT and Routing" on page 204.

1. **Print the addressing information for all interfaces.**

   ```
   primary# ifconfig -a
   ```

2. **Configure the virtual switch network interface.**

   ```
   primary# ifconfig vsw0 plumb
   ```

3. **Remove the physical interface for the device that is assigned to the virtual switch (`net-dev`).**

   ```
   primary# ifconfig nxge0 down unplumb
   ```

4. **To migrate properties of the physical network device (`nxge0`) to the virtual switch device (`vsw0`), do one of the following:**

   - **If networking is configured by using a static IP address, reuse the IP address and netmask of `nxge0` for the virtual switch.**

     ```
     primary# ifconfig vsw0 IP-of-nxge0 netmask netmask-of-nxge0 broadcast + up
     ```

   - **If networking is configured by using DHCP, enable DHCP for the virtual switch.**

     ```
     primary# ifconfig vsw0 dhcp start
     ```

5. **Make the required configuration file modifications to make this change permanent.**

   ```
   primary# mv /etc/hostname.nxge0 /etc/hostname.vsw0
   primary# mv /etc/dhcp.nxge0 /etc/dhcp.vsw0
   ```

Enabling the Virtual Network Terminal Server Daemon

You must enable the virtual network terminal server daemon (`vntsd`) to provide access to the virtual console of each logical domain. Refer to the `vntsd`(1M) man page for information about how to use this daemon.

▼ How to Enable the Virtual Network Terminal Server Daemon

Note – Be sure that you have created the default service `vconscon` (`vcc`) on the control domain before you enable `vntsd`. See "Creating Default Services" on page 60 for more information.

1. **Enable the virtual network terminal server daemon, `vntsd`.**

```
primary# svcadm enable vntsd
```

2. **Verify that the `vntsd` daemon is enabled.**

```
primary# svcs vntsd
STATE          STIME    FMRI
online         Oct_08   svc:/ldoms/vntsd:default
```

◆ ◆ ◆ CHAPTER 5

Setting Up Guest Domains

This chapter describes the procedures necessary to set up guest domains.

You can also use the Oracle VM Server for SPARC Configuration Assistant to configure logical domains and services. See Chapter 15, "Oracle VM Server for SPARC Configuration Assistant (Oracle Solaris 10)."

This chapter covers the following topics:

Creating and Starting a Guest Domain

The guest domain must run an operating system that is compatible with both the `sun4v` platform and the virtual devices presented by the hypervisor. Currently, this requirement means that you must run at least the Oracle Solaris 10 11/06 OS. Running the Oracle Solaris 10 1/13 OS provides you with all the Oracle VM Server for SPARC 3.1 features. See *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* for any specific patches that might be necessary. Once you have created default services and reallocated resources from the control domain, you can create and start a guest domain.

▼ How to Create and Start a Guest Domain

1 Create a logical domain.

The following command would create a guest domain named `ldg1`.

```
primary# ldm add-domain ldg1
```

2 **Add CPUs to the guest domain.**

Do one of the following:

- **Add virtual CPUs.**

  The following command would add eight virtual CPUs to guest domain `ldg1`.

  ```
  primary# ldm add-vcpu 8 ldg1
  ```

- **Add whole cores.**

  The following command would add two whole cores to guest domain `ldg1`.

  ```
  primary# ldm add-core 2 ldg1
  ```

3 **Add memory to the guest domain.**

The following command would add 2 gigabytes of memory to guest domain `ldg1`.

```
primary# ldm add-memory 2G ldg1
```

4 **Add a virtual network device to the guest domain.**

The following command would add a virtual network device with these specifics to the guest domain `ldg1`.

```
primary# ldm add-vnet vnet1 primary-vsw0 ldg1
```

Where:

- `vnet1` is a unique interface name to the logical domain, assigned to this virtual network device instance for reference on subsequent `set-vnet` or `remove-vnet` subcommands.
- `primary-vsw0` is the name of an existing network service (virtual switch) to which to connect.

Note – Steps 5 and 6 are simplified instructions for adding a virtual disk server device (`vdsdev`) to the primary domain and a virtual disk (`vdisk`) to the guest domain. To learn how ZFS volumes and file systems can be used as virtual disks, see "How to Export a ZFS Volume as a Single-Slice Disk" on page 168 and "Using ZFS With Virtual Disks" on page 177.

---

5 **Specify the device to be exported by the virtual disk server as a virtual disk to the guest domain.**

You can export a physical disk, disk slice, volumes, or file as a block device. The following examples show a physical disk and a file.

- **Physical Disk Example.** This example adds a physical disk with these specifics:

  ```
  primary# ldm add-vdsdev /dev/dsk/c2t1d0s2 vol1@primary-vds0
  ```

Where:

- `/dev/dsk/c2t1d0s2` is the path name of the actual physical device. When adding a device, the path name must be paired with the device name.
- `vol1` is a unique name you must specify for the device being added to the virtual disk server. The volume name must be unique to this virtual disk server instance because this name is exported by this virtual disk server to the clients for adding. When adding a device, the volume name must be paired with the path name of the actual device.
- `primary-vds0` is the name of the virtual disk server to which to add this device.

- **File Example.** This example exports a file as a block device.

```
primary# ldm add-vdsdev backend vol1@primary-vds0
```

Where:

- *backend* is the path name of the actual file exported as a block device. When adding a device, the back end must be paired with the device name.
- `vol1` is a unique name you must specify for the device being added to the virtual disk server. The volume name must be unique to this virtual disk server instance because this name is exported by this virtual disk server to the clients for adding. When adding a device, the volume name must be paired with the path name of the actual device.
- `primary-vds0` is the name of the virtual disk server to which to add this device.

6 Add a virtual disk to the guest domain.

The following example adds a virtual disk to the guest domain `ldg1`.

```
primary# ldm add-vdisk vdisk1 vol1@primary-vds0 ldg1
```

Where:

- `vdisk1` is the name of the virtual disk.
- `vol1` is the name of the existing volume to which to connect.
- `primary-vds0` is the name of the existing virtual disk server to which to connect.

Note – The virtual disks are generic block devices that are associated with different types of physical devices, volumes, or files. A virtual disk is not synonymous with a SCSI disk and, therefore, excludes the target ID in the disk label. Virtual disks in a logical domain have the following format: c*N*d*N*s*N*, where c*N* is the virtual controller, d*N* is the virtual disk number, and s*N* is the slice.

---

7 Set the `auto-boot?` and `boot-device` variables for the guest domain.

The following example command sets `auto-boot?` to `true` for guest domain `ldg1`.

```
primary# ldm set-var auto-boot\?=true ldg1
```

The following example command sets `boot-device` to `vdisk1` for guest domain `ldg1`.

```
primary# ldm set-var boot-device=vdisk1 ldg1
```

8 Bind resources to the guest domain `ldg1` and then list the domain to verify that it is bound.

```
primary# ldm bind-domain ldg1
primary# ldm list-domain ldg1
NAME          STATE    FLAGS  CONS   VCPU MEMORY   UTIL  UPTIME
ldg1          bound    -----  5000   8    2G
```

9 To find the console port of the guest domain, you can look at the output of the preceding `list-domain` subcommand.

You can see under the heading `CONS` that logical domain guest 1 (`ldg1`) has its console output bound to port `5000`.

10 Connect to the console of a guest domain from another terminal by logging into the control domain and connecting directly to the console port on the local host.

```
$ ssh hostname.domain-name
$ telnet localhost 5000
```

11 Start the guest domain `ldg1`.

```
primary# ldm start-domain ldg1
```

Installing Oracle Solaris OS on a Guest Domain

This section describes the different methods for installing the Oracle Solaris OS on a guest domain.

Caution – Do *not* disconnect from the virtual console during the installation of the Oracle Solaris OS.

For Oracle Solaris 11 domains, use the `DefaultFixed` network configuration profile (NCP). You can enable this profile during or after installation.

During the Oracle Solaris 11 installation, select the Manual networking configuration. After the Oracle Solaris 11 installation, ensure that the `DefaultFixed` NCP is enabled by using the `netadm list` command. See *Connecting Systems Using Fixed Network Configuration in Oracle Solaris 11.1* and *Connecting Systems Using Reactive Network Configuration in Oracle Solaris 11.1*.

▼ How to Install the Oracle Solaris OS on a Guest Domain From a DVD

1 Insert the Oracle Solaris 10 OS or Oracle Solaris 11 OS DVD into the DVD drive.

2 Stop the volume management daemon, `vold`(1M), on the `primary` domain.

```
primary# svcadm disable volfs
```

3 Stop and unbind the guest domain (`ldg1`).

```
primary# ldm stop ldg1
primary# ldm unbind ldg1
```

4 Add the DVD with the DVD-ROM media as a secondary volume and virtual disk.

The following example uses `c0t0d0s2` as the DVD drive in which the Oracle Solaris media resides, `dvd_vol@primary-vds0` as a secondary volume, and `vdisk_cd_media` as a virtual disk.

```
primary# ldm add-vdsdev options=ro /dev/dsk/c0t0d0s2 dvd_vol@primary-vds0
primary# ldm add-vdisk vdisk_cd_media dvd_vol@primary-vds0 ldg1
```

5 Verify that the DVD is added as a secondary volume and virtual disk.

```
primary# ldm list-bindings
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   -n-cv   SP      4     4G       0.2%  22h 45m
...
VDS
   NAME             VOLUME         OPTIONS          DEVICE
   primary-vds0     vol1                            /dev/dsk/c2t1d0s2
   dvd_vol                                          /dev/dsk/c0t0d0s2
....
------------------------------------------------------------------------------
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
ldg1             inactive -----           60    6G
...
DISK
   NAME             VOLUME                     TOUT DEVICE  SERVER
   vdisk1           vol1@primary-vds0
   vdisk_cd_media   dvd_vol@primary-vds0
....
```

6 Bind and start the guest domain (`ldg1`).

```
primary# ldm bind ldg1
primary# ldm start ldg1
LDom ldg1 started
primary# telnet localhost 5000
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Connecting to console "ldg1" in group "ldg1" ....
Press ~? for control options ..
```

7 Show the device aliases in the client OpenBoot PROM.

In this example, see the device aliases for `vdisk_cd_media`, which is the Oracle Solaris DVD, and `vdisk1`, which is a virtual disk on which you can install the Oracle Solaris OS.

```
ok devalias
vdisk_cd_media  /virtual-devices@100/channel-devices@200/disk@1
vdisk1          /virtual-devices@100/channel-devices@200/disk@0
vnet1           /virtual-devices@100/channel-devices@200/network@0
virtual-console /virtual-devices/console@1
name            aliases
```

8 On the guest domain's console, boot from `vdisk_cd_media` (`disk@1`) on slice `f`.

```
ok boot vdisk_cd_media:f
Boot device: /virtual-devices@100/channel-devices@200/disk@1:f  File and args: -s
SunOS Release 5.10 Version Generic_139555-08 64-bit
Copyright (c), 1983-2010, Oracle and/or its affiliates.  All rights reserved.
```

9 Continue with the Oracle Solaris OS installation.

▼ How to Install the Oracle Solaris OS on a Guest Domain From an Oracle Solaris ISO File

1 Stop and unbind the guest domain (`ldg1`).

```
primary# ldm stop ldg1
primary# ldm unbind ldg1
```

2 Add the Oracle Solaris ISO file as a secondary volume and virtual disk.

The following example uses `solarisdvd.iso` as the Oracle Solaris ISO file, `iso_vol@primary-vds0` as a secondary volume, and `vdisk_iso` as a virtual disk:

```
primary# ldm add-vdsdev /export/solarisdvd.iso  iso_vol@primary-vds0
primary# ldm add-vdisk vdisk_iso iso_vol@primary-vds0 ldg1
```

3 Verify that the Oracle Solaris ISO file is added as a secondary volume and virtual disk.

```
primary# ldm list-bindings
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   -n-cv   SP      4     4G       0.2%  22h 45m
...
VDS
   NAME             VOLUME         OPTIONS          DEVICE
   primary-vds0     vol1                            /dev/dsk/c2t1d0s2
   iso_vol                                          /export/solarisdvd.iso
....
------------------------------------------------------------------------------
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
ldg1             inactive -----           60    6G
...
DISK
   NAME       VOLUME               TOUT ID DEVICE  SERVER  MPGROUP
   vdisk1     vol1@primary-vds0
```

```
   vdisk_iso  iso_vol@primary-vds0
....
```

4 **Bind and start the guest domain (`ldg1`).**

```
primary# ldm bind ldg1
primary# ldm start ldg1
LDom ldg1 started
primary# telnet localhost 5000
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Connecting to console "ldg1" in group "ldg1" ....
Press ~? for control options ..
```

5 **Show the device aliases in the client OpenBoot PROM.**

In this example, see the device aliases for `vdisk_iso`, which is the Oracle Solaris ISO image, and `vdisk_install`, which is the disk space.

```
ok devalias
vdisk_iso       /virtual-devices@100/channel-devices@200/disk@1
vdisk1          /virtual-devices@100/channel-devices@200/disk@0
vnet1           /virtual-devices@100/channel-devices@200/network@0
virtual-console /virtual-devices/console@1
name            aliases
```

6 **On the guest domain's console, boot from `vdisk_iso` (`disk@1`) on slice `f`.**

```
ok boot vdisk_iso:f
Boot device: /virtual-devices@100/channel-devices@200/disk@1:f  File and args: -s
SunOS Release 5.10 Version Generic_139555-08 64-bit
Copyright (c) 1983-2010, Oracle and/or its affiliates.  All rights reserved.
```

7 **Continue with the Oracle Solaris OS installation.**

▼ How to Use the Oracle Solaris JumpStart Feature on an Oracle Solaris 10 Guest Domain

Note – The Oracle Solaris JumpStart feature is available only for the Oracle Solaris 10 OS. See *Oracle Solaris 10 8/11 Installation Guide: Custom JumpStart and Advanced Installations*.

To perform an automated installation of the Oracle Solaris 11 OS, you can use the Automated Installer (AI) feature. See *Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.1 Automated Installer*.

- **Modify your JumpStart profile to reflect the different disk device name format for the guest domain.**

  Virtual disk device names in a logical domain differ from physical disk device names. Virtual disk device names do not contain a target ID (`t`*N*). Instead of the usual `c`*N*`t`*N*`d`*N*`s`*N* format, virtual disk device names use the `c`*N*`d`*N*`s`*N* format. `c`*N* is the virtual controller, `d`*N* is the virtual disk number, and `s`*N* is the slice number.

  Note – A virtual disk can appear either as a full disk or as a single-slice disk. The Oracle Solaris OS can be installed on a full disk by using a regular JumpStart profile that specifies multiple partitions. A single-slice disk only has a single partition, `s0`, that uses the entire disk. To install the Oracle Solaris OS on a single disk, you must use a profile that has a single partition (`/`) that uses the entire disk. You cannot define any other partitions, such as swap. For more information about full disks and single-slice disks, see "Virtual Disk Appearance" on page 161.

  - **JumpStart profile for installing a UFS root file system.**

    See *Oracle Solaris 10 8/11 Installation Guide: Custom JumpStart and Advanced Installations*.

    Normal UFS Profile

    ```
    filesys c1t1d0s0 free /
    filesys c1t1d0s1 2048 swap
    filesys c1t1d0s5 120 /spare1
    filesys c1t1d0s6 120 /spare2
    ```

    Actual UFS Profile for Installing a Domain on a Full Disk

    ```
    filesys c0d0s0 free /
    filesys c0d0s1 2048 swap
    filesys c0d0s5 120 /spare1
    filesys c0d0s6 120 /spare2
    ```

    Actual UFS Profile for Installing a Domain on a Single-Slice Disk

    ```
    filesys c0d0s0 free /
    ```

  - **JumpStart profile for installing a ZFS root file system.**

    See Chapter 9, "Installing a ZFS Root Pool With JumpStart," in *Oracle Solaris 10 8/11 Installation Guide: Custom JumpStart and Advanced Installations*.

    Normal ZFS Profile

    ```
    pool rpool auto 2G 2G c1t1d0s0
    ```

    Actual ZFS Profile for Installing a Domain

    ```
    pool rpool auto 2G 2G c0d0s0
    ```

◆ ◆ ◆ CHAPTER 6

Setting Up I/O Domains

This chapter describes I/O domains and how to configure them in an Oracle VM Server for SPARC environment.

This chapter covers the following topics:

I/O Domain Overview

An I/O domain has direct ownership of and direct access to physical I/O devices. It can be created by assigning a PCI EXPRESS (PCIe) bus, a PCIe endpoint device, or a PCIe SR-IOV virtual function to a domain. Use the `ldm add-io` command to assign a bus, device, or virtual function to a domain.

You might want to configure I/O domains for the following reasons:

- An I/O domain has direct access to a physical I/O device, which avoids the performance overhead that is associated with virtual I/O. As a result, the I/O performance on an I/O domain more closely matches the I/O performance on a bare-metal system.
- An I/O domain can host virtual I/O services to be used by guest domains.

For information about configuring I/O domains, see the following:

- "Creating a Root Domain by Assigning PCIe Buses" on page 76
- "Creating an I/O Domain by Assigning PCIe Endpoint Devices" on page 82

Note – You cannot migrate an I/O domain that is configured with PCIe endpoint devices. For information about other migration limitations, see Chapter 9, "Migrating Domains."

General Guidelines for Creating an I/O Domain

An I/O domain might have direct access to one or more I/O devices, such as PCIe buses, network interface units (NIUs), PCIe endpoint devices, and PCIe single root I/O virtualization (SR-IOV) virtual functions.

This type of direct access to I/O devices means that more I/O bandwidth is available to provide the following:

- Services to the applications in the I/O domain
- Virtual I/O services to guest domains

The following basic guidelines enable you to effectively use the I/O bandwidth:

- Assign CPU resources at the granularity of CPU cores. Assign one or more CPU cores based on the type of I/O device and the number of I/O devices in the I/O domain.

  For example, a 1-Gbps Ethernet device might require fewer CPU cores to use the full bandwidth compared to a 10-Gbps Ethernet device.
- Abide by memory requirements. Memory requirements depend on the type of I/O device that is assigned to the domain. A minimum of 4 Gbytes is recommended per I/O device. The more I/O devices you assign, the more memory you must allocate.
- When you use the PCIe SR-IOV feature, follow the same guidelines for each SR-IOV virtual function that you would use for other I/O devices. So, assign one or more CPU cores and memory (in Gbytes) to fully use the bandwidth that is available from the virtual function.

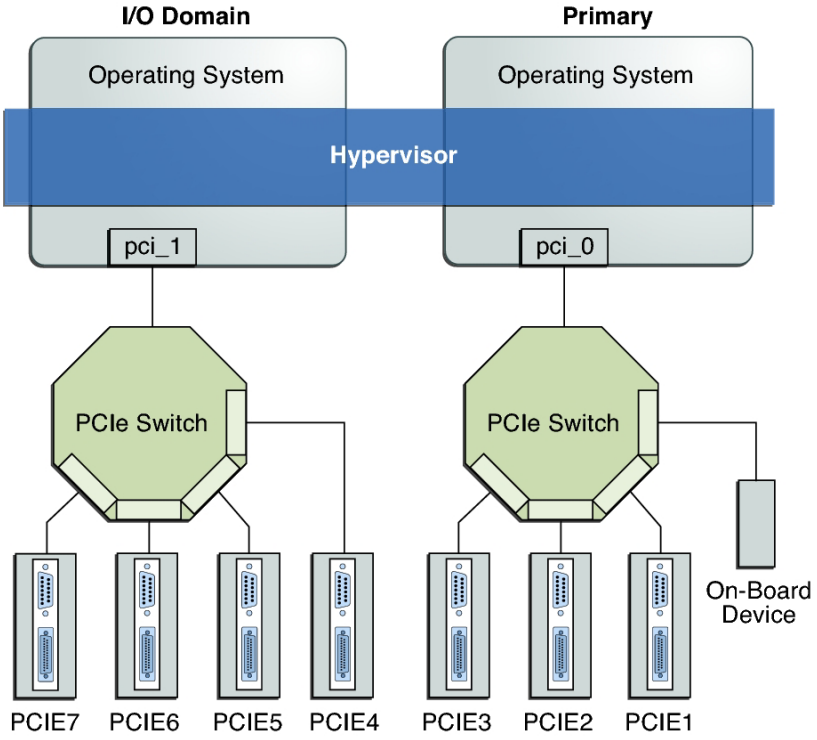
Note that creating and assigning a large number of virtual functions to a domain that does not have sufficient CPU and memory resources is unlikely to produce an optimal configuration.

Creating a Root Domain by Assigning PCIe Buses

You can use the Oracle VM Server for SPARC software to assign an entire PCIe bus (also known as a *root complex*) to a domain. An entire PCIe bus consists of the PCIe bus itself and all of its PCI switches and devices. PCIe buses that are present on a server are identified with names such as `pci@400` (`pci_0`). An I/O domain that is configured with an entire PCIe bus is also known as a *root domain*.

The following diagram shows a system that has two root complexes, `pci_0` and `pci_1`.

FIGURE 6–1 Assigning a PCIe Bus to an I/O Domain



The maximum number of I/O domains that you can create with PCIe buses depends on the number of PCIe buses that are available on the server. For example, if you are using an Oracle Sun SPARC Enterprise T5440 server, you can have up to four I/O domains.

Note – Some UltraSPARC servers have only one PCIe bus. In such cases, you can create an I/O domain by assigning a PCIe endpoint (or direct I/O-assignable) device to a domain. See "Creating an I/O Domain by Assigning PCIe Endpoint Devices" on page 82. If the system has a Network Interface Unit (NIU), you can also assign an NIU to a domain to create an I/O domain.

When you assign a PCIe bus to an I/O domain, all devices on that bus are owned by that I/O domain. You can assign any of the PCIe endpoint devices on that bus to other domains.

When a server is initially configured in an Oracle VM Server for SPARC environment or is using the `factory-default` configuration, the `primary` domain has access to all the physical device resources. Therefore, the `primary` domain is the only I/O domain configured on the system and it owns all the PCIe buses.

How to Create an I/O Domain by Assigning a PCIe Bus

This example procedure shows how to create a new I/O domain from an initial configuration where several buses are owned by the `primary` domain. By default the `primary` domain owns all buses present on the system. This example is for a SPARC T4-2 server. This procedure can also be used on other servers. The instructions for different servers might vary slightly from these, but you can obtain the basic principles from this example.

First, you must retain the bus that has the `primary` domain's boot disk. Then, you remove another bus from the `primary` domain and assign it to another domain.

Caution – All internal disks on the supported servers might be connected to a single PCIe bus. If a domain is booted from an internal disk, do not remove that bus from the domain. Also, ensure that you are not removing a bus with devices (such as network ports) that are used by a domain. If you remove the wrong bus, a domain might not be able to access the required devices and could become unusable. To remove a bus that has devices that are used by a domain, reconfigure that domain to use devices from other buses. For example, you might have to reconfigure the domain to use a different on-board network port or a PCIe card from a different PCIe slot.

In this example, the `primary` domain uses only a ZFS pool (`rpool`) and network interface (`igb0`). If the `primary` domain uses more devices, repeat Steps 2-4 for each device to ensure that none are located on the bus that will be removed.

You can add a bus to or remove a bus from a domain by using its device path (`pci@`*nnn*) or its pseudonym (`pci_`*n*). The `ldm list-bindings primary` or `ldm list -l -o physio primary` command shows the following:

- `pci@400` corresponds to `pci_0`
- `pci@500` corresponds to `pci_1`
- `pci@600` corresponds to `pci_2`
- `pci@700` corresponds to `pci_3`

1 Verify that the `primary` domain owns more than one PCIe bus.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
pci_0                                     BUS    pci_0    primary
pci_1                                     BUS    pci_1    primary
pci_2                                     BUS    pci_2    primary
pci_3                                     BUS    pci_3    primary
/SYS/MB/PCIE1                             PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA0                           PCIE   pci_0    primary  OCC
/SYS/MB/NET0                              PCIE   pci_0    primary  OCC
/SYS/MB/PCIE5                             PCIE   pci_1    primary  EMP
/SYS/MB/PCIE6                             PCIE   pci_1    primary  EMP
/SYS/MB/PCIE7                             PCIE   pci_1    primary  EMP
```

```
/SYS/MB/PCIE2                          PCIE   pci_2    primary  EMP
/SYS/MB/PCIE3                          PCIE   pci_2    primary  EMP
/SYS/MB/PCIE4                          PCIE   pci_2    primary  EMP
/SYS/MB/PCIE8                          PCIE   pci_3    primary  EMP
/SYS/MB/SASHBA1                        PCIE   pci_3    primary  OCC
/SYS/MB/NET2                           PCIE   pci_3    primary  OCC
/SYS/MB/NET0/IOVNET.PF0                PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF0                PF     pci_3    primary
/SYS/MB/NET2/IOVNET.PF1                PF     pci_3    primary
```

2 Determine the device path of the boot disk that must be retained.

- **For UFS file systems, run the `df /` command to determine the device path of the boot disk.**

```
primary# df /
/                  (/dev/dsk/c0t5000CCA03C138904d0s0):22755742 blocks  2225374 files
```

- **For ZFS file systems, first run the `df /` command to determine the pool name. Then, run the `zpool status` command to determine the device path of the boot disk.**

```
primary# zpool status rpool
  pool: rpool
 state: ONLINE
  scan: none requested
config:

        NAME                       STATE     READ WRITE CKSUM
        rpool                      ONLINE       0     0     0
          c0t5000CCA03C138904d0s0  ONLINE       0     0     0
```

3 Obtain information about the system's boot disk.

- **For a disk that is managed with Solaris I/O multipathing, determine the PCIe bus under which the boot disk is connected by using the `mpathadm` command.**

  Starting with the SPARC T3 servers, the internal disks are managed by Solaris I/O multipathing.

  a. Find the initiator port to which the disk is connected.

```
primary# mpathadm show lu /dev/rdsk/c0t5000CCA03C138904d0s0
Logical Unit:  /dev/rdsk/c0t5000CCA03C138904d0s2
        mpath-support:  libmpscsi_vhci.so
        Vendor:  HITACHI
        Product:  H106030SDSUN300G
        Revision:  A2B0
        Name Type:  unknown type
        Name:  5000cca03c138904
        Asymmetric:  no
        Current Load Balance:  round-robin
        Logical Unit Group ID:  NA
        Auto Failback:  on
        Auto Probing:  NA

        Paths:
```

```
                Initiator Port Name:  w50800200014100c8
                Target Port Name:  w5000cca03c138905
                Override Path:  NA
                Path State:  OK
                Disabled:  no

        Target Ports:
                Name:  w5000cca03c138905
                Relative ID:  0
```

b. Determine the PCIe bus on which the initiator port is present.

```
primary# mpathadm show initiator-port w50800200014100c8
Initiator Port:  w50800200014100c8
        Transport Type:  unknown
        OS Device File:  /devices/pci@400/pci@2/pci@0/pci@e/scsi@0/iport@1
```

- **For a disk that is not managed with Solaris I/O multipathing, determine the physical device to which the block device is linked by using the `ls -l` command.**

  Use this command for a disk on an UltraSPARC T2 or UltraSPARC T2 Plus system that is not managed with Solaris I/O multipathing.

  The following example uses block device `c1t0d0s0`:

```
primary# ls -l /dev/dsk/c0t1d0s0
lrwxrwxrwx   1 root     root          49 Oct  1 10:39 /dev/dsk/c0t1d0s0 ->
../../devices/pci@400/pci@0/pci@1/scsi@0/sd@1,0:a
```

  In this example, the physical device for the `primary` domain's boot disk is connected to the `pci@400` bus.

4 Determine the network interface that is used by the system.

Identify the primary network interface that is "plumbed" by using the `ifconfig` command. A plumbed interface has streams set up so that the IP protocol can use the device.

- **Oracle Solaris 10:**

```
primary# ifconfig -a
lo0: flags=2001000849<UP,LOOPBACK,RUNNING,MULTICAST,IPv4,VIRTUAL> mtu 8232 index 1
        inet 127.0.0.1 netmask ff000000
igb0: flags=1004843<UP,BROADCAST,RUNNING,MULTICAST,DHCP,IPv4> mtu 1500 index 3
        inet 10.129.241.135 netmask ffffff00 broadcast 10.129.241.255
        ether 0:10:e0:e:f1:78
```

- **Oracle Solaris 11:**

```
primary# ifconfig -a
lo0: flags=2001000849<UP,LOOPBACK,RUNNING,MULTICAST,IPv4,VIRTUAL> mtu 8232 index 1
        inet 127.0.0.1 netmask ff000000
net0: flags=1004843<UP,BROADCAST,RUNNING,MULTICAST,DHCP,IPv4> mtu 1500 index 3
        inet 10.129.241.135 netmask ffffff00 broadcast 10.129.241.255
        ether 0:10:e0:e:f1:78

primary# dladm show-phys net0
LINK              MEDIA               STATE      SPEED  DUPLEX    DEVICE
net0              Ethernet            up         1000   full      igb0
```

5 Determine the physical device to which the network interface is linked.

The following command uses the `igb0` network interface:

```
primary# ls -l /dev/igb0
lrwxrwxrwx   1 root     root          46 Oct  1 10:39 /dev/igb0  ->
../devices/pci@500/pci@0/pci@c/network@0:igb0
```

In this example, the physical device for the network interface used by the `primary` domain is under bus `pci@500`, which corresponds to the earlier listing of `pci_1`. So, the other two buses, `pci_2` (`pci@600`) and `pci_3` (`pci@700`), can safely be assigned to other domains because they are not used by the `primary` domain.

If the network interface used by the `primary` domain is on a bus that you want to assign to another domain, reconfigure the `primary` domain to use a different network interface.

6 Remove a bus that does not contain the boot disk or the network interface from the `primary` domain.

In this example, the `pci_2` bus is being removed from the `primary` domain. You must also initiate a delayed reconfiguration.

```
primary# ldm start-reconf primary
primary# ldm remove-io pci_2 primary
```

The bus that the `primary` domain uses for the boot disk and the network device cannot be assigned to other domains. You can assign any of the other buses to another domain. In this example, the `pci@600` is not used by the `primary` domain, so you can reassign it to another domain.

7 Save this configuration to the service processor.

In this example, the configuration is `io-domain`.

```
primary# ldm add-config io-domain
```

This configuration, `io-domain`, is also set as the next configuration to be used after the reboot.

8 Reboot the root domain so that the change takes effect.

```
primary# shutdown -i6 -g0 -y
```

9 Stop the domain to which you want to add the PCIe bus.

The following example stops the `ldg1` domain:

```
primary# ldm stop ldg1
```

10 Add the available bus to the domain that needs direct access.

The available bus is `pci_2` and the domain is `ldg1`.

```
primary# ldm add-io pci_2 ldg1
```

11 Restart the domain so that the change takes affect.

The following commands restart the `ldg1` domain:

```
primary# ldm start ldg1
```

12 Confirm that the correct bus is still assigned to the `primary` domain and that the correct bus is assigned to domain `ldg1`.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
pci_0                                     BUS    pci_0    primary
pci_1                                     BUS    pci_1    primary
pci_2                                     BUS    pci_2    ldg1
pci_3                                     BUS    pci_3    primary
/SYS/MB/PCIE1                             PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA0                           PCIE   pci_0    primary  OCC
/SYS/MB/NET0                              PCIE   pci_0    primary  OCC
/SYS/MB/PCIE5                             PCIE   pci_1    primary  EMP
/SYS/MB/PCIE6                             PCIE   pci_1    primary  EMP
/SYS/MB/PCIE7                             PCIE   pci_1    primary  EMP
/SYS/MB/PCIE2                             PCIE   pci_2    ldg1     EMP
/SYS/MB/PCIE3                             PCIE   pci_2    ldg1     EMP
/SYS/MB/PCIE4                             PCIE   pci_2    ldg1     EMP
/SYS/MB/PCIE8                             PCIE   pci_3    primary  EMP
/SYS/MB/SASHBA1                           PCIE   pci_3    primary  OCC
/SYS/MB/NET2                              PCIE   pci_3    primary  OCC
/SYS/MB/NET0/IOVNET.PF0                   PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                   PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF0                   PF     pci_3    primary
/SYS/MB/NET2/IOVNET.PF1                   PF     pci_3    primary
```

This output confirms that PCIe buses `pci_0`, `pci_1`, and `pci_3` and their devices are assigned to the `primary` domain. It also confirms that PCIe bus `pci_2` and its devices are assigned to the `ldg1` domain.

Creating an I/O Domain by Assigning PCIe Endpoint Devices

You can assign an individual PCIe endpoint (or direct I/O-assignable) device to a domain. This use of PCIe endpoint devices increases the granularity of the device assignment to I/O domains. This capability is delivered by means of the direct I/O (DIO) feature.

The DIO feature enables you to create more I/O domains than the number of PCIe buses in a system. The possible number of I/O domains is now limited only by the number of PCIe endpoint devices.

A PCIe endpoint device can be one of the following:

- A PCIe card in a slot
- An on-board PCIe device that is identified by the platform

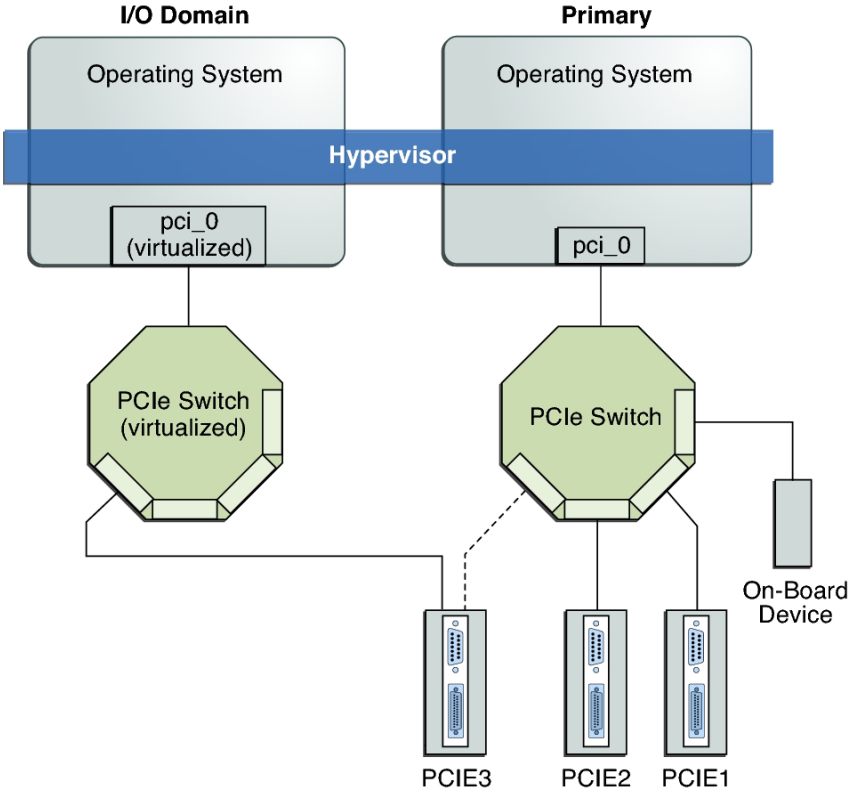
Note – Because root domains cannot have dependencies on other root domains, a root domain that owns a PCIe bus cannot have its PCIe endpoint devices or SR-IOV virtual functions assigned to another root domain. However, you *can* assign a PCIe endpoint device or virtual function from a PCIe bus to the root domain that owns that bus.

The following diagram shows that the PCIe endpoint device, `PCIE3`, is assigned to an I/O domain. Both bus `pci_0` and the switch in the I/O domain are virtual. The `PCIE3` endpoint device is no longer accessible in the `primary` domain.

In the I/O domain, the `pci_0` block and the switch are a virtual root complex and a virtual PCIe switch, respectively. This block and switch are similar to the `pci_0` block and the switch in the `primary` domain. In the `primary` domain, the devices in slot `PCIE3` are a "shadow" form of the original devices and are identified as `SUNW,assigned`.

Caution – You cannot use Oracle Solaris hot-plug operations to hot-remove a PCIe endpoint device after that device is removed from the `primary` domain by using the `ldm rm-io` command. For information about replacing or removing a PCIe endpoint device, see "Making PCIe Hardware Changes" on page 89.

FIGURE 6–2 Assigning a PCIe Endpoint Device to an I/O Domain



Use the `ldm list-io` command to list the PCIe endpoint devices.

Though the DIO feature permits any PCIe card in a slot to be assigned to an I/O domain, only certain PCIe cards are supported. See "Direct I/O Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Caution – PCIe cards that have a bridge are not supported. PCIe function-level assignment is also not supported. Assigning an unsupported PCIe card to an I/O domain might result in unpredictable behavior.

The following items describe important details about the DIO feature:

- This feature is enabled only when all the software requirements are met. See "Direct I/O Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- Only PCIe endpoints that are connected to a PCIe bus assigned to a root domain can be assigned to another domain with the DIO feature.
- I/O domains that use DIO have access to the PCIe endpoint devices only when the root domain is running.
- Rebooting the root domain affects I/O domains that have PCIe endpoint devices. See "Rebooting the Root Domain" on page 87. The root domain also performs the following tasks:
  - Initializes and manages the PCIe bus.
  - Handles all bus errors that are triggered by the PCIe endpoint devices that are assigned to I/O domains. Note that only the `primary` root domain receives all PCIe bus-related errors.

Direct I/O Hardware and Software Requirements

To successfully use the DIO feature, you must be running the appropriate software and assign only the PCIe cards that are supported by the DIO feature to I/O domains. For the hardware and software requirements, see "Direct I/O Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Note – All PCIe cards that are supported on a platform are supported in the `primary` domain. See the documentation for your platform for the list of supported PCIe cards. However, only direct I/O-supported PCIe cards can be assigned to I/O domains.

To add or remove PCIe endpoint devices by using the direct I/O feature, you must first enable I/O virtualization on the PCIe bus itself.

You can use the `ldm set-io` or `ldm add-io` command to set the `iov` property to `on`. You can also use the `ldm add-domain` or `ldm set-domain` command to set the `rc-add-policy` property to `iov`. See the `ldm(1M)` man page.

Rebooting the root domain affects direct I/O, so carefully plan your direct I/O configuration changes to maximize the direct I/O-related changes to the root domain and to minimize root domain reboots.

Current Direct I/O Feature Limitations

For information about how to work around the following limitations, see "Planning PCIe Endpoint Device Configuration" on page 86.

- Assignment or removal of a PCIe endpoint device to any non-root domain is permitted only when that domain is either stopped or inactive.

Planning PCIe Endpoint Device Configuration

Carefully plan ahead when you assign or remove PCIe endpoint devices to avoid `primary` domain downtime. The reboot of the `primary` domain not only affects the services that are available on the `primary` domain itself but also the I/O domains that have PCIe endpoint devices assigned. Though the changes to each I/O domain do not affect the other domains, planning ahead helps to minimize the consequences on the services that are provided by that domain.

When in a delayed reconfiguration, you can continue to add or remove more devices and then reboot the root domain only one time to make all the changes take effect.

For an example, see "How to Create an I/O Domain by Assigning a PCIe Endpoint Device" on page 89.

You must take the following general steps to plan and perform a DIO device configuration:

1. Understand and record your system hardware configuration.

   Specifically, record information about the part numbers and other details of the PCIe cards in the system.

   Use the `ldm list-io -l` and `prtdiag -v` commands to obtain the information and save it for future reference.
2. Determine which PCIe endpoint devices are required to be in the `primary` domain.

   For example, determine the PCIe endpoint devices that provide access to the following:

   - Boot disk device
   - Network device
   - Other devices that the `primary` domain offers as services
3. Remove all PCIe endpoint devices that you might use in I/O domains.

   This step helps you to avoid performing subsequent reboot operations on the root domain, because reboots affect I/O domains.

   Use the `ldm rm-io` command to remove the PCIe endpoint devices. Use pseudonyms rather than device paths to specify the devices to the `rm-io` and `add-io` subcommands.

Note – After you have removed all the devices you want during a delayed reconfiguration, you need to reboot the root domain only one time to make all the changes take effect.

4. Save this configuration to the service processor (SP).

   Use the `ldm add-config` command.

5. Reboot the root domain to release the PCIe endpoint devices that you removed in Step 3.
6. Confirm that the PCIe endpoint devices you removed are no longer assigned to the root domain.

   Use the `ldm list-io -l` command to verify that the devices you removed appear as `SUNW,assigned-device` in the output.

7. Assign an available PCIe endpoint device to a guest domain to provide direct access to the physical device.

   After you make this assignment, you can no longer migrate the guest domain to another physical system by means of the domain migration feature.

8. Add a PCIe endpoint device to or remove one from a guest domain.

   Use the `ldm add-io` command.

   Minimize the changes to I/O domains by reducing the reboot operations and by avoiding downtime of services offered by that domain.

9. (Optional) Make changes to the PCIe hardware.

   See "Making PCIe Hardware Changes" on page 89.

Rebooting the Root Domain

The root domain is the owner of the PCIe bus and is responsible for initializing and managing the bus. The root domain must be active and running a version of the Oracle Solaris OS that supports the DIO feature. Shutting down, halting, or rebooting the root domain interrupts access to the PCIe bus. When the PCIe bus is unavailable, the PCIe devices on that bus are affected and might become unavailable.

The behavior of I/O domains with PCIe endpoint devices is unpredictable when the root domain is rebooted while those I/O domains are running. For instance, I/O domains with PCIe endpoint devices might panic during or after the reboot. Upon reboot of the root domain, you would need to manually stop and start each domain.

To work around these issues, perform one of the following steps:

- Manually shut down any domains on the system that have PCIe endpoint devices assigned to them *before* you shut down the root domain.

  This step ensures that these domains are cleanly shut down before you shut down, halt, or reboot the root domain.

  To find all the domains that have PCIe endpoint devices assigned to them, run the `ldm list-io` command. This command enables you to list the PCIe endpoint devices that have been assigned to domains on the system. For a detailed description of this command output, see the `ldm(1M)` man page.

  For each domain found, stop the domain by running the `ldm stop` command.

- Configure a domain dependency relationship between the root domain and the domains that have PCIe endpoint devices assigned to them.

  This dependency relationship ensures that domains with PCIe endpoint devices are automatically restarted when the root domain reboots for any reason.

  Note that this dependency relationship forcibly resets those domains, and they cannot cleanly shut down. However, the dependency relationship does not affect any domains that were manually shut down.

  ```
  # ldm set-domain failure-policy=reset primary
  # ldm set-domain master=primary domain-name
  ```

EXAMPLE 6–1 Configuring Failure Policy Dependencies for a Configuration With a Non-primary Root Domain and I/O Domains

The following example describes how you can configure failure policy dependencies in a configuration that has a non-`primary` root domain and I/O domains.

In this example, `ldg1` is a non-`primary` root domain. `ldg2` is an I/O domain that has either PCIe SR-IOV virtual functions or PCIe endpoint devices assigned from a root complex that is owned by the `ldg1` domain.

```
primary# ldm set-domain failure-policy=stop primary
primary# ldm set-domain failure-policy=stop ldg1
primary# ldm set-domain master=primary ldg1
primary# ldm set-domain master=primary,ldg1 ldg2
```

This dependency relationship ensures that the I/O domain is stopped when either the `primary` domain or the non-`primary` root domain reboots.

- If it is the non-`primary` root domain rebooting, this dependency relationship ensures that the I/O domain is stopped. Start the I/O domain after the non-`primary` root domain boots.

  ```
  primary# ldm start ldg2
  ```

- If it is the `primary` root domain rebooting, this policy setting stops both the non-`primary` root domain and the dependent I/O domains. When the `primary` domain boots, you must start the non-`primary` root domain first. When the domain boots, start the I/O domain.

EXAMPLE 6–1 Configuring Failure Policy Dependencies for a Configuration With a Non-primary Root Domain and I/O Domains *(Continued)*

```
primary# ldm start ldg1
```

Wait for the `ldg1` domain to become active and then start the I/O domain.

```
primary# ldm start ldg2
```

Making PCIe Hardware Changes

The following steps help you avoid misconfiguring the PCIe endpoint assignments. For platform-specific information about installing and removing specific hardware, see the documentation for your platform.

- No action is required if you are installing a PCIe card into an empty slot. This PCIe card is automatically owned by the domain that owns the PCIe bus.

  To assign the new PCIe card to an I/O domain, use the `ldm rm-io` command to first remove the card from the root domain. Then, use the `ldm add-io` command to assign the card to an I/O domain.
- No action is required if a PCIe card is removed from the system and assigned to the root domain.
- To remove a PCIe card that is assigned to an I/O domain, first remove the device from the I/O domain. Then, add the device to the root domain before you physically remove the device from the system.
- To replace a PCIe card that is assigned to an I/O domain, verify that the new card is supported by the DIO feature.

  If so, no action is required to automatically assign the new card to the current I/O domain.

  If not, first remove that PCIe card from the I/O domain by using the `ldm rm-io` command. Next, use the `ldm add-io` command to reassign that PCIe card to the root domain. Then, physically replace the PCIe card you assigned to the root domain with a different PCIe card. These steps enable you to avoid a configuration that is unsupported by the DIO feature.

▼ How to Create an I/O Domain by Assigning a PCIe Endpoint Device

Plan all DIO deployments ahead of time to minimize downtime.

Caution – The `primary` domain loses access to the on-board DVD device if you assign the `/SYS/MB/SASHBA1` slot on a SPARC T3-1 or a SPARC T4-1 system to a DIO domain.

The SPARC T3-1 and SPARC T4-1 systems include two DIO slots for on-board storage, which are represented by the `/SYS/MB/SASHBA0` and `/SYS/MB/SASHBA1` paths. In addition to hosting multiheaded on-board disks, the `/SYS/MB/SASHBA1` slot hosts the on-board DVD device. So, if you assign `/SYS/MB/SASHBA1` to a DIO domain, the `primary` domain loses access to the on-board DVD device.

The SPARC T3-2 and SPARC T4-2 systems have a single `SASHBA` slot that hosts all on-board disks as well as the on-board DVD device. So, if you assign `SASHBA` to a DIO domain, the on-board disks *and* the on-board DVD device are loaned to the DIO domain and unavailable to the `primary` domain.

For an example of adding a PCIe endpoint device to create an I/O domain, see "Planning PCIe Endpoint Device Configuration" on page 86.

Note – In this release, use the `DefaultFixed` NCP to configure datalinks and network interfaces on Oracle Solaris 11 systems.

The Oracle Solaris 11 OS includes the following NCPs:

- `DefaultFixed` – Enables you to use the `dladm` or `ipadm` command to manage networking
- `Automatic` – Enables you to use the `netcfg` or `netadm` command to manage networking

Ensure that the `DefaultFixed` NCP is enabled by using the `netadm list` command. See Chapter 7, "Using Datalink and Interface Configuration Commands on Profiles," in *Oracle Solaris Administration: Network Interfaces and Network Virtualization*.

1 Identify and archive the devices that are currently installed on the system.

The output of the `ldm list-io -l` command shows how the I/O devices are currently configured. You can obtain more detailed information by using the `prtdiag -v` command.

Note – After the devices are assigned to I/O domains, the identity of the devices can be determined only in the I/O domains.

```
primary# ldm list-io -l
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
niu_0                                     NIU    niu_0    primary
[niu@480]
niu_1                                     NIU    niu_1    primary
[niu@580]
```

```
pci_0                                    BUS    pci_0    primary
[pci@400]
pci_1                                    BUS    pci_1    primary
[pci@500]
/SYS/MB/PCIE0                            PCIE   pci_0    primary  OCC
[pci@400/pci@2/pci@0/pci@8]
    SUNW,emlxs@0/fp/disk
    SUNW,emlxs@0/fp/tape
    SUNW,emlxs@0/fp@0,0
    SUNW,emlxs@0,1/fp/disk
    SUNW,emlxs@0,1/fp/tape
    SUNW,emlxs@0,1/fp@0,0
/SYS/MB/PCIE2                            PCIE   pci_0    primary  OCC
[pci@400/pci@2/pci@0/pci@4]
    pci/scsi/disk
    pci/scsi/tape
    pci/scsi/disk
    pci/scsi/tape
/SYS/MB/PCIE4                            PCIE   pci_0    primary  OCC
[pci@400/pci@2/pci@0/pci@0]
    ethernet@0
    ethernet@0,1
    SUNW,qlc@0,2/fp/disk
    SUNW,qlc@0,2/fp@0,0
    SUNW,qlc@0,3/fp/disk
    SUNW,qlc@0,3/fp@0,0
/SYS/MB/PCIE6                            PCIE   pci_0    primary  EMP
[pci@400/pci@1/pci@0/pci@8]
/SYS/MB/PCIE8                            PCIE   pci_0    primary  EMP
[pci@400/pci@1/pci@0/pci@c]
/SYS/MB/SASHBA                           PCIE   pci_0    primary  OCC
[pci@400/pci@2/pci@0/pci@e]
    scsi@0/iport@1
    scsi@0/iport@2
    scsi@0/iport@4
    scsi@0/iport@8
    scsi@0/iport@80/cdrom@p7,0
    scsi@0/iport@v0
/SYS/MB/NET0                             PCIE   pci_0    primary  OCC
[pci@400/pci@1/pci@0/pci@4]
    network@0
    network@0,1
/SYS/MB/PCIE1                            PCIE   pci_1    primary  OCC
[pci@500/pci@2/pci@0/pci@a]
    SUNW,qlc@0/fp/disk
    SUNW,qlc@0/fp@0,0
    SUNW,qlc@0,1/fp/disk
    SUNW,qlc@0,1/fp@0,0
/SYS/MB/PCIE3                            PCIE   pci_1    primary  OCC
[pci@500/pci@2/pci@0/pci@6]
    network@0
    network@0,1
    network@0,2
    network@0,3
/SYS/MB/PCIE5                            PCIE   pci_1    primary  OCC
[pci@500/pci@2/pci@0/pci@0]
    network@0
    network@0,1
/SYS/MB/PCIE7                            PCIE   pci_1    primary  EMP
```

```
[pci@500/pci@1/pci@0/pci@6]
/SYS/MB/PCIE9                              PCIE   pci_1    primary  EMP
[pci@500/pci@1/pci@0/pci@0]
/SYS/MB/NET2                               PCIE   pci_1    primary  OCC
[pci@500/pci@1/pci@0/pci@5]
    network@0
    network@0,1
    ethernet@0,80
/SYS/MB/NET0/IOVNET.PF0                    PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@4/network@0]
    maxvfs = 7
/SYS/MB/NET0/IOVNET.PF1                    PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@4/network@0,1]
    maxvfs = 7
/SYS/MB/PCIE5/IOVNET.PF0                   PF     pci_1    primary
[pci@500/pci@2/pci@0/pci@0/network@0]
    maxvfs = 63
/SYS/MB/PCIE5/IOVNET.PF1                   PF     pci_1    primary
[pci@500/pci@2/pci@0/pci@0/network@0,1]
    maxvfs = 63
/SYS/MB/NET2/IOVNET.PF0                    PF     pci_1    primary
[pci@500/pci@1/pci@0/pci@5/network@0]
    maxvfs = 7
/SYS/MB/NET2/IOVNET.PF1                    PF     pci_1    primary
[pci@500/pci@1/pci@0/pci@5/network@0,1]
    maxvfs = 7
```

2 Determine the device path of the boot disk that must be retained.

See Step 2 in "How to Create an I/O Domain by Assigning a PCIe Bus" on page 78.

3 Determine the physical device to which the block device is linked.

See Step 3 in "How to Create an I/O Domain by Assigning a PCIe Bus" on page 78.

4 Determine the network interface that is used by the system.

See Step 4 in "How to Create an I/O Domain by Assigning a PCIe Bus" on page 78.

5 Determine the physical device to which the network interface is linked.

The following command uses the `igb0` network interface:

```
primary# ls -l /dev/igb0
lrwxrwxrwx   1 root     root          46 Jul 30 17:29 /dev/igb0 ->
../devices/pci@500/pci@0/pci@8/network@0:igb0
```

In this example, the physical device for the network interface used by the `primary` domain is connected to the PCIe endpoint device (`pci@500/pci@0/pci@8`), which corresponds to the listing of `MB/NET0` in Step 1. So, you do not want to remove this device from the `primary` domain. You can safely assign all other PCIe devices to other domains because they are not used by the `primary` domain.

If the network interface used by the `primary` domain is on a bus that you want to assign to another domain, the `primary` domain would need to be reconfigured to use a different network interface.

6 Remove the PCIe endpoint devices that you might use in I/O domains.

In this example, you can remove the PCIE2, PCIE3, PCIE4, and PCIE5 endpoint devices because they are not being used by the primary domain.

a. Remove the PCIe endpoint devices.

Caution – Do not remove the devices that are used or required by the primary domain.

If you mistakenly remove the wrong devices, use the ldm cancel-reconf primary command to cancel the delayed reconfiguration on the primary domain.

You can remove multiple devices at one time to avoid multiple reboots.

```
primary# ldm start-reconf primary
primary# ldm set-io iov=on pci_1
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.
primary# ldm remove-io /SYS/MB/PCIE1 primary
------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------------
primary# ldm remove-io /SYS/MB/PCIE3 primary
------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------------
primary# ldm remove-io /SYS/MB/PCIE5 primary
------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------------
```

b. Save the new configuration to the service processor (SP).

The following command saves the configuration in a file called dio:

```
primary# ldm add-config dio
```

c. Reboot the system to reflect the removal of the PCIe endpoint devices.

```
primary# shutdown -i6 -g0 -y
```

7 Log in to the primary domain and verify that the PCIe endpoint devices are no longer assigned to the domain.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
niu_0                                     NIU    niu_0    primary
niu_1                                     NIU    niu_1    primary
pci_0                                     BUS    pci_0    primary
pci_1                                     BUS    pci_1    primary  IOV
```

```
/SYS/MB/PCIE0                          PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                          PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                          PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                          PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                          PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                         PCIE   pci_0    primary  OCC
/SYS/MB/NET0                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                          PCIE   pci_1             OCC
/SYS/MB/PCIE3                          PCIE   pci_1             OCC
/SYS/MB/PCIE5                          PCIE   pci_1             OCC
/SYS/MB/PCIE7                          PCIE   pci_1    primary  EMP
/SYS/MB/PCIE9                          PCIE   pci_1    primary  EMP
/SYS/MB/NET2                           PCIE   pci_1    primary  OCC
/SYS/MB/NET0/IOVNET.PF0                PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF0                PF     pci_1    primary
/SYS/MB/NET2/IOVNET.PF1                PF     pci_1    primary
```

Note – The `ldm list-io -l` output might show `SUNW,assigned-device` for the PCIe endpoint devices that were removed. Actual information is no longer available from the `primary` domain, but the domain to which the device is assigned has this information.

8 Assign a PCIe endpoint device to a domain.

a. Add the `PCIE3` device to the `ldg1` domain.

```
primary# ldm add-io /SYS/MB/PCIE3 ldg1
```

b. Bind and start the `ldg1` domain.

```
primary# ldm bind ldg1
primary# ldm start ldg1
LDom ldg1 started
```

9 Log in to the `ldg1` domain and verify that the device is available for use.

Verify that the network device is available and then configure the network device for use in the domain.

- **Oracle Solaris 10 OS: Run the following command:**

```
primary# dladm show-dev
nxge0           link: unknown   speed: 0     Mbps       duplex: unknown
nxge1           link: unknown   speed: 0     Mbps       duplex: unknown
nxge2           link: unknown   speed: 0     Mbps       duplex: unknown
nxge3           link: unknown   speed: 0     Mbps       duplex: unknown
```

- **Oracle Solaris 11 OS: Run the following command:**

```
primary# dladm show-phys
LINK              MEDIA               STATE      SPEED  DUPLEX    DEVICE
net0              Ethernet            unknown    0      unknown   nxge0
net1              Ethernet            unknown    0      unknown   nxge1
net2              Ethernet            unknown    0      unknown   nxge2
net3              Ethernet            unknown    0      unknown   nxge3
```

Creating an I/O Domain by Assigning PCIe SR-IOV Virtual Functions

Note – Because root domains cannot have dependencies on other root domains, a root domain that owns a PCIe bus cannot have its PCIe endpoint devices or SR-IOV virtual functions assigned to another root domain. However, you *can* assign a PCIe endpoint device or virtual function from a PCIe bus to the root domain that owns that bus.

SR-IOV Overview

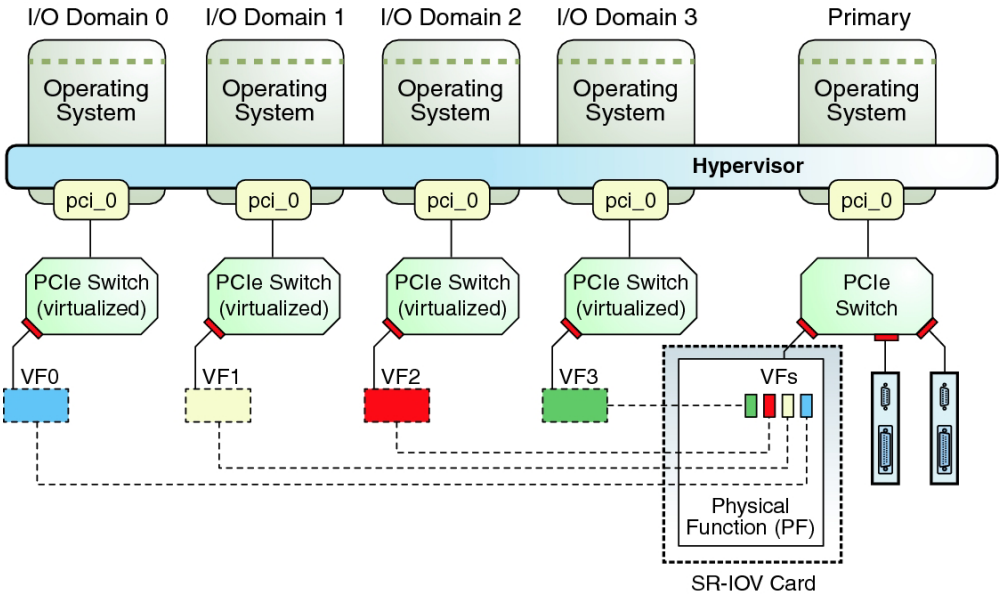
The Peripheral Component Interconnect Express (PCIe) single root I/O virtualization (SR-IOV) implementation is based on version 1.1 of the standard as defined by the PCI-SIG. The SR-IOV standard enables the efficient sharing of PCIe devices among virtual machines and is implemented in the hardware to achieve I/O performance that is comparable to native performance. The SR-IOV specification defines a new standard wherein new devices that are created enable the virtual machine to be directly connected to the I/O device.

A single I/O resource, which is known as a *physical function*, can be shared by many virtual machines. The shared devices provide dedicated resources and also use shared common resources. In this way, each virtual machine has access to unique resources. Therefore, a PCIe device, such as an Ethernet port, that is SR-IOV-enabled with appropriate hardware and OS support can appear as multiple, separate physical devices, each with its own PCIe configuration space.

For more information about SR-IOV, see the PCI-SIG web site (`http://www.pcisig.com/`).

The following figure shows the relationship between virtual functions and a physical function in an I/O domain.

FIGURE 6–3 Using Virtual Functions and a Physical Function in an I/O Domain



SR-IOV has the following function types:

- **Physical function** – A PCI function that supports the SR-IOV capabilities as defined by the SR-IOV specification. A physical function contains the SR-IOV capability structure and manages the SR-IOV functionality. Physical functions are fully featured PCIe functions that can be discovered, managed, and manipulated like any other PCIe device. Physical functions can be used to configure and control a PCIe device.
- **Virtual function** – A PCI function that is associated with a physical function. A virtual function is a lightweight PCIe function that shares one or more physical resources with the physical function and with virtual functions that are associated with that physical function. Unlike a physical function, a virtual function can only configure its own behavior.

Each SR-IOV device can have a physical function and each physical function can have up to 64,000 virtual functions associated with it. This number is dependent on the particular SR-IOV device. The virtual functions are created by the physical function.

After SR-IOV is enabled in the physical function, the PCI configuration space of each virtual function can be accessed by the bus, device, and function number of the physical function. Each virtual function has a PCI memory space, which is used to map its register set. The virtual function device drivers operate on the register set to enable its functionality and the virtual function appears as an actual PCI device. After creation, you can directly assign a virtual function to an I/O domain. This capability enables the virtual function to share the physical device and to perform I/O without CPU and hypervisor software overhead.

You might want to use the SR-IOV feature in your environment to reap the following benefits:

- **Higher performance and reduced latency** – Direct access to hardware from a virtual machines environment
- **Cost reduction** – Capital and operational expenditure savings, which include:
  - Power savings
  - Reduced adapter count
  - Less cabling
  - Fewer switch ports

The Oracle VM Server for SPARC SR-IOV implementation includes both static and dynamic configuration methods. For more information, see "Static SR-IOV" on page 98 and "Dynamic SR-IOV" on page 99.

The Oracle VM Server for SPARC SR-IOV feature enables you to perform the following operations:

- Creating a virtual function on a specified physical function
- Destroying a specified virtual function on a physical function
- Assigning a virtual function to a domain
- Removing a virtual function from a domain

To create and destroy virtual functions in the SR-IOV physical function devices, you must first enable I/O virtualization on that PCIe bus. You can use the `ldm set-io` or `ldm add-io` command to set the `iov` property to `on`. You can also use the `ldm add-domain` or `ldm set-domain` command to set the `rc-add-policy` property to `iov`. See the `ldm(1M)` man page.

SR-IOV Hardware and Software Requirements

For information about the required PCIe SR-IOV hardware, see "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

See the following for more information about static and dynamic SR-IOV software requirements:

- "Static SR-IOV Software Requirements" on page 99
- "Dynamic SR-IOV Software Requirements" on page 100

See the following for more information about the class-specific SR-IOV software requirements:

- "Ethernet SR-IOV Hardware Requirements" on page 103
- "InfiniBand SR-IOV Hardware Requirements" on page 121
- "Fibre Channel SR-IOV Hardware Requirements" on page 135

Current SR-IOV Feature Limitations

The SR-IOV feature has the following limitations in this release:

- Migration is disabled for any domain that has one or more virtual functions assigned to it.
- You can destroy only the last virtual function that was created for a physical function. So, if you create three virtual functions, the first virtual function that you can destroy must be the third one.
- Only Ethernet, InfiniBand, and Fibre Channel SR-IOV cards are supported.
- The SR-IOV feature is enabled only for the SR-IOV cards that are installed on a PCIe bus of a root domain. If an SR-IOV card is assigned to a domain by using the Direct I/O (DIO) feature, the SR-IOV feature is not enabled for that card.
- The PCIe endpoint devices and SR-IOV virtual functions from a particular PCIe bus can be assigned up to a maximum of 15 domains. The PCIe resources, such as interrupt vectors for each PCIe bus, are divided among the root domain and I/O domains. As a result, the number of devices that you can assign to a particular I/O domain is also limited. Make sure that you do not assign a large number virtual functions to the same I/O domain. For a description of the problems related to SR-IOV, see *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Static SR-IOV

The static SR-IOV method requires that the root domain be in delayed reconfiguration or the I/O domain be stopped while performing SR-IOV operations. After you complete the configuration steps on the root domain, you must reboot it. You must use this method when the Oracle VM Server for SPARC 3.1 firmware is not installed in the system or when the OS version that is installed in the respective domain does not support dynamic SR-IOV.

To create or destroy an SR-IOV virtual function, you first must initiate a delayed reconfiguration on the root domain. Then you can run one or more `ldm create-vf` and `ldm destroy-vf` commands to configure the virtual functions. Finally, reboot the root domain. The following commands show how to create a virtual function on a non-`primary` root domain:

```
primary# ldm start-reconf root-domain-name
primary# ldm create-vf pf-name
primary# ldm stop-domain -r root-domain-name
```

If the root domain is the `primary` domain, you must use the `shutdown` command to reboot it.

```
primary# shutdown -i6 -g0 -y
```

To statically add a virtual function to or remove one from a guest domain, you must first stop the guest domain. Then perform the `ldm add-io` and `ldm remove-io` commands to configure the virtual functions. After the changes are complete, start the domain. The following commands show how to assign a virtual function in this way:

```
primary# ldm stop guest-domain
primary# ldm add-io vf-name guest-domain
primary# ldm start guest-domain
```

You can also add a virtual function to or remove one from a root domain instead of a guest domain. To add an SR-IOV virtual function to or remove one from a root domain, first initiate a delayed reconfiguration on the root domain. Then, you can run one or more of the `ldm add-io` and `ldm remove-io` commands. Finally, reboot the root domain.

To minimize domain downtime, plan ahead before configuring virtual functions.

Note – InfiniBand SR-IOV devices are supported only with static SR-IOV.

Static SR-IOV Software Requirements

The static SR-IOV features are supported by the Oracle VM Server for SPARC 3.0 software and firmware. See "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.0 Release Notes*.

To create and destroy virtual functions in the SR-IOV physical function devices, you must first enable I/O virtualization on that PCIe bus.

You can use the `ldm set-io` or `ldm add-io` command to set the `iov` property to `on`. You can also use the `ldm add-domain` or `ldm set-domain` command to set the `rc-add-policy` property to `iov`. See the `ldm(1M)` man page.

Rebooting the root domain affects SR-IOV, so carefully plan your direct I/O configuration changes to maximize the SR-IOV related changes to the root domain and to minimize root domain reboots.

Dynamic SR-IOV

The dynamic SR-IOV feature removes the following static SR-IOV requirements:

- **Root domain.** Initate a delayed reconfiguration on the root domain, create or destroy a virtual function, and reboot the root domain
- **I/O domain.** Stop the I/O domain, add or remove a virtual function, and start the I/O domain

With dynamic SR-IOV you can dynamically create or destroy a virtual function without having to initiate a delayed reconfiguration on the root domain. A virtual function can also be dynamically added to or removed from an I/O domain without having to stop the domain. The Logical Domains Manager communicates with the Logical Domains agent and the Oracle Solaris I/O virtualization framework to effect these changes dynamically.

Note – You must plan ahead and enable I/O virtualization for any PCIe bus that you want to use before you begin to configure the physical functions and virtual functions.

Dynamic SR-IOV Software Requirements

For information about the required PCIe SR-IOV software and firmware versions, see "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Note – If your system does not meet the dynamic SR-IOV software and firmware requirements, you must use the static SR-IOV method to perform SR-IOV-related tasks. See "Static SR-IOV" on page 98.

Dynamic SR-IOV Configuration Requirements

To dynamically create or destroy a virtual function, ensure that the following conditions are met:

- I/O virtualization has been enabled for a PCIe bus before you begin to configure virtual functions.
- The OS that runs on the root domain and on I/O domains must be at least the Oracle Solaris 11.1.10.5.0 OS or the Oracle Solaris 10 1/13 OS plus the required patches in "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- The physical function device is not configured in the OS or is in a multipathing configuration. For example, you can unplumb an Ethernet SR-IOV device or have it in an IPMP or an aggregation to successfully create or destroy a virtual function.

  An operation to create or destroy a virtual function requires that the physical function device driver toggle between the offline and online states. A multipathing configuration permits the device driver to toggle between these states.
- The virtual function is either not in use or in a multipathing configuration before you remove a virtual function from an I/O domain. For example, you can either unplumb an Ethernet SR-IOV virtual function or not use it in an IPMP configuration.

  Note – You cannot use aggregation for Ethernet SR-IOV virtual functions because the current multipathing implementation does not support virtual functions.

Enabling I/O Virtualization

Before you can configure SR-IOV virtual functions, you must enable I/O virtualization for the PCIe bus while the root domain is in a delayed reconfiguration. Reboot the domain to make this change take effect.

▼ How to Enable I/O Virtualization for a PCIe Bus

This procedure needs to be performed only one time per root complex. The root complex must be running as part of the same SP configuration.

1 Initiate a delayed reconfiguration on the root domain.

```
primary# ldm start-reconf root-domain-name
```

2 Enable I/O virtualization operations for a PCIe bus.

Perform this step only if I/O virtualization is not enabled already for the bus that has the physical function.

Run one of the following commands:

- **Enable I/O virtualization if the specified PCIe bus already is assigned to a root domain.**

  ```
  primary# ldm set-io iov=on bus
  ```

- **Enable I/O virtualization while you add a PCIe bus to a root domain.**

  ```
  primary# ldm add-io iov=on bus
  ```

3 Reboot the root domain.

Run one of the following commands:

- **Reboot the non-`primary` root domain.**

  ```
  primary# ldm stop-domain -r root-domain
  ```

- **Reboot the `primary` root domain.**

  ```
  primary# shutdown -i6 -g0 -y
  ```

Planning for the Use of PCIe SR-IOV Virtual Functions

Plan ahead to determine how you want to use virtual functions in your configuration. Determine which virtual functions from the SR-IOV devices will satisfy your current and future configuration needs.

If you have not yet enabled I/O virtualization, which requires using the static method, combine this step with the steps to create virtual functions. By combining these steps, you need to reboot the root domain only once.

Even when dynamic SR-IOV is available, the recommended practice is to create all the virtual functions at once because you might not be able to create them dynamically after they have been assigned to I/O domains.

In the static SR-IOV case, planning helps you to avoid performing multiple root domain reboots, each of which might negatively affect I/O domains.

For information about I/O domains, see "General Guidelines for Creating an I/O Domain" on page 76.

Use the following general steps to plan and perform SR-IOV virtual function configuration and assignment:

1. Determine which PCIe SR-IOV physical functions are available on your system and which ones are best suited to your needs.

   Use the following commands to identify the required information:

`ldm list-io`	Identifies the available SR-IOV physical function devices.
`prtdiag -v`	Identifies which PCIe SR-IOV cards and on-board devices are available.
`ldm list-io -l` *pf-name*	Identifies additional information about a specified physical function, such as the maximum number of virtual functions that are supported by the device.
`ldm list-io -d` *pf-name*	Identifies the device-specific properties that are supported by the device. See "Advanced SR-IOV Topics: Ethernet SR-IOV" on page 114.

2. Enable I/O virtualization operations for a PCIe bus.

   See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

3. Create the required number of virtual functions on the specified SR-IOV physical function.

   Use the following command to create the virtual functions for the physical function:

   ```
   primary# ldm create-vf -n max pf-name
   ```

   For more information, see "How to Create an Ethernet SR-IOV Virtual Function" on page 104, "How to Create an InfiniBand Virtual Function" on page 121, and "How to Create a Fibre Channel SR-IOV Virtual Function" on page 138.

4. Use the `ldm add-config` command to save the configuration to the SP.

   For more information, see "How to Add an Ethernet SR-IOV Virtual Function to an I/O Domain" on page 112, "How to Add an InfiniBand Virtual Function to an I/O Domain" on page 126, and "How to Add a Fibre Channel SR-IOV Virtual Function to an I/O Domain" on page 144.

Using Ethernet SR-IOV Virtual Functions

You can use both the static and dynamic SR-IOV methods to manage Ethernet SR-IOV devices.

Ethernet SR-IOV Hardware Requirements

For information about the required PCIe Ethernet SR-IOV hardware, see "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Ethernet SR-IOV Limitations

You can enable VLAN configurations of virtual functions by setting either the `pvid` or the `vid` property. You cannot set both of these virtual function properties simultaneously.

Planning for the Use of Ethernet SR-IOV Virtual Functions

When dynamically creating virtual functions, ensure that the physical functions use multipathing or that they are not plumbed.

If you cannot use multipathing or must plumb the physical function, use the static method to create the virtual functions. See "Static SR-IOV" on page 98.

Ethernet Device-Specific and Network-Specific Properties

Use the `ldm create-vf` command to set device-specific and network-specific properties of a virtual function. The `unicast-slots` property is device-specific. The `mac-addr`, `alt-mac-addrs`, `mtu`, `pvid`, and `vid` properties are network-specific.

Note that the `mac-addr`, `alt-mac-addrs`, and `mtu` network-specific properties can be changed only when the virtual function is assigned to the `primary` domain while in a delayed reconfiguration.

Attempts to change these properties fail when the virtual function is assigned as follows:

- When the virtual function is assigned to an active I/O domain: A property change request is rejected because the change must be made when the owning domain is in the inactive or bound state.
- When the virtual function is assigned to a non-`primary` domain and a delayed reconfiguration is already in effect: A property change request fails with an error message.

The `pvid` and `vid` network-specific properties can be changed without restriction.

Creating Ethernet Virtual Functions

This section describes how to dynamically create and destroy virtual functions. If you cannot use the dynamic methods to perform these actions, initiate a delayed reconfiguration on the root domain before you create or destroy virtual functions.

▼ How to Create an Ethernet SR-IOV Virtual Function

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

1 Identify the physical function device.

```
primary# ldm list-io
```

Note that the name of the physical function includes the location information for the PCIe SR-IOV card or on-board device.

2 If I/O virtualization for the bus that has the physical function is not enabled already, enable it.

Perform this step only if I/O virtualization is not enabled already for the bus that has the physical function.

See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

3 Create a single virtual function or multiple virtual functions from an Ethernet physical function either dynamically or statically.

After you create one or more virtual functions, you can assign them to a guest domain.

- **Dynamic method:**
  - **To create multiple virtual functions from a physical function all at the same time, use the following command:**

    ```
    primary# ldm create-vf -n number | max pf-name
    ```

    Use the `ldm create-vf -n max` command to create all the virtual functions for that physical function at one time.

Caution – When your system uses an Intel 10-Gbit Ethernet card, maximize performance by creating no more than 31 virtual functions from each physical function.

You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

  - **To create one virtual function from a physical function, use the following command:**

```
primary# ldm create-vf [mac-addr=num] [alt-mac-addrs=[auto|num1,[auto|num2,...]]]
  [pvid=pvid] [vid=vid1,vid2,...] [mtu=size] [name=value...] pf-name
```

Note – If not explicitly assigned, the MAC address is automatically allocated for network devices.

Use this command to create one virtual function for that physical function. You can also manually specify Fibre Channel class-specific property values.

- **Static method:**

  a. **Initiate a delayed reconfiguration.**

     ```
     primary# ldm start-reconf root-domain-name
     ```

  b. **Create a single virtual function or multiple virtual functions from an Ethernet physical function.**

     Use the same commands as shown previously to dynamically create the virtual functions.

  c. **Reboot the root domain.**

     - **To reboot the non-`primary` root domain:**

       ```
       primary# ldm stop-domain -r root-domain
       ```

     - **To reboot the `primary` root domain:**

       ```
       primary# shutdown -i6 -g0 -y
       ```

Example 6–2 Displaying Information About the Ethernet Physical Function

This example shows information about the `/SYS/MB/NET0/IOVNET.PF0` physical function:

- This physical function is from an on-board `NET0` network device.
- The `IOVNET` string indicates that the physical function is a network SR-IOV device.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
niu_0                                     NIU    niu_0    primary
niu_1                                     NIU    niu_1    primary
pci_0                                     BUS    pci_0    primary
pci_1                                     BUS    pci_1    primary
/SYS/MB/PCIE0                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                             PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                             PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                            PCIE   pci_0    primary  OCC
/SYS/MB/NET0                              PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                             PCIE   pci_1    primary  OCC
```

```
/SYS/MB/PCIE3                              PCIE   pci_1    primary  OCC
/SYS/MB/PCIE5                              PCIE   pci_1    primary  OCC
/SYS/MB/PCIE7                              PCIE   pci_1    primary  EMP
/SYS/MB/PCIE9                              PCIE   pci_1    primary  EMP
/SYS/MB/NET2                               PCIE   pci_1    primary  OCC
/SYS/MB/NET0/IOVNET.PF0                    PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                    PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0                   PF     pci_1    primary
/SYS/MB/PCIE5/IOVNET.PF1                   PF     pci_1    primary
/SYS/MB/NET2/IOVNET.PF0                    PF     pci_1    primary
/SYS/MB/NET2/IOVNET.PF1                    PF     pci_1    primary
```

The following command shows more details about the specified physical function. The `maxvfs` value indicates the maximum number of virtual functions that is supported by the device.

```
primary# ldm list-io -l /SYS/MB/NET0/IOVNET.PF0
NAME                                       TYPE   BUS      DOMAIN   STATUS
----                                       ----   ---      ------   ------
/SYS/MB/NET0/IOVNET.PF0                    PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@4/network@0]
    maxvfs = 7
```

Example 6–3 Dynamically Creating an Ethernet Virtual Function Without Setting Optional Properties

This example dynamically creates a virtual function without setting any optional properties. In this case, the MAC address for a network class virtual function is automatically allocated.

Ensure that I/O virtualization is enabled on the `pci_0` PCIe bus. See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

Now, you can use the `ldm create-vf` command to create the virtual function from the `/SYS/MB/NET0/IOVNET.PF0` physical function.

```
primary# ldm create-vf /SYS/MB/NET0/IOVNET.PF0
Created new vf: /SYS/MB/NET0/IOVNET.PF0.VF0
```

Example 6–4 Dynamically Creating an Ethernet Virtual Function and Setting Properties

This example dynamically creates a virtual function while setting the `mac-addr` property to `00:14:2f:f9:14:c0` and the `vid` property to VLAN IDs 2 and 3.

```
primary# ldm create-vf mac-addr=00:14:2f:f9:14:c0 vid=2,3 /SYS/MB/NET0/IOVNET.PF0
```

Example 6–5 Dynamically Creating an Ethernet Virtual Function With Two Alternate MAC Addresses

This example dynamically creates a virtual function that has two alternate MAC addresses. One MAC address is automatically allocated, and the other is explicitly specified as `00:14:2f:f9:14:c2`.

```
primary# ldm create-vf alt-mac-addrs=auto,00:14:2f:f9:14:c2 /SYS/MB/NET0/IOVNET.PF0
```

Example 6–6 Statically Creating a Virtual Function Without Setting Optional Properties

This example statically creates a virtual function without setting any optional properties. In this case, the MAC address for a network class virtual function is automatically allocated.

First you initiate a delayed reconfiguration on the `primary` domain and then enable I/O virtualization on the `pci_0` PCIe bus. Because the `pci_0` bus has already been assigned to the `primary` root domain, use the `ldm set-io` command to enable I/O virtualization.

```
primary# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.

primary# ldm set-io iov=on pci_0
```

Now, you can use the `ldm create-vf` command to create the virtual function from the `/SYS/MB/NET0/IOVNET.PF0` physical function.

```
primary# ldm create-vf /SYS/MB/NET0/IOVNET.PF0

------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------------

Created new vf: /SYS/MB/NET0/IOVNET.PF0.VF0
```

Finally, reboot the `primary` root domain to make the changes take effect.

```
primary# shutdown -i6 -g0 -y
```

Example 6–7 Creating Multiple SR-IOV Ethernet Virtual Functions

The following command shows how you can create four virtual functions from the `/SYS/MB/NET2/IOVNET.PF1` physical function:

```
primary# ldm create-vf -n 31 /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF0
```

```
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF2
...
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF30
```

Note that the `ldm create-vf -n` command creates multiple virtual functions that are set with default property values, if appropriate. You can later specify non-default property values by using the `ldm set-io` command.

Destroying Ethernet Virtual Functions

A virtual function can be destroyed if it is not currently assigned to a domain. A virtual function can be destroyed only in the reverse sequential order of creation, so only the last virtual function that was created can be destroyed. The resulting configuration is validated by the physical function driver.

▼ How to Destroy an Ethernet SR-IOV Virtual Function

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

1 Identify the physical function device.

```
primary# ldm list-io
```

2 Destroy single a virtual function or multiple virtual functions either dynamically or statically.

- **Dynamic method:**
  - **To destroy all of the virtual functions from a physical function at one time, use the following command:**

    ```
    primary# ldm destroy-vf -n number | max pf-name
    ```

    Use the `ldm destroy-vf -n max` command to destroy all the virtual functions for that physical function at one time.

    If you specify *number* as an argument to the `-n` option, the last *number* of virtual functions are destroyed. Use this method as it performs this operation with only one physical function device driver state transition.

    You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

  - **To destroy a specified virtual function:**

    ```
    primary# ldm destroy-vf vf-name
    ```

- **Static method:**

  a. **Initiate a delayed reconfiguration.**

     ```
     primary# ldm start-reconf root-domain-name
     ```

  b. **Destroy either a single virtual function or multiple virtual functions.**

     - **To destroy all of the virtual functions from the specified physical function at the same time, use the following command:**

       ```
       primary# ldm destroy-vf -n number | max pf-name
       ```

       You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

     - **To destroy a specified virtual function:**

       ```
       primary# ldm destroy-vf vf-name
       ```

  c. **Reboot the root domain.**

     - **To reboot the non-`primary` root domain:**

       ```
       primary# ldm stop-domain -r root-domain
       ```

     - **To reboot the `primary` root domain:**

       ```
       primary# shutdown -i6 -g0 -y
       ```

Example 6–8 Destroying an Ethernet Virtual Function

This example shows how to dynamically destroy the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function.

```
primary# ldm destroy-vf /SYS/MB/NET0/IOVNET.PF0.VF0
```

The following example shows how to statically destroy the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function.

```
primary# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.

primary# ldm destroy-vf /SYS/MB/NET0/IOVNET.PF0.VF0
primary# shutdown -i6 -g0 -y
```

Example 6–9 Destroying Multiple Ethernet SR-IOV Virtual Functions

This example shows the results of destroying all the virtual functions from the `/SYS/MB/NET2/IOVNET.PF1` physical function. The `ldm list-io` output shows that the physical function has seven virtual functions. The `ldm destroy-vf` command destroys all virtual functions, and the final `ldm list-io` output shows that none of the virtual functions remain.

```
primary# ldm list-io
...
/SYS/MB/NET2/IOVNET.PF1                   PF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF0               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF1               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF2               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF3               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF4               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF5               VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF6               VF     pci_1
primary# ldm destroy-vf -n max /SYS/MB/NET2/IOVNET.PF1
primary# ldm list-io
...
/SYS/MB/NET2/IOVNET.PF1                   PF     pci_1    ldg1
```

Modifying Ethernet SR-IOV Virtual Functions

The `ldm set-io` *vf-name* command modifies the current configuration of a virtual function by changing the property values or by setting new properties. This command can modify both the network-specific properties and the device-specific properties. For information about device-specific properties, see "Advanced SR-IOV Topics: Ethernet SR-IOV" on page 114.

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

You can use the `ldm set-io` command to modify the following properties:

- `mac-addr`, `alt-mac-addrs`, and `mtu`

  To change these virtual function properties, stop the domain that owns the virtual function, use the `ldm set-io` command to change the property values, and start the domain.

- `pvid` and `vid`

  You can dynamically change these properties while the virtual functions are assigned to a domain. Note that doing so might result in a change to the network traffic of an active virtual function; setting the `pvid` property enables a transparent VLAN. Setting the `vid` property to specify VLAN IDs permits VLAN traffic to those specified VLANs.

- **Device-specific properties**

  Use the `ldm list-io -d` *pf-name* command to view the list of valid device-specific properties. You can modify these properties for both the physical function and the virtual function. You must use the static method to modify device-specific properties. See "Static

SR-IOV" on page 98. For more information about device-specific properties, see "Advanced SR-IOV Topics: Ethernet SR-IOV" on page 114.

▼ How to Modify an Ethernet SR-IOV Virtual Function

1 Identify the physical function device.

```
primary# ldm list-io
```

Note that the name of the physical function includes the location information for the PCIe SR-IOV card or on-board device.

2 Modify a virtual function.

```
primary# ldm set-io name=value [name=value...] vf-name
```

Example 6–10 Modifying an Ethernet Virtual Function

These examples describe how to use the `ldm set-io` command to set properties on a virtual function.

- The following example modifies the specified virtual function, `/SYS/MB/NET0/IOVNET.PF0.VF0`, to be part of VLAN IDs 2, 3, and 4.

  ```
  primary# ldm set-io vid=2,3,4 /SYS/MB/NET0/IOVNET.PF0.VF0
  ```

  Note that this command dynamically changes the VLAN association for a virtual function. To use these VLANs, the VLAN interfaces in the I/O domains must be configured by using the appropriate Oracle Solaris OS networking commands.

- The following example sets the `pvid` property value to 2 for the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function, which transparently makes the virtual function part of VLAN 2. Namely, the virtual function will not view any tagged VLAN traffic.

  ```
  primary# ldm set-io pvid=2 /SYS/MB/NET0/IOVNET.PF0.VF0
  ```

- The following example assigns three automatically allocated alternate MAC addresses to a virtual function. The alternate addresses enable the creation of Oracle Solaris 11 virtual network interface cards (VNICs) on top of a virtual function. Note that to use VNICs, you must run the Oracle Solaris 11 OS in the domain.

  Note – Before you run this command, stop the domain that owns the virtual function.

  ```
  primary# ldm set-io alt-mac-addrs=auto,auto,auto /SYS/MB/NET0/IOVNET.PF0.VF0
  ```

- The following example sets the device-specific `unicast-slots` property to 12 for the specified virtual function. To find the device-specific properties that are valid for a physical function, use the `ldm list-io -d` *pf-name* command.

```
primary# ldm set-io unicast-slots=12 /SYS/MB/NET0/IOVNET.PF0.VF0

All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.
```

Adding and Removing Ethernet SR-IOV Virtual Functions on I/O Domains

▼ How to Add an Ethernet SR-IOV Virtual Function to an I/O Domain

If you cannot dynamically remove the virtual function, use the static method. See "Static SR-IOV" on page 98.

1 Identify the virtual function that you want to add to an I/O domain.

```
primary# ldm list-io
```

2 Add a virtual function dynamically or statically.

- **To dynamically add a virtual function:**

  ```
  primary# ldm add-io vf-name domain-name
  ```

  vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *domain-name* specifies the name of the domain to which you add the virtual function.

  The device path name for the virtual function in the domain is the path shown in the `list-io -l` output.

- **To statically add a virtual function:**

  a. **Initiate a delayed reconfiguration and then add the virtual function.**

  ```
  primary# ldm start-reconf root-domain-name
  primary# ldm add-io vf-name domain-name
  ```

  vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *domain-name* specifies the name of the domain to which you add the virtual function. The specified guest must be in the inactive or bound state.

  The device path name for the virtual function in the domain is the path shown in the `list-io -l` output.

b. Reboot the root domain.

- **To reboot the non-`primary` root domain:**

  ```
  primary# ldm stop-domain -r root-domain
  ```

- **To reboot the `primary` root domain:**

  ```
  primary# shutdown -i6 -g0 -y
  ```

Example 6–11 Adding an Ethernet Virtual Function

This example shows how to dynamically add the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function to the `ldg1` domain.

```
primary# ldm add-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
```

If you cannot add the virtual function dynamically, use the static method:

```
primary# ldm stop-domain ldg1
primary# ldm add-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
primary# ldm start-domain ldg1
```

▼ How to Remove an Ethernet Virtual SR-IOV Function From an I/O Domain

If you cannot dynamically remove the virtual function, use the static method. See "Static SR-IOV" on page 98.

Caution – Before removing the virtual function from the domain, ensure that it is not critical for booting that domain.

1 Identify the virtual function that you want to remove from an I/O domain.

```
primary# ldm list-io
```

2 Remove a virtual function either dynammically or statically.

- **To dynamically remove a virtual function:**

  ```
  primary# ldm rm-io vf-name  domain-name
  ```

  vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the device pseudonym. *domain-name* specifies the name of the domain from which you remove the virtual function.

- **To statically remove a virtual function:**

  a. **Stop the I/O domain.**

     ```
     primary# ldm stop-domain domain-name
     ```

  b. **Remove the virtual function.**

     ```
     primary# ldm rm-io vf-name domain-name
     ```

     vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the device pseudonym. *domain-name* specifies the name of the domain from which you remove the virtual function. The specified guest must be in the inactive or bound state.

  c. **Start the I/O domain.**

     ```
     primary# ldm start-domain domain-name
     ```

Example 6–12 Dynamically Removing an Ethernet Virtual Function

This example shows how to dynamically remove the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function from the `ldg1` domain.

```
primary# ldm remove-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
```

If the command succeeds, the virtual function is removed from the `ldg1` domain. When `ldg1` is restarted, the specified virtual function no longer appears in that domain.

If you cannot remove the virtual function dynamically, use the static method:

```
primary# ldm stop-domain ldg1
primary# ldm remove-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
primary# ldm start-domain ldg1
```

Advanced SR-IOV Topics: Ethernet SR-IOV

This section describes some advanced topics related to using SR-IOV virtual functions.

Advanced Network Configuration for Virtual Functions

When you use SR-IOV virtual functions, note the following issues:

- SR-IOV virtual functions can only use the MAC addresses that are assigned by the Logical Domains Manager. If you use other Oracle Solaris OS networking commands to change the MAC address on the I/O domain, the commands might fail or might not function properly.
- At this time, link aggregation of SR-IOV network virtual functions in the I/O domain is not supported. If you attempt to create a link aggregation, it might not function as expected.

- You can create virtual I/O services and assign them to I/O domains. These virtual I/O services can be created on the same physical function from which virtual functions are also created. For example, you can use an on-board 1-Gbps network device (`net0` or `igb0`) as a network back-end device for a virtual switch and also create virtual functions from the same physical function device.

Booting an I/O Domain by Using an SR-IOV Virtual Function

An SR-IOV virtual function provides similar capabilities to any other type of PCIe device, such as the ability to use a virtual function as a logical domain boot device. For example, a network virtual function can be used to boot over the network to install the Oracle Solaris OS in an I/O domain.

Note – When booting the Oracle Solaris OS from a virtual function device, verify that the Oracle Solaris OS that is being loaded has virtual function device support. If so, you can continue with the rest of the installation as planned.

SR-IOV Device-Specific Properties

SR-IOV physical function device drivers can export device-specific properties. These properties can be used to tune the resource allocation of both the physical function and its virtual functions. For information about the properties, see the man page for the physical function driver, such as the `igb(7D)` and `ixgbe(7D)` man pages.

The `ldm list-io -d` command shows device-specific properties that are exported by the specified physical function device driver. The information for each property includes its name, brief description, default value, maximum values, and one or more of the following flags:

`P` Applies to a physical function

`V` Applies to a virtual function

`R` Read-only or informative parameter only

```
primary# ldm list-io -d pf-name
```

Use the `ldm create-vf` or `ldm set-io` command to set the read-write properties for a physical function or a virtual function. Note that to set a device-specific property, you must use the static method. See "Static SR-IOV" on page 98.

The following example shows the device-specific properties that are exported by the on-board Intel 1-Gbps SR-IOV device:

```
primary# ldm list-io -d /SYS/MB/NET0/IOVNET.PF0
Device-specific Parameters
--------------------------
```

```
max-config-vfs
    Flags = PR
    Default = 7
    Descr = Max number of configurable VFs
max-vf-mtu
    Flags = VR
    Default = 9216
    Descr = Max MTU supported for a VF
max-vlans
    Flags = VR
    Default = 32
    Descr = Max number of VLAN filters supported
pvid-exclusive
    Flags = VR
    Default = 1
    Descr = Exclusive configuration of pvid required
unicast-slots
    Flags = PV
    Default = 0 Min = 0 Max = 24
    Descr = Number of unicast mac-address slots
```

The following example sets the `unicast-slots` property to 8:

```
primary# ldm create-vf unicast-slots=8 /SYS/MB/NET0/IOVNET.PF0
```

Creating VNICs on SR-IOV Virtual Functions

The creation of Oracle Solaris 11 VNICs is supported on SR-IOV virtual functions. However, the number of VNICs that is supported is limited to the number of alternate MAC addresses (`alt-mac-addrs` property) assigned to the virtual function. Make sure that you assign a sufficient number of alternate MAC addresses when you use VNICs on the virtual function. Use the `ldm create-vf` or `ldm set-io` command to set the `alt-mac-addrs` property with the alternate MAC addresses.

The following example shows the creation of four VNICs on an SR-IOV virtual function. The first command assigns alternate MAC addresses to the virtual function device. This command uses the automatic allocation method to allocate four alternate MAC addresses to the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function device:

```
primary# ldm set-io alt-mac-addrs=auto,auto,auto,auto /SYS/MB/NET0/IOVNET.PF0.VF0
```

The next command starts the `ldg1` I/O domain. Because the `auto-boot?` property is set to `true` in this example, the Oracle Solaris 11 OS is also booted in the I/O domain.

```
primary# ldm start ldg1
```

The following command uses the Oracle Solaris 11 `dladm` command in the guest domain to show virtual function that has alternate MAC addresses. This output shows that the `net30` virtual function has four alternate MAC addresses.

```
guest# dladm show-phys -m
LINK              SLOT     ADDRESS            INUSE CLIENT
net0              primary  0:14:4f:fa:b4:d1   yes   net0
net25             primary  0:14:4f:fa:c9:eb   no    --
net30             primary  0:14:4f:fb:de:4c   no    --
                   1       0:14:4f:f9:e8:73   no    --
                   2       0:14:4f:f8:21:58   no    --
                   3       0:14:4f:fa:9d:92   no    --
                   4       0:14:4f:f9:8f:1d   no    --
```

The following commands create four VNICs. Note that attempts to create more VNICs than are specified by using alternate MAC addresses will fail.

```
guest# dladm create-vnic -l net30 vnic0
guest# dladm create-vnic -l net30 vnic1
guest# dladm create-vnic -l net30 vnic2
guest# dladm create-vnic -l net30 vnic3
guest# dladm show-link
LINK                CLASS     MTU    STATE    OVER
net0                phys      1500   up       --
net25               phys      1500   up       --
net30               phys      1500   up       --
vnic0               vnic      1500   up       net30
vnic1               vnic      1500   up       net30
vnic2               vnic      1500   up       net30
vnic3               vnic      1500   up       net30
```

Using an SR-IOV Virtual Function to Create an I/O Domain

The following procedure explains how to create an I/O domain that includes PCIe SR-IOV virtual functions.

▼ How to Create an I/O Domain by Assigning an SR-IOV Virtual Function to It

Plan ahead to minimize the number of reboots of the root domain, which minimizes downtime.

Before You Begin Before you begin, ensure that you have enabled I/O virtualization for the PCIe bus that is the parent of the physical function from which you create virtual functions. See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

1 Identify an SR-IOV physical function to share with an I/O domain that uses the SR-IOV feature.

```
primary# ldm list-io
```

2 Create one or more virtual functions for the physical function.

```
primary# ldm create-vf pf-name
```

You can run this command for each virtual function that you want to create. You can also use the `-n` option to create more than one virtual function from the same physical function in a single command. See Example 6–7 and the `ldm`(1M) man page.

Note – This command fails if other virtual functions have already been created from the associated physical function and if any of those virtual functions are bound to another domain.

---

3 View the list of available virtual functions on the root domain.

```
primary# ldm list-io
```

4 Assign the virtual function that you created in Step 2 to its target I/O domain.

```
primary# ldm add-io vf-name domain-name
```

Note – If the OS in the target I/O domain does not support dynamic SR-IOV, you must use the static method. See "Static SR-IOV" on page 98.

---

5 Verify that the virtual function is available on the I/O domain.

The following Oracle Solaris 11 command shows the availability of the virtual function:

```
guest# dladm show-phys
```

Example 6–13 Dynamically Creating an I/O Domain by Assigning an SR-IOV Virtual Function to It

The following dynamic example shows how to create a virtual function, `/SYS/MB/NET0/IOVNET.PF0.VF0`, for a physical function, `/SYS/MB/NET0/IOVNET.PF0`, and assign the virtual function to the `ldg1` I/O domain.

This example assumes that the following circumstances are true:

- The OS on the `primary` domain supports dynamic SR-IOV operations
- The `pci_0` bus is assigned to the `primary` domain and has been initialized for I/O virtualization operations
- The `/SYS/MB/NET0/IOVNET.PF0` physical function belongs to the `pci_0` bus
- The `/SYS/MB/NET0/IOVNET.PF0` physical function does not have any existing virtual functions assigned to domains
- The `ldg1` domain is active and booted and its OS supports dynamic SR-IOV operations

Create the virtual function from the `/SYS/MB/NET0/IOVNET.PF0` physical function.

```
primary# ldm create-vf /SYS/MB/NET0/IOVNET.PF0
Created new vf: /SYS/MB/NET0/IOVNET.PF0.VF0
```

Add the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function to the `ldg1` domain.

```
primary# ldm add-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
```

The following command shows that the virtual function has been added to the `ldg1` domain.

```
primary# ldm list-io
NAME                            TYPE  BUS      DOMAIN    STATUS
----                            ----  ---      ------    ------
niu_0                           NIU   niu_0    primary
niu_1                           NIU   niu_1    primary
pci_0                           BUS   pci_0    primary   IOV
pci_1                           BUS   pci_1    primary
/SYS/MB/PCIE0                   PCIE  pci_0    primary   OCC
/SYS/MB/PCIE2                   PCIE  pci_0    primary   OCC
/SYS/MB/PCIE4                   PCIE  pci_0    primary   OCC
/SYS/MB/PCIE6                   PCIE  pci_0    primary   EMP
/SYS/MB/PCIE8                   PCIE  pci_0    primary   EMP
/SYS/MB/SASHBA                  PCIE  pci_0    primary   OCC
/SYS/MB/NET0                    PCIE  pci_0    primary   OCC
/SYS/MB/PCIE1                   PCIE  pci_1    primary   OCC
/SYS/MB/PCIE3                   PCIE  pci_1    primary   OCC
/SYS/MB/PCIE5                   PCIE  pci_1    primary   OCC
/SYS/MB/PCIE7                   PCIE  pci_1    primary   EMP
/SYS/MB/PCIE9                   PCIE  pci_1    primary   EMP
/SYS/MB/NET2                    PCIE  pci_1    primary   OCC
/SYS/MB/NET0/IOVNET.PF0         PF    pci_0    primary
/SYS/MB/NET0/IOVNET.PF1         PF    pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0        PF    pci_1    primary
/SYS/MB/PCIE5/IOVNET.PF1        PF    pci_1    primary
/SYS/MB/NET2/IOVNET.PF0         PF    pci_1    primary
/SYS/MB/NET2/IOVNET.PF1         PF    pci_1    primary
/SYS/MB/NET0/IOVNET.PF0.VF0     VF    pci_0    ldg1
```

Example 6–14 Statically Creating an I/O Domain by Assigning an SR-IOV Virtual Function to It

The following static example shows how to create a virtual function, `/SYS/MB/NET0/IOVNET.PF0.VF0`, for a physical function, `/SYS/MB/NET0/IOVNET.PF0`, and assign the virtual function to the `ldg1` I/O domain.

This example assumes that the following circumstances are true:

- The OS on the `primary` domain does not support dynamic SR-IOV operations
- The `pci_0` bus is assigned to the `primary` domain and has not been initialized for I/O virtualization operations
- The `/SYS/MB/NET0/IOVNET.PF0` physical function belongs to the `pci_0` bus
- The `/SYS/MB/NET0/IOVNET.PF0` physical function does not have any existing virtual functions assigned to domains
- The `ldg1` domain is active and booted and its OS does not support dynamic SR-IOV operations
- The `ldg1` domain has the `auto-boot?` property set to `true` so that the domain boots automatically when the domain is started

First, initiate a delayed reconfiguration on the `primary` domain, enable I/O virtualization, and create the virtual function from the `/SYS/MB/NET0/IOVNET.PF0` physical function.

```
primary# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.

primary# ldm set-io iov=on pci_0
primary# ldm create-vf /SYS/MB/NET0/IOVNET.PF0

--------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
--------------------------------------------------------------------------------
Created new vf: /SYS/MB/NET0/IOVNET.PF0.VF0
```

Next, shut down the `primary` domain.

```
primary# shutdown -i6 -g0 -y
```

Stop the `ldg1` domain, add the virtual function, and start the domain.

```
primary# ldm stop ldg1
primary# ldm add-io /SYS/MB/NET0/IOVNET.PF0.VF0 ldg1
primary# ldm start ldg1
```

The following command shows that the virtual function has been added to the `ldg1` domain.

```
primary# ldm list-io
NAME                          TYPE  BUS      DOMAIN    STATUS
----                          ----  ---      ------    ------
niu_0                         NIU   niu_0    primary
niu_1                         NIU   niu_1    primary
pci_0                         BUS   pci_0    primary   IOV
pci_1                         BUS   pci_1    primary
/SYS/MB/PCIE0                 PCIE  pci_0    primary   OCC
/SYS/MB/PCIE2                 PCIE  pci_0    primary   OCC
/SYS/MB/PCIE4                 PCIE  pci_0    primary   OCC
/SYS/MB/PCIE6                 PCIE  pci_0    primary   EMP
/SYS/MB/PCIE8                 PCIE  pci_0    primary   EMP
/SYS/MB/SASHBA                PCIE  pci_0    primary   OCC
/SYS/MB/NET0                  PCIE  pci_0    primary   OCC
/SYS/MB/PCIE1                 PCIE  pci_1    primary   OCC
/SYS/MB/PCIE3                 PCIE  pci_1    primary   OCC
/SYS/MB/PCIE5                 PCIE  pci_1    primary   OCC
/SYS/MB/PCIE7                 PCIE  pci_1    primary   EMP
/SYS/MB/PCIE9                 PCIE  pci_1    primary   EMP
/SYS/MB/NET2                  PCIE  pci_1    primary   OCC
/SYS/MB/NET0/IOVNET.PF0       PF    pci_0    primary
/SYS/MB/NET0/IOVNET.PF1       PF    pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0      PF    pci_1    primary
/SYS/MB/PCIE5/IOVNET.PF1      PF    pci_1    primary
/SYS/MB/NET2/IOVNET.PF0       PF    pci_1    primary
```

```
/SYS/MB/NET2/IOVNET.PF1       PF    pci_1    primary
/SYS/MB/NET0/IOVNET.PF0.VF0   VF    pci_0    ldg1
```

Using InfiniBand SR-IOV Virtual Functions

Only the static SR-IOV feature is supported for InfiniBand SR-IOV devices.

To minimize downtime, run all of the SR-IOV commands as a group while the root domain is in delayed reconfiguration or a guest domain is stopped. The SR-IOV commands that are limited in this way are the `ldm create-vf`, `ldm destroy-vf`, `ldm add-io`, and `ldm remove-io` commands.

Typically, virtual functions are assigned to more than one guest domain. A reboot of the root domain affects all of the guest domains that have been assigned the root domain's virtual functions.

Because an unused InfiniBand virtual function has very little overhead, you can avoid downtime by creating the necessary virtual functions ahead of time, even if they are not used immediately.

InfiniBand SR-IOV Hardware Requirements

For information about the required PCIe InfiniBand SR-IOV hardware, see "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

For InfiniBand SR-IOV support, the root domain must be running at least the Oracle Solaris 11.1.10.5.0 OS. The I/O domains can run the Oracle Solaris 10 1/13 OS plus patch 148888-04 or at least the Oracle Solaris 11.1.10.5.0 OS.

Creating and Destroying InfiniBand Virtual Functions

▼ How to Create an InfiniBand Virtual Function

This procedure describes how to create an InfiniBand SR-IOV virtual function.

1 Initiate a delayed reconfiguration on the root domain.

```
primary# ldm start-reconf root-domain-name
```

2 Enable I/O virtualization by setting `iov=on`.

Perform this step only if I/O virtualization is not enabled already for the bus that has the physical function.

```
primary# ldm set-io iov=on bus
```

3 **Create one or more virtual functions that are associated with the physical functions from that root domain.**

```
primary# ldm create-vf pf-name
```

You can run this command for each virtual function that you want to create. You can also use the `-n` option to create more than one virtual function from the same physical function in a single command. See Example 6–7 and the `ldm`(1M) man page.

4 **Reboot the root domain.**

Run one of the following commands:

- **Reboot the non-`primary` root domain.**

```
primary# ldm stop-domain -r root-domain
```

- **Reboot the `primary` root domain.**

```
primary# shutdown -i6 -g0 -y
```

Example 6–15 Creating an InfiniBand Virtual Function

The following example shows information about the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0` physical function:

- This physical function is in PCIE slot 4.
- The `IOVIB` string indicates that the physical function is an InfiniBand SR-IOV device.

```
primary# ldm list-io
NAME                                TYPE   BUS      DOMAIN   STATUS
----                                ----   ---      ------   ------
pci_0                               BUS    pci_0    primary
niu_0                               NIU    niu_0    primary
/SYS/MB/RISER0/PCIE0                PCIE   pci_0    primary  EMP
/SYS/MB/RISER1/PCIE1                PCIE   pci_0    primary  EMP
/SYS/MB/RISER2/PCIE2                PCIE   pci_0    primary  EMP
/SYS/MB/RISER0/PCIE3                PCIE   pci_0    primary  OCC
/SYS/MB/RISER1/PCIE4                PCIE   pci_0    primary  OCC
/SYS/MB/RISER2/PCIE5                PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA0                     PCIE   pci_0    primary  OCC
/SYS/MB/SASHBA1                     PCIE   pci_0    primary  OCC
/SYS/MB/NET0                        PCIE   pci_0    primary  OCC
/SYS/MB/NET2                        PCIE   pci_0    primary  OCC
/SYS/MB/RISER0/PCIE3/IOVIB.PF0      PF     pci_0    primary
/SYS/MB/RISER1/PCIE4/IOVIB.PF0      PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF0             PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1             PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF0             PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF1             PF     pci_0    primary
```

The following command shows more details about the specified physical function. The `maxvfs` value indicates the maximum number of virtual functions that are supported by the device.

```
primary# ldm list-io -l /SYS/MB/RISER1/PCIE4/IOVIB.PF0
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
/SYS/MB/RISER1/PCIE4/IOVIB.PF0            PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0]
    maxvfs = 64
```

The following example shows how to create a static virtual function. First, initiate a delayed reconfiguration on the `primary` domain and enable I/O virtualization on the `pci_0` PCIe bus. Because the `pci_0` bus has been assigned already to the `primary` root domain, use the `ldm set-io` command to enable I/O virtualization.

```
primary# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.

primary# ldm set-io iov=on pci_0
--------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
--------------------------------------------------------------------------
```

Now, use the `ldm create-vf` command to create a virtual function from the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0` physical function.

```
primary# ldm create-vf /SYS/MB/RISER1/PCIE4/IOVIB.PF0
--------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
--------------------------------------------------------------------------
Created new vf: /SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0
```

Note that you can create more than one virtual function during the same delayed reconfiguration. The following command creates a second virtual function:

```
primary# ldm create-vf /SYS/MB/RISER1/PCIE4/IOVIB.PF0
--------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
--------------------------------------------------------------------------
Created new vf: /SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1
```

Finally, reboot the `primary` root domain to make the changes take effect.

```
primary# shutdown -i6 -g0 -y
Shutdown started.

Changing to init state 6 - please wait
...
```

How to Destroy an InfiniBand Virtual Function

This procedure describes how to destroy an InfiniBand SR-IOV virtual function.

A virtual function can be destroyed if it is not currently assigned to a domain. A virtual function can be destroyed only in the reverse sequential order of creation, so only the last virtual function that was created can be destroyed. The resulting configuration is validated by the physical function driver.

1. **Initiate a delayed reconfiguration on the root domain.**

   ```
   primary# ldm start-reconf root-domain-name
   ```

2. **Destroy one or more virtual functions that are associated with the physical functions from that root domain.**

   ```
   primary# ldm destroy-vf vf-name
   ```

   You can run this command for each virtual function that you want to destroy. You can also use the `-n` option to destroy more than one virtual function from the same physical function in a single command. See Example 6–9 and the `ldm`(1M) man page.

3. **Reboot the root domain.**

   Run one of the following commands:

   - **Reboot the non-`primary` root domain.**

     ```
     primary# ldm stop-domain -r root-domain
     ```

   - **Reboot the `primary` root domain.**

     ```
     primary# shutdown -i6 -g0 -y
     ```

Example 6–16 Destroying an InfiniBand Virtual Function

The following example shows how to destroy a static InfiniBand virtual function, `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1`.

The `ldm list-io` command shows information about the buses, physical functions, and virtual functions.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN STATUS
----                                    ----   ---      ------ ------
pci_0                                   BUS    pci_0    primary  IOV
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1      VF     pci_0
```

You can obtain more details about the physical function and related virtual functions by using the `ldm list-io -l` command.

```
primary# ldm list-io -l /SYS/MB/RISER1/PCIE4/IOVIB.PF0
NAME                                    TYPE   BUS      DOMAIN STATUS
----                                    ----   ---      ------ ------
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0]
    maxvfs = 64
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0      VF     pci_0
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,1]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1      VF     pci_0
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,2]
```

A virtual function can be destroyed only if it is unassigned to a domain. The DOMAIN column of the `ldm list-io -l` output shows the name of any domain to which a virtual function is assigned. Also, virtual functions must be destroyed in the reverse order of their creation. Therefore, in this example, you must destroy the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1` virtual function before you can destroy the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0` virtual function.

After you identify the proper virtual function, you can destroy it. First, initiate a delayed reconfiguration.

```
primary# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the primary
domain reboots, at which time the new configuration for the primary domain
will also take effect.

primary# ldm destroy-vf /SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1
------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------
```

You can issue more than one `ldm destroy-vf` command while in delayed reconfiguration. Thus, you could also destroy the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0`.

Finally, reboot the `primary` root domain to make the changes take effect.

```
primary# shutdown -i6 -g0 -y
Shutdown started.

Changing to init state 6 - please wait
...
```

Adding and Removing InfiniBand Virtual Functions on I/O Domains

▼ How to Add an InfiniBand Virtual Function to an I/O Domain

This procedure describes how to add an InfiniBand SR-IOV virtual function to an I/O domain.

1 Stop the I/O domain.

```
primary# ldm stop-domain domain-name
```

2 Add one or more virtual functions to the I/O domain.

vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *domain-name* specifies the name of the domain to which you add the virtual function. The specified I/O domain must be in the inactive or bound state.

```
primary# ldm add-io vf-name domain-name
```

3 Start the I/O domain.

```
primary# ldm start-domain domain-name
```

Example 6–17 Adding an InfiniBand Virtual Function

The following example shows how to add the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2` virtual function to the `iodom1` I/O domain.

First, identify the virtual function that you want to assign.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN STATUS
----                                    ----   ---      ------ ------
pci_0                                   BUS    pci_0    primary  IOV
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3      VF     pci_0
```

To add a virtual function to an I/O domain, it must be unassigned. The DOMAIN column indicates the name of the domain to which the virtual function is assigned. In this case, the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2` is not assigned to a domain.

To add a virtual function to a domain, the domain must be in the inactive or bound state.

```
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      0.2%  0.2%  56m
```

```
iodom1           active     -n----  5000    8     8G        33%   33%  25m
```

The `ldm list-domain` output shows that the `iodom1` I/O domain is active, so it must be stopped.

```
primary# ldm stop iodom1
LDom iodom1 stopped
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      0.0%  0.0%  57m
iodom1           bound      ------  5000    8     8G
```

Now you can add the virtual function to the I/O domain.

```
primary# ldm add-io /SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2 iodom1
primary# ldm list-io
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2        VF     pci_0    iodom1
```

Note that you can add more than one virtual function while an I/O domain is stopped. For example, you might add other unassigned virtual functions such as `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3` to `iodom1`. After you add the virtual functions, you can restart the I/O domain.

```
primary# ldm start iodom1
LDom iodom1 started
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      1.0%  1.0%  1h 18m
iodom1           active     -n----  5000    8     8G        36%   36%  1m
```

▼ How to Remove an InfiniBand Virtual Function From an I/O Domain

This procedure describes how to remove an InfiniBand SR-IOV virtual function from an I/O domain.

1 Stop the I/O domain.

```
primary# ldm stop-domain domain-name
```

2 Remove one or more virtual functions from the I/O domain.

vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the device pseudonym. *domain-name* specifies the name of the domain from which you remove the virtual function. The specified I/O domain must be in the inactive or bound state.

Note – Before removing the virtual function from the I/O domain, ensure that it is not critical for booting that domain.

```
primary# ldm rm-io vf-name domain-name
```

3 Start the I/O domain.

```
primary# ldm start-domain domain-name
```

Example 6–18 Removing an InfiniBand Virtual Function

The following example shows how to remove the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2` virtual function from the `iodom1` I/O domain.

First, identify the virtual function that you want to remove.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN STATUS
----                                    ----   ---      ------ ------
pci_0                                   BUS    pci_0    primary  IOV
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1      VF     pci_0
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2      VF     pci_0    iodom1
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3      VF     pci_0    iodom1
```

The DOMAIN column shows the name of the domain to which the virtual function is assigned. The `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2` virtual function is assigned to `iodom1`.

To remove a virtual function from an I/O domain, the domain must be inactive or bound state. Use the `ldm list-domain` command to determine the state of the domain.

```
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      0.3%  0.3%  29m
iodom1           active     -n----  5000    8     8G        17%   17%  11m
```

In this case, the `iodom1` domain is active and so must be stopped.

```
primary# ldm stop iodom1
LDOM iodom1 stopped
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      0.0%  0.0%  31m
iodom1           bound      ------  5000    8     8G
```

Now you can remove the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2` virtual function from `iodom1`.

```
primary# ldm rm-io /SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2 iodom1
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN STATUS
----                                    ----   ---      ------ ------
```

```
...
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2        VF     pci_0
...
```

Note that the DOMAIN column for the virtual function is now empty.

You can remove more than one virtual function while an I/O domain is stopped. In this example, you could also remove the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3` virtual function. After you remove the virtual functions, you can restart the I/O domain.

```
primary# ldm start iodom1
LDom iodom1 started
primary# ldm list-domain
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    32    64G      0.3%  0.3%  39m
iodom1           active     -n----  5000    8     8G       9.4%  9.4%  5s
```

Adding and Removing InfiniBand Virtual Functions to Root Domains

▼ How to Add an InfiniBand Virtual Function to a Root Domain

This procedure describes how to add an InfiniBand SR-IOV virtual function to a root domain.

1 Initiate a delayed reconfiguration.

```
primary# ldm start-reconf root-domain
```

2 Add one or more virtual functions to the root domain.

vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *root-domain-name* specifies the name of the root domain to which you add the virtual function.

```
primary# ldm add-io vf-name root-domain-name
```

3 Reboot the root domain.

Run one of the following commands:

- **Reboot the non-`primary` root domain.**

  ```
  primary# ldm stop-domain -r root-domain-name
  ```

- **Reboot the `primary` root domain.**

  ```
  primary# shutdown -i6 -g0 -y
  ```

▼ How to Remove an InfiniBand Virtual Function From a Root Domain

This procedure describes how to remove an InfiniBand SR-IOV virtual function from a root domain.

1. **Initiate a delayed reconfiguration.**

   ```
   primary# ldm start-reconf root-domain
   ```

2. **Remove one or more virtual functions from the root domain.**

   vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *root-domain-name* specifies the name of the root domain to which you add the virtual function.

   ```
   primary# ldm remove-io vf-name root-domain-name
   ```

3. **Reboot the root domain.**

   Run one of the following commands:

   - **Reboot the non-`primary` root domain.**

     ```
     primary# ldm stop-domain -r root-domain-name
     ```

   - **Reboot the `primary` root domain.**

     ```
     primary# shutdown -i6 -g0 -y
     ```

Advanced SR-IOV Topics: InfiniBand SR-IOV

This section describes how to identify InfiniBand physical and virtual functions as well as to correlate the Logical Domains Manager and the Oracle Solaris view of InfiniBand physical and virtual functions.

Listing InfiniBand SR-IOV Virtual Functions

The following example shows different ways to display information about the `/SYS/MB/RISER1/PCIE4/IOVIB.PF0` physical function. A physical function name that includes the `IOVIB` string indicates that it is an InfiniBand SR-IOV device.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN   STATUS
----                                    ----   ---      ------   ------
pci_0                                   BUS    pci_0    primary  IOV
niu_0                                   NIU    niu_0    primary
/SYS/MB/RISER0/PCIE0                    PCIE   pci_0    primary  EMP
/SYS/MB/RISER1/PCIE1                    PCIE   pci_0    primary  EMP
/SYS/MB/RISER2/PCIE2                    PCIE   pci_0    primary  EMP
/SYS/MB/RISER0/PCIE3                    PCIE   pci_0    primary  OCC
/SYS/MB/RISER1/PCIE4                    PCIE   pci_0    primary  OCC
/SYS/MB/RISER2/PCIE5                    PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA0                         PCIE   pci_0    primary  OCC
/SYS/MB/SASHBA1                         PCIE   pci_0    primary  OCC
/SYS/MB/NET0                            PCIE   pci_0    primary  OCC
/SYS/MB/NET2                            PCIE   pci_0    primary  OCC
/SYS/MB/RISER0/PCIE3/IOVIB.PF0          PF     pci_0    primary
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
```

```
/SYS/MB/NET0/IOVNET.PF0                  PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                  PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF0                  PF     pci_0    primary
/SYS/MB/NET2/IOVNET.PF1                  PF     pci_0    primary
/SYS/MB/RISER0/PCIE3/IOVIB.PF0.VF0       VF     pci_0    primary
/SYS/MB/RISER0/PCIE3/IOVIB.PF0.VF1       VF     pci_0    primary
/SYS/MB/RISER0/PCIE3/IOVIB.PF0.VF2       VF     pci_0    iodom1
/SYS/MB/RISER0/PCIE3/IOVIB.PF0.VF3       VF     pci_0    iodom1
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0       VF     pci_0    primary
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1       VF     pci_0    primary
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2       VF     pci_0    iodom1
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3       VF     pci_0    iodom1
```

The `ldm list-io -l` command provides more detailed information about the specified physical function device, `/SYS/MB/RISER1/PCIE4/IOVIB.PF0`. The `maxvfs` value shows that the maximum number of virtual functions supported by the physical device is 64. For each virtual function that is associated with the physical function, the output shows the following:

- Function name
- Function type
- Bus name
- Domain name
- Optional status of the function
- Device path

This `ldm list-io -l` output shows that `VF0` and `VF1` are assigned to the `primary` domain and that `VF2` and `VF3` are assigned to the `iodom1` I/O domain.

```
primary# ldm list-io -l /SYS/MB/RISER1/PCIE4/IOVIB.PF0
NAME                                     TYPE   BUS      DOMAIN   STATUS
----                                     ----   ---      ------   ------
/SYS/MB/RISER1/PCIE4/IOVIB.PF0           PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0]
    maxvfs = 64
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0       VF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,1]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1       VF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,2]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2       VF     pci_0    iodom1
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,3]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3       VF     pci_0    iodom1
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,4]
```

Identifying InfiniBand SR-IOV Functions

This section describes how to identify the InfiniBand SR-IOV devices on an Oracle Solaris 11 and an Oracle Solaris 10 system.

Use the `ldm list-io -l` command to show the Oracle Solaris device path name that is associated with each physical function and virtual function.

```
primary# ldm list-io -l /SYS/MB/RISER1/PCIE4/IOVIB.PF0
NAME                                    TYPE   BUS      DOMAIN   STATUS
----                                    ----   ---      ------   ------
/SYS/MB/RISER1/PCIE4/IOVIB.PF0          PF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0]
    maxvfs = 64
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF0      VF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,1]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF1      VF     pci_0    primary
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,2]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF2      VF     pci_0    iodom1
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,3]
/SYS/MB/RISER1/PCIE4/IOVIB.PF0.VF3      VF     pci_0    iodom1
[pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0,4]
```

Oracle Solaris 11:

Use the Oracle Solaris 11 `dladm show-phys -L` command to match each IP over InfiniBand (IPoIB) instance to its physical card. For example, the following command shows which IPoIB instances use the card in slot `PCIE4`, which is the same card shown in the previous `ldm list-io -l` example.

```
primary# dladm show-phys -L | grep PCIE4
net5              ibp0          PCIE4/PORT1
net6              ibp1          PCIE4/PORT2
net19             ibp8          PCIE4/PORT1
net9              ibp9          PCIE4/PORT2
net18             ibp4          PCIE4/PORT1
net11             ibp5          PCIE4/PORT2
```

Each InfiniBand host channel adapter (HCA) device has a globally unique ID (GUID). There are also GUIDs for each port (typically there are two ports to an HCA). An InfiniBand HCA GUID uniquely identifies the adapter. The port GUID uniquely identifies each HCA port and plays a role similar to a network device's MAC address. These 16-hexadecimal digit GUIDs are used by InfiniBand management tools and diagnostic tools.

Use the Oracle Solaris 11 `dladm show-ib` command to obtain GUID information about the InfiniBand SR-IOV devices. Physical functions and virtual functions for the same device have related HCA GUID values. The 11th hexadecimal digit of the HCA GUID shows the relationship between a physical function and its virtual functions. Note that leading zeros are suppressed in the HCAGUID and PORTGUID columns.

For example, physical function `PF0` has two virtual functions, `VF0` and `VF1`, which are assigned to the `primary` domain. The 11th hexadecimal digit of each virtual function is incremented by one from the related physical function. So, if the GUID for the `PF0` is `8`, the GUIDs for `VF0` and `VF1` will be `9` and `A`, respectively.

The following `dladm show-ib` command output shows that the `net5` and `net6` links belong to the physical function `PF0`. The `net19` and `net9` links belong to `VF0` of the same device while the `net18` and `net11` links belong to `VF1`.

```
primary# dladm show-ib
LINK         HCAGUID         PORTGUID        PORT STATE  PKEYS
net6         212800001A17F56  21280001A17F58  2    up     FFFF
net5         212800001A17F56  21280001A17F57  1    up     FFFF
net19        212900001A17F56  14050000000001  1    up     FFFF
net9         212900001A17F56  14050000000008  2    up     FFFF
net18        212A0001A17F56  14050000000002  1    up     FFFF
net11        212A0001A17F56  14050000000009  2    up     FFFF
```

The device in the following Oracle Solaris 11 `dladm show-phys` output shows the relationship between the links and the underlying InfiniBand port devices (`ibp`*X*).

```
primary# dladm show-phys
LINK              MEDIA                STATE      SPEED  DUPLEX    DEVICE
...
net6              Infiniband           up         32000  unknown   ibp1
net5              Infiniband           up         32000  unknown   ibp0
net19             Infiniband           up         32000  unknown   ibp8
net9              Infiniband           up         32000  unknown   ibp9
net18             Infiniband           up         32000  unknown   ibp4
net11             Infiniband           up         32000  unknown   ibp5
```

Use the `ls -l` command to show the actual InfiniBand port (IB port) device paths. An IB port device is a child of a device path that is shown in the `ldm list-io -l` output. A physical function has a one-part unit address such as `pciex15b3,673c@0` while virtual functions have a two-part unit address, `pciex15b3,1002@0,2`. The second part of the unit address is one higher than the virtual function number. (In this case, the second component is `2`, so this device is virtual function `1`.) The following output shows that `/dev/ibp0` is a physical function and `/dev/ibp5` is a virtual function.

```
primary# ls -l /dev/ibp0
lrwxrwxrwx   1 root     root          83 Apr 18 12:02 /dev/ibp0 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,673c@0/hermon@0/ibport@1,0,ipib:ibp0
primary# ls -l /dev/ibp5
lrwxrwxrwx   1 root     root          85 Apr 22 23:29 /dev/ibp5 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,1002@0,2/hermon@3/ibport@2,0,ipib:ibp5
```

You can use the OpenFabrics `ibv_devices` command to view the OpenFabrics device name and the node (HCA) GUID. When virtual functions are present, the Type column indicates whether the function is physical or virtual.

```
primary# ibv_devices
device                 node GUID            type
------              ----------------        ----
mlx4_4              0002c90300a38910         PF
mlx4_5              0021280001a17f56         PF
mlx4_0              0002cb0300a38910         VF
mlx4_1              0002ca0300a38910         VF
mlx4_2              00212a0001a17f56         VF
mlx4_3              0021290001a17f56         VF
```

Oracle Solaris 10:

In an Oracle Solaris 10 guest I/O domain, use the `dladm show-dev` command to show each IPoIB instance, which has a name in the form `ibd`*xx*.

```
# dladm show-dev
vnet0           link: up        speed: 0     Mbps       duplex: unknown
ibd0            link: up        speed: 32000 Mbps       duplex: unknown
ibd1            link: up        speed: 32000 Mbps       duplex: unknown
ibd2            link: up        speed: 32000 Mbps       duplex: unknown
ibd3            link: up        speed: 32000 Mbps       duplex: unknown
```

You can use the `ls -l` command on the HCA path names in the `/devices/` directory to extract an HCA and its HCA GUID.

```
# ls -l /devices/ib\:[0-9]*
crw-r--r--   1 root     sys       67,  0 Jun 12 16:27 /devices/ib:212B0001A17F56
crw-r--r--   1 root     sys       67,  0 Jun 12 16:27 /devices/ib:212C0001A17F56
```

The GUIDs in the `ibv_devices` output (note the 11th hexadecimal digit, "B" and "C" in this case) indicate that these are virtual functions assigned to the Oracle Solaris 10 domain. You can obtain more information about the IPoIB instances by using the `ls -l` command on the `/dev` IPoIB path names.

```
# ls -l /dev/ibd*
lrwxrwxrwx   1 root     other         29 May 23 16:26 /dev/ibd ->
../devices/pseudo/clone@0:ibd
lrwxrwxrwx   1 root     root          89 May 31 10:52 /dev/ibd0 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,1002@0,3/hermon@0/ibport@1,ffff,ipib:ibd0
lrwxrwxrwx   1 root     root          89 May 31 10:52 /dev/ibd1 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,1002@0,3/hermon@0/ibport@2,ffff,ipib:ibd1
lrwxrwxrwx   1 root     root          89 Jun 12 18:36 /dev/ibd2 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,1002@0,4/hermon@1/ibport@1,ffff,ipib:ibd2
lrwxrwxrwx   1 root     root          89 Jun 12 18:36 /dev/ibd3 ->
../devices/pci@400/pci@1/pci@0/pci@0/pciex15b3,1002@0,4/hermon@1/ibport@2,ffff,ipib:ibd3
```

Each path begins with the device path that is shows in the `ldm list-io -l` output. The virtual functions such as `pciex15b3,1002@0,4` have a two-part unit address where the second part of the unit address is one higher than the virtual function number (in this case, VF3).

The `ibport` device has a three-part unit address followed by a colon and then the IPoIB device instance name. The first part of the unit address is the port number. The second is the partition key (P-key) hexadecimal value. Note that InfiniBand P-key values are similar to VLANs for Ethernet. The third part is a the string `ipib`.

The `ls -l /dev/ibd3` command output shows that the `ibd3` IPoIB instance uses port `2` and P-key value `ffff`.

Using Fibre Channel SR-IOV Virtual Functions

Starting with the Oracle VM Server for SPARC 3.1.1 release provides support for SR-IOV Fibre Channel. An SR-IOV Fibre Channel host bus adapter (HBA) might have one or more ports each of which appears as SR-IOV physical function. You can identify Fibre Channel physical functions by the `IOVFC` string in its device name.

Each Fibre Channel physical function has unique port and node world-wide name (WWN) values that are provided by the card manufacturer. When you create virtual functions from a Fibre Channel physical function, the virtual functions behave like a Fibre Channel HBA device. Each virtual function must have a unique identity that is specified by the port WWN and node WWN of the SAN fabric. You can use the Logical Domains Manager to automatically or manually assign the port and node WWNs. By assigning your own values, you can fully control the identity of any virtual function.

The Fibre Channel HBA virtual functions use the N_Port ID Virtualization (NPIV) method to log in to the SAN fabric. Because of this NPIV requirement, you must connect the Fibre Channel HBA port to an NPIV-capable Fibre Channel switch. The virtual functions are managed entirely by the hardware or the firmware of the SR-IOV card. Other than these exceptions, Fibre Channel virtual functions work and behave the same way as a non-SR-IOV Fibre Channel HBA device. The SR-IOV virtual functions have the same capabilities as the non-SR-IOV devices, so all types of SAN storage devices are supported in either configuration.

The virtual functions' unique port and node WWN values enable a SAN administrator to assign storage to the virtual functions in the same way as he would for any non-SR-IOV Fibre Channel HBA port. This mananagement includes zoning, LUN masking, and quality of service (QoS). You can configure the storage so that it is accessible exclusively to a specific logical domain without being visible to the physical function in the root domain.

You can use both the static and dynamic SR-IOV methods to manage Fibre Channel SR-IOV devices.

Fibre Channel SR-IOV Hardware Requirements

For information about the required PCIe Fibre Channel SR-IOV hardware, see "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

For Fibre Channel SR-IOV support, the root domain must be running at least the Oracle Solaris 11.1.17.0.0 OS. The I/O domains must be running at least the Oracle Solaris 11.1.17.0.0 OS.

Fibre Channel SR-IOV Requirements and Limitations

The Fibre Channel SR-IOV feature has the following recommendations and limitations:

- The SR-IOV card must run the latest version of firmware that supports the SR-IOV feature.
- The Fibre Channel PCIe card must be connected to a Fibre Channel switch that supports NPIV and that is compatible with the PCIe card.
- The Logical Domains Manager properly autogenerates unique `port-wwn` and `node-wwn` property values by connecting the control domains of all systems to the same SAN fabric and by being part of the same multicast domain.

  If you cannot configure this environment, you must manually provide the `node-wwn` and `port-wwn` values when you create the virtual function. This behavior ensures that there are no naming conflicts. See "World-Wide Name Allocation for Fibre Channel Virtual Functions" on page 137.

Fibre Channel Device Class-Specific Properties

You can use the `ldm create-vf` or the `ldm set-io` commands to set the following Fibre Channel virtual function properties:

`bw-percent` Specifies the percentage of the bandwidth to be allocated to the Fibre Channel virtual function. Valid values are from 0 to 100. The total bandwidth value assigned to a Fibre Channel physical function's virtual functions cannot exceed 100. The default value is 0 so that the virtual function gets a fair share of the bandwidth that is not already reserved by other virtual functions that share the same physical function.

`node-wwn` Specifies the node world-wide name (WWN) for the Fibre Channel virtual function. Valid values are non-zero. By default, this value is allocated automatically. If you manually specify this value, you must also specify a value for the `port-wwn` property. For more information, see "World-Wide Name Allocation for Fibre Channel Virtual Functions" on page 137.

`port-wwn` Specifies the port WWN for the Fibre Channel virtual function. Valid values are non-zero. By default, this value is allocated automatically. If you manually specify this value, you must also specify a value for the `node-wwn` property. For more information, see "World-Wide Name Allocation for Fibre Channel Virtual Functions" on page 137.

You cannot modify the `node-wwn` or the `port-wwn` property values while the Fibre Channel virtual function is in use. However, you can modify the `bw-percent` property value dynamically even when the Fibre Channel virtual function is in use.

World-Wide Name Allocation for Fibre Channel Virtual Functions

The Logical Domains Manager supports both the automatic allocation and the manual assignment of world-wide names for the Fibre Channel virtual functions.

Automatic World-Wide Name Allocation
: Logical Domains Manager allocates a unique MAC address from its automatic MAC address allocation pool and creates IEEE format `node-wwn` and `port-wwn` property values.

```
port-wwn = 10:00:XX:XX:XX:XX:XX:XX
node-wwn = 20:00:XX:XX:XX:XX:XX:XX
```

XX:*XX*:*XX*:*XX*:*XX*:*XX* is the automatically allocated MAC address.

This automatic allocation method produces unique WWNs when the control domains of all systems that are connected to the same Fibre Channel fabric are also connected by Ethernet and are part of the same multicast domain. If you cannot meet this requirement, you must manually assign unique WWNs, which is required on the SAN.

Manual World-Wide Name Allocation
: You can construct unique WWNs by using any method. This section describes how to to create WWNs from the Logical Domains Manager manual MAC address allocation pool. You must guarantee the uniqueness of the WWNs you allocate.

Logical Domains Manager has a pool of 256,000 MAC addresses that are available for manual allocation in the `00:14:4F:FC:00:00` - `00:14:4F:FF:FF:FF` range.

The following example shows the `port-wwn` and `node-wwn` property values based on the `00:14:4F:FC:00:01` MAC address:

```
port-wwn = 10:00:00:14:4F:FC:00:01
node-wwn = 20:00:00:14:4F:FC:00:01
```

`00:14:4F:FC:00:01` is the manually allocated MAC address. For information about automatic MAC address allocation, see "Assigning MAC Addresses Automatically or Manually" on page 200.

Note – It is best to manually assign the WWNs to ensure predictable configuration of the SAN storage.

You must use the manual WWN allocation method when all systems are not connected to the same multicast domain by Ethernet. You can also use this method to guarantee that the same WWNs are used when Fibre Channel virtual functions are destroyed and re-created.

Creating Fibre Channel SR-IOV Virtual Functions

This section describes how to dynamically create and destroy virtual functions. If you cannot use the dynamic methods to perform these actions, initiate a delayed reconfiguration on the root domain before you create or destroy virtual functions.

How to Create a Fibre Channel SR-IOV Virtual Function

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

1. **Identify the physical function device.**

   ```
   primary# ldm list-io
   ```

   Note that the name of the physical function includes the location information for the PCIe SR-IOV card or on-board device.

2. **If I/O virtualization for the bus that has the physical function is not enabled already, enable it.**

   Perform this step only if I/O virtualization is not enabled already for the bus that has the physical function.

   See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

3. **Create a single virtual function or multiple virtual functions from a physical function either dynamically or statically.**

   After you create one or more virtual functions, you can assign them to a guest domain.

   - **Dynamic method:**

     - **To create multiple virtual functions from a physical function all at the same time, use the following command:**

       ```
       primary# ldm create-vf -n number | max pf-name
       ```

       Use the `ldm create-vf -n max` command to create all the virtual functions for that physical function at one time. This command automatically allocates the port and node WWNs for each virtual function and sets the `bw-percent` property to the default value, which is `0`. This value specifies that fair share bandwidth is allocated to all virtual functions.

       Tip – Create all virtual functions for the physical function at once. If you want to manually assign WWNs, first create all of the virtual functions and then use the `ldm set-io` command to manually assign your WWN values for each virtual function. This technique minimizes the number of state transitions when creating virtual functions from a physical function.

       You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

     - **To create one virtual function from a physical function, use the following command:**

       ```
       primary# ldm create-vf [bw-percent=value] [port-wwn=value node-wwn=value] pf-name
       ```

       You can also manually specify Fibre Channel class-specific property values.

- **Static method:**

  a. **Initiate a delayed reconfiguration.**

     ```
     primary# ldm start-reconf root-domain-name
     ```

  b. **Create a single virtual function or multiple virtual functions from a physical function.**

     Use the same commands as shown previously to dynamically create the virtual functions.

  c. **Reboot the root domain.**

     - **To reboot the non-`primary` root domain:**

       ```
       primary# ldm stop-domain -r root-domain
       ```

     - **To reboot the `primary` root domain:**

       ```
       primary# shutdown -i6 -g0 -y
       ```

Example 6–19 Displaying Information About the Fibre Channel Physical Function

This example shows information about the `/SYS/MB/PCIE7/IOVFC.PF0` physical function:

- This physical function is from a board in a PCIe slot, `PCIE7`.
- The `IOVFC` string indicates that the physical function is a Fibre Channel SR-IOV device.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
pci_0                                     BUS    pci_0    primary  IOV
pci_1                                     BUS    pci_1    rootdom1 IOV
niu_0                                     NIU    niu_0    primary
niu_1                                     NIU    niu_1    primary
/SYS/MB/PCIE0                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                             PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                             PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                            PCIE   pci_0    primary  OCC
/SYS/MB/NET0                              PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                             PCIE   pci_1    rootdom1 OCC
/SYS/MB/PCIE3                             PCIE   pci_1    rootdom1 OCC
/SYS/MB/PCIE5                             PCIE   pci_1    rootdom1 OCC
/SYS/MB/PCIE7                             PCIE   pci_1    rootdom1 OCC
/SYS/MB/PCIE9                             PCIE   pci_1    rootdom1 OCC
/SYS/MB/NET2                              PCIE   pci_1    rootdom1 OCC
/SYS/MB/NET0/IOVNET.PF0                   PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                   PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0                  PF     pci_1    rootdom1
/SYS/MB/PCIE5/IOVNET.PF1                  PF     pci_1    rootdom1
/SYS/MB/PCIE7/IOVFC.PF0                   PF     pci_1    rootdom1
/SYS/MB/PCIE7/IOVFC.PF1                   PF     pci_1    rootdom1
```

```
/SYS/MB/NET2/IOVNET.PF0                   PF     pci_1    rootdom1
/SYS/MB/NET2/IOVNET.PF1                   PF     pci_1    rootdom1
```

The following command shows more details about the specified physical function. The `maxvfs` value indicates the maximum number of virtual functions that is supported by the device.

```
primary# ldm list-io -l /SYS/MB/PCIE7/IOVFC.PF0
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
/SYS/MB/PCIE7/IOVNET.PF0                  PF     pci_0    rootdom1
[pci@400/pci@1/pci@0/pci@6/SUNW,fcdev@0]
    maxvfs = 8
```

Example 6–20 Dynamically Creating a Fibre Channel Virtual Function Without Setting Optional Properties

This example dynamically creates a virtual function without setting any optional properties. In this case, the `ldm create-vf` command automatically allocates the default bandwidth percentage, port world-wide name (WWN), and node WWN values.

Ensure that I/O virtualization is enabled on the `pci_1` PCIe bus. See "How to Enable I/O Virtualization for a PCIe Bus" on page 101.

You can use the `ldm create-vf` command to create all the virtual functions from the `/SYS/MB/PCIE7/IOVFC.PF0` physical function.

```
primary# ldm create-vf -n max /SYS/MB/PCIE7/IOVFC.PF0
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF0
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF1
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF2
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF3
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF4
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF5
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF6
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF7
```

Example 6–21 Dynamically Creating a Fibre Channel Virtual Function and Setting Properties

This example dynamically creates a virtual function while setting the `bw-percent` property value to 25 and specifies the port and node WWNs.

```
primary# ldm create-vf port-wwn=10:00:00:14:4F:FC:00:01 \
node-wwn=20:00:00:14:4F:FC:00:01 bw-percent=25 /SYS/MB/PCIE7/IOVFC.PF0
```

Example 6–22 Statically Creating a Fibre Channel Virtual Function Without Setting Optional Properties

This example statically creates a virtual function without setting any optional properties. In this case, the `ldm create-vf` command automatically allocates the default bandwidth percentage, port world-wide name (WWN), and node WWN values.

First you initiate a delayed reconfiguration on the `rootdom1` domain. Then, enable I/O virtualization on the `pci_1` PCIe bus. Because the `pci_1` bus has already been assigned to the `rootdom1` root domain, use the `ldm set-io` command to enable I/O virtualization.

```
primary# ldm start-reconf rootdom1
Initiating a delayed reconfiguration operation on the rootdom1 domain.
All configuration changes for other domains are disabled until the rootdom1
domain reboots, at which time the new configuration for the rootdom1 domain
will also take effect.

primary# ldm set-io iov=on pci_1
```

Now, you can use the `ldm create-vf` command to create all the virtual functions from the `/SYS/MB/PCIE7/IOVFC.PF0` physical function.

```
primary# ldm create-vf -n max /SYS/MB/PCIE7/IOVFC.PF0

------------------------------------------------------------------------------
Notice: The rootdom1 domain is in the process of a delayed reconfiguration.
Any changes made to the rootdom1 domain will only take effect after it reboots.
------------------------------------------------------------------------------

Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF0
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF1
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF2
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF3
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF4
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF5
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF6
Created new vf: /SYS/MB/PCIE7/IOVFC.PF0.VF7
```

Finally, reboot the `rootdom1` root domain to make the changes take effect in one of the following ways:

- `rootdom1` is a non-`primary` root domain

  ```
  primary# ldm stop-domain -r rootdom1
  ```

- `rootdom1` is the `primary` domain

  ```
  primary# shutdown -i6 -g0 -y
  ```

Destroying Fibre Channel SR-IOV Virtual Functions

A virtual function can be destroyed if it is not currently assigned to a domain. A virtual function can be destroyed only in the reverse sequential order of creation, so only the last virtual function that was created can be destroyed. The resulting configuration is validated by the physical function driver.

▼ How to Destroy a Fibre Channel SR-IOV Virtual Function

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

1. **Identify the physical function device.**

   ```
   primary# ldm list-io
   ```

2. **Destroy a single virtual function or multiple virtual functions either dynamically or statically.**

   - **Dynamic method:**

     - **To destroy all of the virtual functions from a physical function at one time, use the following command:**

       ```
       primary# ldm destroy-vf -n number | max pf-name
       ```

       You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

       Use the `ldm destroy-vf -n max` command to destroy all the virtual functions for that physical function at one time.

       If you specify *number* as an argument to the `-n` option, the last *number* of virtual functions are destroyed. Use this method as it performs this operation with only one physical function device driver state transition.

     - **To destroy a specified virtual function:**

       ```
       primary# ldm destroy-vf vf-name
       ```

   - **Static method:**

     a. **Initiate a delayed reconfiguration.**

        ```
        primary# ldm start-reconf root-domain-name
        ```

     b. **Destroy either a single virtual function or multiple virtual functions.**

        - **To destroy all of the virtual functions from the specified physical function at the same time, use the following command:**

          ```
          primary# ldm destroy-vf -n number | max pf-name
          ```

          You can use either the path name or the pseudonym name to specify virtual functions. However, the recommended practice is to use the pseudonym name.

        - **To destroy a specified virtual function:**

          ```
          primary# ldm destroy-vf vf-name
          ```

     c. **Reboot the root domain.**

        - **To reboot the non-`primary` root domain:**

          ```
          primary# ldm stop-domain -r root-domain
          ```

- **To reboot the `primary` root domain:**

```
primary# shutdown -i6 -g0 -y
```

Example 6–23 Dynamically Destroying Multiple Fibre Channel SR-IOV Virtual Functions

This example shows the results of destroying all the virtual functions from the `/SYS/MB/PCIE5/IOVFC.PF1` physical function. The `ldm list-io` output shows that the physical function has eight virtual functions. The `ldm destroy-vf -n max` command destroys all the virtual functions, and the final `ldm list-io` output shows that none of the virtual functions remain.

```
primary# ldm list-io
...
/SYS/MB/PCIE5/IOVFC.PF1                 PF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF0             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF1             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF2             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF3             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF4             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF5             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF6             VF     pci_1
/SYS/MB/PCIE5/IOVFC.PF1.VF7             VF     pci_1
primary# ldm destroy-vf -n max /SYS/MB/PCIE5/IOVFC.PF1
primary# ldm list-io
...
/SYS/MB/PCIE5/IOVFC.PF1                 PF     pci_1
```

Example 6–24 Destroying a Fibre Channel Virtual Function

This example shows how to statically destroy the virtual functions from the `/SYS/MB/PCIE7/IOVFC.PF0` physical function.

```
primary# ldm start-reconf rootdom1
Initiating a delayed reconfiguration operation on the rootdom1 domain.
All configuration changes for other domains are disabled until the rootdom1
domain reboots, at which time the new configuration for the rootdom1 domain
will also take effect.

primary# ldm destroy-vf -n max /SYS/MB/PCIE7/IOVFC.PF0
primary# ldm stop-domain -r rootdom1
```

Modifying Fibre Channel SR-IOV Virtual Functions

The `ldm set-io` command modifies the current configuration of a virtual function by changing the property values or by setting new properties.

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

You can use the `ldm set-io` command to modify the `bw-percent`, `port-wwn`, and `node-wwn` properties.

You can dynamically change only the `bw-percent` propery while the virtual functions are assigned to a domain.

▼ How to Modify a Fibre Channel SR-IOV Virtual Function

1 Identify the physical function device.

```
primary# ldm list-io
```

Note that the name of the physical function includes the location information for the PCIe SR-IOV card or on-board device.

2 Modify a virtual function.

```
primary# ldm set-io [bw-percent=value] [port-wwn=value node-wwn=value] pf-name
```

Unlike the `bw-percent` property value, which you can dynamically change at any time, you can dynamically modify the `port-wwn` and `node-wwn` property values only when the virtual function is not assigned to a domain.

Example 6–25 Modifying a Fibre Channel SR-IOV Virtual Function

This example modifies the specified virtual function, `/SYS/MB/PCIE7/IOVFC.PF0.VF0`, to specify the bandwidth percentage and the port and node WWN values.

```
primary# ldm set-io port-wwn=10:00:00:14:4f:fb:f4:7c \
node-wwn=20:00:00:14:4f:fb:f4:7c bw-percent=25 /SYS/MB/PCIE7/IOVFC.PF0.VF0
```

Adding and Removing Fibre Channel SR-IOV Virtual Functions on I/O Domains

▼ How to Add a Fibre Channel SR-IOV Virtual Function to an I/O Domain

If you cannot dynamically remove the virtual function, use the static method. See "Static SR-IOV" on page 98.

1 Identify the virtual function that you want to add to an I/O domain.

```
primary# ldm list-io
```

2 Add a virtual function either dynamically or statically.

- **To dynamically add a virtual function:**

  ```
  primary# ldm add-io vf-name domain-name
  ```

  vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *domain-name* specifies the name of the domain to which you add the virtual function.

The device path name for the virtual function in the domain is the path shown in the `list-io -l` output.

- **To statically add a virtual function:**

  a. **Stop the domain and then add the virtual function.**

  ```
  primary# ldm stop-domain domain-name
  primary# ldm add-io vf-name domain-name
  ```

  vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the pseudonym name. *domain-name* specifies the name of the domain to which you add the virtual function. The specified guest must be in the inactive or bound state.

  The device path name for the virtual function in the domain is the path shown in the `list-io -l` output.

  b. **Restart the domain.**

  ```
  primary# ldm start-domain domain-name
  ```

Example 6–26 Adding a Fibre Channel Virtual Function

This example shows how to dynamically add the `/SYS/MB/PCIE7/IOVFC.PF0.VF0` virtual function to the `ldg2` domain.

```
primary# ldm add-io /SYS/MB/PCIE7/IOVFC.PF0.VF0 ldg2
```

If you cannot add the virtual function dynamically, use the static method:

```
primary# ldm stop-domain ldg2
primary# ldm add-io /SYS/MB/PCIE7/IOVFC.PF0.VF0 ldg2
primary# ldm start-domain ldg2
```

▼ How to Remove a Fibre Channel SR-IOV Virtual Function From an I/O Domain

If you cannot use this dynamic method, use the static method instead. See "Static SR-IOV" on page 98.

Caution – Before removing the virtual function from the domain, ensure that it is not critical for booting that domain.

1 **Identify the virtual function that you want to remove from an I/O domain.**

```
primary# ldm list-io
```

2. **Remove a virtual function either dynamically or statically.**

   - **To dynamically remove a virtual function:**

     ```
     primary# ldm rm-io vf-name domain-name
     ```

     vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the device pseudonym. *domain-name* specifies the name of the domain from which you remove the virtual function.

   - **To statically remove a virtual function:**

     a. **Stop the I/O domain.**

        ```
        primary# ldm stop-domain domain-name
        ```

     b. **Remove the virtual function.**

        ```
        primary# ldm rm-io vf-name domain-name
        ```

        vf-name is the pseudonym name or the path name of the virtual function. The recommended practice is to use the device pseudonym. *domain-name* specifies the name of the domain from which you remove the virtual function. The specified guest must be in the inactive or bound state.

     c. **Start the I/O domain.**

        ```
        primary# ldm start-domain domain-name
        ```

Example 6–27 Dynamically Removing a Fibre Channel Virtual Function

This example shows how to dynamically remove the `/SYS/MB/PCIE7/IOVFC.PF0.VF0` virtual function from the `ldg2` domain.

```
primary# ldm remove-io /SYS/MB/PCIE7/IOVFC.PF0.VF0 ldg2
```

If the command succeeds, the virtual function is removed from the `ldg2` domain. When `ldg2` is restarted, the specified virtual function no longer appears in that domain.

If you cannot remove the virtual function dynamically, use the static method:

```
primary# ldm stop-domain ldg2
primary# ldm remove-io /SYS/MB/PCIE7/IOVFC.PF0.VF0 ldg2
primary# ldm start-domain ldg2
```

Advanced SR-IOV Topics: Fibre Channel SR-IOV

This section describes some advanced topics related to using Fibre Channel SR-IOV virtual functions.

Accessing a Fibre Channel Virtual Function in a Guest Domain

The `ldg2` console log shows the operations of the assigned Fibre Channel virtual function device. Use the `fcadm` command to view and access the Fibre Channel virtual function device.

```
ldg2# fcadm hba-port
HBA Port WWN: 100000144ffb8a99
       Port Mode: Initiator
       Port ID: 13d02
       OS Device Name: /dev/cfg/c3
       Manufacturer: Emulex
       Model: 7101684
       Firmware Version: 7101684 1.1.60.1
       FCode/BIOS Version: Boot:1.1.60.1 Fcode:4.03a4
       Serial Number: 4925382+133400002R
       Driver Name: emlxs
       Driver Version: 2.90.15.0 (2014.01.22.14.50)
       Type: N-port
       State: online
       Supported Speeds: 4Gb 8Gb 16Gb
       Current Speed: 16Gb
       Node WWN: 200000144ffb8a99
       NPIV Not Supported
```

The output shows that the Fibre Channel port is connected to a Fibre Channel switch. Use the `format` command to show the visible LUNs.

```
ldg2# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
   0. c2d0 <Unknown-Unknown-0001-25.00GB>
      /virtual-devices@100/channel-devices@200/disk@0
   1. c3t21000024FF4C4BF8d0 <SUN-COMSTAR-1.0-10.00GB>
      /pci@340/pci@1/pci@0/pci@6/SUNW,emlxs@0,2/fp@0,0/ssd@w21000024ff4c4bf8,0
Specify disk (enter its number): ^D
ldg2#
```

SR-IOV: Rebooting the Root Domain

Take care when rebooting the root domain. As with PCIe slots in the I/O domain, the concerns that are described in "Rebooting the Root Domain" on page 87 also pertain to the virtual functions that are assigned to an I/O domain.

Using Non-primary Root Domains

Prior to Oracle VM Server for SPARC 3.1, direct I/O and SR-IOV support was limited to PCIe buses assigned to the `primary` domain only. Now, this software extends the support for direct I/O and SR-IOV operations on PCIe buses that are assigned to root domains other than the `primary`. You can now perform the following operations for all root domains, including non-`primary` root domains:

- Show the status of PCIe slots
- Show the SR-IOV physical functions that are present
- Assign a PCIe slot to an I/O domain or a root domain
- Remove a PCIe slot from an I/O domain or a root domain
- Create a virtual function from its physical function
- Destroy a virtual function
- Assign a virtual function to another domain
- Remove a virtual function from another domain

The Logical Domains Manager obtains the PCIe endpoint devices and SR-IOV physical function devices from the Logical Domains agents that run in the non-`primary` root domains. This information is cached while the root domain is down after it is first discovered but only until the root domain is booted.

You can perform direct I/O and SR-IOV operations only when the root domain is active. Logical Domains Manager operates on the actual devices that are present at that time. The cached data might be refreshed when the following operations occur:

- The Logical Domains agent is restarted in the specified root domain
- A hardware change, such as a hot-plug operation, is performed in the specified root domain

Use the `ldm list-io` command to view the PCIe endpoint device status. The output also shows the sub-devices and physical function devices from the root complexes that are owned by each non-`primary` root domain.

You can use apply the following commands to any root domain:

- `ldm add-io`
- `ldm remove-io`
- `ldm set-io`
- `ldm create-vf`
- `ldm destroy-vf`
- `ldm start-reconf`
- `ldm cancel-reconf`

Delayed reconfiguration support has been extended to include non-`primary` root domains. However, it can be used *only* to run the `ldm add-io`, `ldm remove-io`, `ldm set-io`, `ldm create-vf` and `ldm destroy-vf` commands. The delayed reconfiguration can be used for any operation that cannot be completed by using dynamic operations such as the following:

- Performing direct I/O operations
- Creating and destroying virtual functions from a physical function that does not meet the dynamic SR-IOV configuration requirements.

Caution – Plan ahead to minimize the number of reboots of the root domain, which minimizes downtime.

Non-primary Root Domain Requirements

The direct I/O and SR-IOV virtualization features for non-`primary` root domains depend on the appropriate version of the Oracle VM Server for SPARC 3.1 system firmware for your platform. See "Direct I/O Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* and "PCIe SR-IOV Hardware and Software Requirements" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Non-primary Root Domain Limitations

Use of the non-`primary` root domain has the following limitations:

- Support for delayed reconfiguration has been extended to the non-`primary` root domains. Only the following commands can be run until that root domain has been rebooted or the delayed reconfiguration has been canceled:
  - `ldm add-io`
  - `ldm remove-io`
  - `ldm set-io`
  - `ldm create-vf`
  - `ldm destroy-vf`
- The root domain must be active and booted to perform the following operations:
  - Creating and destroying SR-IOV virtual functions
  - Adding and removing PCIe slots
  - Adding and removing SR-IOV virtual functions
- You must initiate a delayed reconfiguration on the root domain when you perform the `ldm add-io` and `ldm remove-io` direct I/O operations for PCIe slots.
- When your configuration does not meet the dynamic I/O virtualization requirements, you must use delayed reconfiguration for the following SR-IOV virtual function operations:
  - `ldm create-vf`
  - `ldm destroy-vf`
  - `ldm add-io`
  - `ldm remove-io`
  - `ldm set-io`

- The reboot of a root domain affects any I/O domain that has a device from the PCIe buses that the root domain owns. See "Rebooting the Root Domain" on page 87.
- You cannot assign an SR-IOV virtual function or a PCIe slot from one root domain to another root domain. This limitation prevents circular dependencies.

Enabling I/O Virtualization for a PCIe Bus

The following example shows how to enable I/O virtualization by using the `ldm add-io` and `ldm set-io` commands.

The following SPARC T4-2 I/O configuration shows that bus `pci_1` already has been removed from the `primary` domain.

```
primary# ldm list-io
NAME                                      TYPE   BUS      DOMAIN   STATUS
----                                      ----   ---      ------   ------
pci_0                                     BUS    pci_0    primary  IOV
pci_1                                     BUS    pci_1
niu_0                                     NIU    niu_0    primary
niu_1                                     NIU    niu_1    primary
/SYS/MB/PCIE0                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                             PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                             PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                             PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                            PCIE   pci_0    primary  OCC
/SYS/MB/NET0                              PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                             PCIE   pci_1             UNK
/SYS/MB/PCIE3                             PCIE   pci_1             UNK
/SYS/MB/PCIE5                             PCIE   pci_1             UNK
/SYS/MB/PCIE7                             PCIE   pci_1             UNK
/SYS/MB/PCIE9                             PCIE   pci_1             UNK
/SYS/MB/NET2                              PCIE   pci_1             UNK
/SYS/MB/NET0/IOVNET.PF0                   PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                   PF     pci_0    primary
```

The following listing shows that the guest domains are in the bound state:

```
primary# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    8     8G       0.6%  0.6%  8m
rootdom1         bound      ------  5000    8     4G
ldg2             bound      ------  5001    8     4G
ldg3             bound      ------  5002    8     4G
```

The following `ldm add-io` command adds the `pci_1` bus to the `rootdom1` domain with I/O virtualization enabled for that bus. The `ldm start` command starts the `rootdom1` domain.

```
primary# ldm add-io iov=on pci_1 rootdom1
primary# ldm start rootdom1
LDom rootdom1 started
```

If a specified PCIe bus is assigned already to a root domain, use the `ldm set-io` command to enable I/O virtualization.

```
primary# ldm start-reconf rootdom1
primary# ldm set-io iov=on pci_1
primary# ldm stop-domain -r rootdom1
```

The root domain must be running its OS before you can configure the I/O devices. Connect to the console of the `rootdom1` guest domain and then boot the OS of the `rootdom1` root domain if your guest domains are not already set to autoboot.

```
primary# telnet localhost 5000
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
Connecting to console "rootdom1" in group "rootdom1" ....
Press ~? for control options ..
ok> boot
...
primary#
```

The following command shows that the `pci_1` PCIe bus and its children are now owned by the `rootdom1` root domain.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN   STATUS
----                                    ----   ---      ------   ------
pci_0                                   BUS    pci_0    primary  IOV
pci_1                                   BUS    pci_1    rootdom1     IOV
niu_0                                   NIU    niu_0    primary
niu_1                                   NIU    niu_1    primary
/SYS/MB/PCIE0                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                           PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                           PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                          PCIE   pci_0    primary  OCC
/SYS/MB/NET0                            PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                           PCIE   pci_1    rootdom1     OCC
/SYS/MB/PCIE3                           PCIE   pci_1    rootdom1     OCC
/SYS/MB/PCIE5                           PCIE   pci_1    rootdom1     OCC
/SYS/MB/PCIE7                           PCIE   pci_1    rootdom1     OCC
/SYS/MB/PCIE9                           PCIE   pci_1    rootdom1     EMP
/SYS/MB/NET2                            PCIE   pci_1    rootdom1     OCC
/SYS/MB/NET0/IOVNET.PF0                 PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                 PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0                PF     pci_1    rootdom1
/SYS/MB/PCIE5/IOVNET.PF1                PF     pci_1    rootdom1
/SYS/MB/NET2/IOVNET.PF0                 PF     pci_1    rootdom1
/SYS/MB/NET2/IOVNET.PF1                 PF     pci_1    rootdom1
```

Managing Direct I/O Devices on Non-primary Root Domains

The following example shows how to manage direct I/O devices on non-`primary` root domains.

The following command produces an error because it attempts to remove a slot from the root domain while it is still active:

```
primary# ldm rm-io /SYS/MB/PCIE7 ldg1
Dynamic I/O operations on PCIe slots are not supported.
Use start-reconf command to trigger delayed reconfiguration and make I/O
changes statically.
```

The following command shows the correct method of removing a slot by first initiating a delayed reconfiguration on the root domain.

```
primary# ldm start-reconf ldg1
Initiating a delayed reconfiguration operation on the ldg1 domain.
All configuration changes for other domains are disabled until the ldg1
domain reboots, at which time the new configuration for the ldg1 domain
will also take effect.
primary# ldm rm-io /SYS/MB/PCIE7 ldg1
--------------------------------------------------------------------------------
Notice: The ldg1 domain is in the process of a delayed reconfiguration.
Any changes made to the ldg1 domain will only take effect after it reboots.
--------------------------------------------------------------------------------
primary# ldm stop-domain -r ldg1
```

The following `ldm list-io` command verifies that the `/SYS/MB/PCIE7` slot is no longer on the root domain.

```
primary# ldm list-io
NAME                                TYPE   BUS      DOMAIN   STATUS
----                                ----   ---      ------   ------
pci_0                               BUS    pci_0    primary  IOV
pci_1                               BUS    pci_1    ldg1     IOV
niu_0                               NIU    niu_0    primary
niu_1                               NIU    niu_1    primary
/SYS/MB/PCIE0                       PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                       PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                       PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                       PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                       PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                      PCIE   pci_0    primary  OCC
/SYS/MB/NET0                        PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                       PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE3                       PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE5                       PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE7                       PCIE   pci_1             OCC
/SYS/MB/PCIE9                       PCIE   pci_1    ldg1     EMP
/SYS/MB/NET2                        PCIE   pci_1    ldg1     OCC
/SYS/MB/NET0/IOVNET.PF0             PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1             PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0            PF     pci_1    ldg1
```

```
/SYS/MB/PCIE5/IOVNET.PF1                PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF0                 PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF1                 PF     pci_1    ldg1
```

The following commands assign the `/SYS/MB/PCIE7` slot to the `ldg2` domain. The `ldm start` command starts the `ldg2` domain.

```
primary# ldm add-io /SYS/MB/PCIE7 ldg2
primary# ldm start ldg2
LDom ldg2 started
```

Managing SR-IOV Virtual Functions on Non-primary Root Domains

These commands create two virtual functions from each of the two physical functions that belong to the non-`primary` root domain.

```
primary# ldm create-vf /SYS/MB/PCIE5/IOVNET.PF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF0
primary# ldm create-vf /SYS/MB/PCIE5/IOVNET.PF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF1
primary# ldm create-vf /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF0
primary# ldm create-vf /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF1
```

You can also use the `-n` option to create the two virtual functions by using the following two commands:

```
primary# ldm create-vf -n 2 /SYS/MB/PCIE5/IOVNET.PF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF1
primary# ldm create-vf -n 2 /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF0
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF1
```

If you were unable to dynamically create the virtual functions on a given physical function, initiate a delayed reconfiguration to create them statically.

```
primary# ldm start-reconf ldg1
primary# ldm create-vf /SYS/MB/PCIE5/IOVNET.PF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF0
primary# ldm create-vf /SYS/MB/PCIE5/IOVNET.PF0
Created new vf: /SYS/MB/PCIE5/IOVNET.PF0.VF1
primary# ldm create-vf /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF0
primary# ldm create-vf /SYS/MB/NET2/IOVNET.PF1
Created new vf: /SYS/MB/NET2/IOVNET.PF1.VF1
```

Then reboot the root domain, `ldg1`, to effect the changes.

```
primary# ldm stop-domain -r ldg1
```

The following command shows the new virtual functions.

```
primary# ldm list-io
NAME                                    TYPE   BUS      DOMAIN   STATUS
----                                    ----   ---      ------   ------
pci_0                                   BUS    pci_0    primary  IOV
pci_1                                   BUS    pci_1    ldg1     IOV
niu_0                                   NIU    niu_0    primary
niu_1                                   NIU    niu_1    primary
/SYS/MB/PCIE0                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                           PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                           PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                          PCIE   pci_0    primary  OCC
/SYS/MB/NET0                            PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE3                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE5                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE7                           PCIE   pci_1    ldg2     OCC
/SYS/MB/PCIE9                           PCIE   pci_1    ldg1     EMP
/SYS/MB/NET2                            PCIE   pci_1    ldg1     OCC
/SYS/MB/NET0/IOVNET.PF0                 PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                 PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0                PF     pci_1    ldg1
/SYS/MB/PCIE5/IOVNET.PF1                PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF0                 PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF1                 PF     pci_1    ldg1
/SYS/MB/PCIE5/IOVNET.PF0.VF0            VF     pci_1
/SYS/MB/PCIE5/IOVNET.PF0.VF1            VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF0             VF     pci_1
/SYS/MB/NET2/IOVNET.PF1.VF1             VF     pci_1
```

The following command dynamically adds the `/SYS/MB/PCIE5/IOVNET.PF0.VF1` virtual function to the `ldg1` non-`primary` root domain:

```
primary# ldm add-io /SYS/MB/PCIE5/IOVNET.PF0.VF1 ldg1
```

The following command dynamically adds the `/SYS/MB/NET2/IOVNET.PF1.VF0` virtual function to the `ldg2` domain:

```
primary# ldm add-io /SYS/MB/NET2/IOVNET.PF1.VF0 ldg2
```

The following command adds the `/SYS/MB/NET2/IOVNET.PF1.VF1` virtual function to the bound `ldg3` domain:

```
primary# ldm add-io /SYS/MB/NET2/IOVNET.PF1.VF1 ldg3
primary# ldm start ldg3
LDom ldg3 started
```

Connect to the console of the `ldg3` domain and then boot its OS.

The following output shows that all the assignments appear as expected. One virtual function is unassigned so it can be assigned dynamically to the `ldg1`, `ldg2`, or `ldg3` domain.

```
# ldm list-io
NAME                                    TYPE   BUS      DOMAIN   STATUS
----                                    ----   ---      ------   ------
pci_0                                   BUS    pci_0    primary  IOV
pci_1                                   BUS    pci_1    ldg1     IOV
niu_0                                   NIU    niu_0    primary
niu_1                                   NIU    niu_1    primary
/SYS/MB/PCIE0                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE2                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE4                           PCIE   pci_0    primary  OCC
/SYS/MB/PCIE6                           PCIE   pci_0    primary  EMP
/SYS/MB/PCIE8                           PCIE   pci_0    primary  EMP
/SYS/MB/SASHBA                          PCIE   pci_0    primary  OCC
/SYS/MB/NET0                            PCIE   pci_0    primary  OCC
/SYS/MB/PCIE1                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE3                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE5                           PCIE   pci_1    ldg1     OCC
/SYS/MB/PCIE7                           PCIE   pci_1    ldg2     OCC
/SYS/MB/PCIE9                           PCIE   pci_1    ldg1     EMP
/SYS/MB/NET2                            PCIE   pci_1    ldg1     OCC
/SYS/MB/NET0/IOVNET.PF0                 PF     pci_0    primary
/SYS/MB/NET0/IOVNET.PF1                 PF     pci_0    primary
/SYS/MB/PCIE5/IOVNET.PF0                PF     pci_1    ldg1
/SYS/MB/PCIE5/IOVNET.PF1                PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF0                 PF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF1                 PF     pci_1    ldg1
/SYS/MB/PCIE5/IOVNET.PF0.VF0            VF     pci_1
/SYS/MB/PCIE5/IOVNET.PF0.VF1            VF     pci_1    ldg1
/SYS/MB/NET2/IOVNET.PF1.VF0             VF     pci_1    ldg2
/SYS/MB/NET2/IOVNET.PF1.VF1             VF     pci_1    ldg3
```

◆ ◆ ◆ CHAPTER 7

Using Virtual Disks

This chapter describes how to use virtual disks with Oracle VM Server for SPARC software.

This chapter covers the following topics:

Introduction to Virtual Disks

A virtual disk contains two components: the virtual disk itself as it appears in a guest domain, and the virtual disk back end, which is where data is stored and where virtual I/O is sent. The virtual disk back end is exported from a service domain by the virtual disk server (`vds`) driver. The `vds` driver communicates with the virtual disk client (`vdc`) driver in the guest domain through the hypervisor using a logical domain channel (LDC). Finally, a virtual disk appears as `/dev/[r]dsk/cXdYsZ` devices in the guest domain.

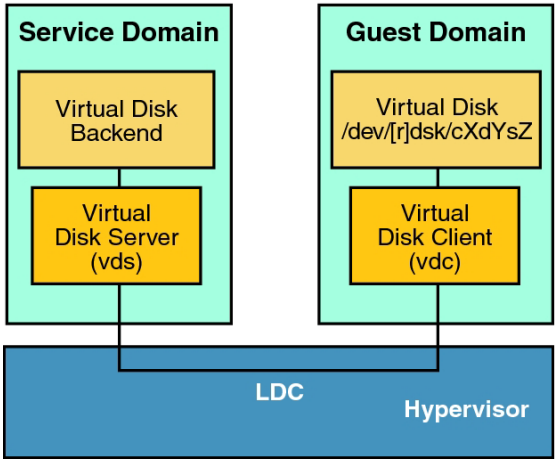
The virtual disk back end can be physical or logical. Physical devices can include the following:

- Physical disk or disk logical unit number (LUN)
- Physical disk slice

Logical devices can be any of the following:

- A file on a local file system, such as ZFS or UFS, or on a remote file system that is made available by means of NFS
- A logical volume from a volume manager, such as ZFS, VxVM, or Solaris Volume Manager
- Any disk pseudo device accessible from the service domain

FIGURE 7–1 Virtual Disks With Oracle VM Server for SPARC



Virtual Disk Identifier and Device Name

When you use the `ldm add-vdisk` command to add a virtual disk to a domain, you can specify its device number by setting the `id` property.

```
# ldm add-vdisk [id=disk-id] disk-name volume-name@service-name ldom
```

Each virtual disk of a domain has a unique device number that is assigned when the domain is bound. If a virtual disk is added with an explicit device number (by setting the `id` property), the specified device number is used. Otherwise, the system automatically assigns the lowest device number available. In that case, the device number assigned depends on how virtual disks were added to the domain. The device number eventually assigned to a virtual disk is visible in the output of the `ldm list-bindings` command when a domain is bound.

When a domain with virtual disks is running the Oracle Solaris OS, each virtual disk appears in the domain as a `c0d`*n* disk device, where *n* is the device number of the virtual disk.

In the following example, the `ldg1` domain has two virtual disks: `rootdisk` and `pdisk`. `rootdisk` has a device number of `0` (`disk@0`) and appears in the domain as the disk device `c0d0`. `pdisk` has a device number of `1` (`disk@1`) and appears in the domain as the disk device `c0d1`.

```
primary# ldm list-bindings ldg1
...
DISK
    NAME             VOLUME                          TOUT DEVICE  SERVER         MPGROUP
    rootdisk         dsk_nevada@primary-vds0              disk@0  primary
    pdisk            c3t40d1@primary-vds0                 disk@1  primary
...
```

Caution – If a device number is not explicitly assigned to a virtual disk, its device number can change when the domain is unbound and is later bound again. In that case, the device name assigned by the OS running in the domain can also change and break the existing configuration of the system. This might happen, for example, when a virtual disk is removed from the configuration of the domain.

Managing Virtual Disks

This section describes adding a virtual disk to a guest domain, changing virtual disk and timeout options, and removing a virtual disk from a guest domain. See "Virtual Disk Back End Options" on page 162 for a description of virtual disk options. See "Virtual Disk Timeout" on page 176 for a description of the virtual disk timeout.

A virtual disk back end can be exported multiple times either through the same or different virtual disk servers. Each exported instance of the virtual disk back end can then be assigned to either the same or different guest domains.

When a virtual disk back end is exported multiple times, it should not be exported with the exclusive (`excl`) option. Specifying the `excl` option will only allow exporting the back end once. The back end can be safely exported multiple times as a read-only device with the `ro` option.

▼ How to Add a Virtual Disk

1 **Export the virtual disk back end from a service domain.**

```
# ldm add-vdsdev [-fq] [options={ro,slice,excl}] [mpgroup=mpgroup] \
backend volume-name@service-name
```

2 **Assign the back end to a guest domain.**

```
# ldm add-vdisk [timeout=seconds] [id=disk-id] disk-name volume-name@service-name ldom
```

You can specify a custom ID of a new virtual disk device by setting the `id` property. By default, ID values are automatically generated, so set this property if you need to match an existing device name in the OS. See "Virtual Disk Identifier and Device Name" on page 158.

Note – A back end is actually exported from the service domain and assigned to the guest domain when the guest domain (*ldom*) is bound.

How to Export a Virtual Disk Back End Multiple Times

Caution – When a virtual disk back end is exported multiple times, applications running on guest domains and using that virtual disk are responsible for coordinating and synchronizing concurrent write access to ensure data coherency.

The following example describes how to add the same virtual disk to two different guest domains through the same virtual disk service.

1. **Export the virtual disk back end two times from a service domain.**

```
# ldm add-vdsdev [options={ro,slice}] backend volume1@service-name
# ldm add-vdsdev -f [options={ro,slice}] backend volume2@service-name
```

Note that the second `ldm add-vdsdev` command uses the `-f` option to force the second export of the back end. Use this option when using the same back-end path for both commands and when the virtual disk servers are located on the same service domain.

2. **Assign the exported back end to each guest domain.**

The *disk-name* can be different for `ldom1` and `ldom2`.

```
# ldm add-vdisk [timeout=seconds] disk-name volume1@service-name ldom1
# ldm add-vdisk [timeout=seconds] disk-name volume2@service-name ldom2
```

How to Change Virtual Disk Options

For more information about virtual disk options, see "Virtual Disk Back End Options" on page 162.

- **After a back end is exported from the service domain, you can change the virtual disk options.**

```
# ldm set-vdsdev options=[{ro,slice,excl}] volume-name@service-name
```

How to Change the Timeout Option

For more information about virtual disk options, see "Virtual Disk Back End Options" on page 162.

- **After a virtual disk is assigned to a guest domain, you can change the timeout of the virtual disk.**

```
# ldm set-vdisk timeout=seconds disk-name ldom
```

▼ How to Remove a Virtual Disk

1. **Remove a virtual disk from a guest domain.**

   `# ldm rm-vdisk` *disk-name ldom*

2. **Stop exporting the corresponding back end from the service domain.**

   `# ldm rm-vdsdev` *volume-name@service-name*

Virtual Disk Appearance

When a back end is exported as a virtual disk, it can appear in the guest domain either as a full disk or as a single-slice disk. The way it appears depends on the type of the back end and on the options used to export it.

Full Disk

When a back end is exported to a domain as a full disk, it appears in that domain as a regular disk with eight slices (`s0` to `s7`). This type of disk is visible with the `format`(1M) command. The disk's partition table can be changed using either the `fmthard` or `format` command.

A full disk is also visible to the OS installation software and can be selected as a disk onto which the OS can be installed.

Any back end can be exported as a full disk except physical disk slices that can be exported only as single-slice disks.

Single-Slice Disk

When a back end is exported to a domain as a single-slice disk, it appears in that domain as a regular disk with eight slices (`s0` to `s7`). However, only the first slice (`s0`) is usable. This type of disk is visible with the `format`(1M) command, but the disk's partition table cannot be changed.

A single-slice disk is also visible from the OS installation software and can be selected as a disk onto which you can install the OS. In that case, if you install the OS using the UNIX File System (UFS), then only the root partition (`/`) must be defined, and this partition must use all the disk space.

Any back end can be exported as a single-slice disk except physical disks that can only be exported as full disks.

Note – Prior to the Oracle Solaris 10 10/08 OS release, a single-slice disk appeared as a disk with a single partition (`s0`). This type of disk was not visible with the `format` command. The disk also was not visible from the OS installation software and could not be selected as a disk device onto which the OS could be installed.

Virtual Disk Back End Options

Different options can be specified when exporting a virtual disk back end. These options are indicated in the `options=` argument of the `ldm add-vdsdev` command as a comma-separated list. The valid options are: `ro`, `slice`, and `excl`.

Read-only (ro) Option

The read-only (`ro`) option specifies that the back end is to be exported as a read-only device. In that case, the virtual disk assigned to the guest domain can be accessed only for read operations, and any write operation to the virtual disk will fail.

Exclusive (excl) Option

The exclusive (`excl`) option specifies that the back end in the service domain has to be opened exclusively by the virtual disk server when it is exported as a virtual disk to another domain. When a back end is opened exclusively, it is not accessible by other applications in the service domain. This restriction prevents the applications running in the service domain from inadvertently using a back end that is also being used by a guest domain.

Note – Some drivers do not honor the `excl` option and will disallow some virtual disk back ends from being opened exclusively. The `excl` option is known to work with physical disks and slices, but the option does not work with files. It might work with pseudo devices, such as disk volumes. If the driver of the back end does not honor the exclusive open, the back end `excl` option is ignored, and the back end is not opened exclusively.

Because the `excl` option prevents applications running in the service domain from accessing a back end exported to a guest domain, do not set the `excl` option in the following situations:

- When guest domains are running, if you want to be able to use commands such as `format` or `luxadm` to manage physical disks, then do not export these disks with the `excl` option.
- When you export a Solaris Volume Manager volume, such as a RAID or a mirrored volume, do not set the `excl` option. Otherwise, this can prevent Solaris Volume Manager from starting some recovery operation in case a component of the RAID or mirrored volume fails. See "Using Virtual Disks With Solaris Volume Manager" on page 182 for more information.
- If the Veritas Volume Manager (VxVM) is installed in the service domain and Veritas Dynamic Multipathing (VxDMP) is enabled for physical disks, then physical disks have to be exported without the (non-default) `excl` option. Otherwise, the export fails, because the virtual disk server (`vds`) is unable to open the physical disk device. See "Using Virtual Disks When VxVM Is Installed" on page 183 for more information.
- If you are exporting the same virtual disk back end multiple times from the same virtual disk service, see "How to Export a Virtual Disk Back End Multiple Times" on page 160 for more information.

By default, the back end is opened non-exclusively. That way the back end still can be used by applications running in the service domain while it is exported to another domain.

Slice (slice) Option

A back end is normally exported either as a full disk or as a single-slice disk depending on its type. If the `slice` option is specified, then the back end is forcibly exported as a single-slice disk.

This option is useful when you want to export the raw content of a back end. For example, if you have a ZFS or Solaris Volume Manager volume where you have already stored data and you want your guest domain to access this data, then you should export the ZFS or Solaris Volume Manager volume using the `slice` option.

For more information about this option, see "Virtual Disk Back End" on page 163.

Virtual Disk Back End

The virtual disk back end is the location where data of a virtual disk are stored. The back end can be a disk, a disk slice, a file, or a volume, such as ZFS, Solaris Volume Manager, or VxVM. A back end appears in a guest domain either as a full disk or as single-slice disk, depending on whether the `slice` option is set when the back end is exported from the service domain. By default, a virtual disk back end is exported non-exclusively as a readable-writable full disk.

Physical Disk or Disk LUN

A physical disk or disk LUN is always exported as a full disk. In that case, virtual disk drivers (`vds` and `vdc`) forward I/O from the virtual disk and act as a pass-through to the physical disk or disk LUN.

A physical disk or disk LUN is exported from a service domain by exporting the device that corresponds to the slice 2 (`s2`) of that disk without setting the `slice` option. If you export the slice 2 of a disk with the `slice` option, only this slice is exported and not the entire disk.

▼ How to Export a Physical Disk as a Virtual Disk

Caution – When configuring virtual disks, ensure that each virtual disk references a distinct physical (back-end) resource, such as a physical disk, a disk slice, a file, or a volume.

Some disks, such as FibreChannel and SAS, have a "dual-ported" nature, which means that the same disk can be referenced by two different paths. Ensure that the paths you assign to different domains do not refer to the same physical disk.

1 Export a physical disk as a virtual disk.

For example, to export the physical disk `c1t48d0` as a virtual disk, you must export slice 2 of that disk (`c1t48d0s2`).

```
primary# ldm add-vdsdev /dev/dsk/c1t48d0s2 c1t48d0@primary-vds0
```

2 Assign the disk to a guest domain.

For example, assign the disk (`pdisk`) to guest domain `ldg1`.

```
primary# ldm add-vdisk pdisk c1t48d0@primary-vds0 ldg1
```

3 After the guest domain is started and running the Oracle Solaris OS, verify that the disk is accessible and is a full disk.

A full disk is a regular disk that has eight (8) slices.

For example, the disk being checked is `c0d1`.

```
ldg1# ls -1 /dev/dsk/c0d1s*
/dev/dsk/c0d1s0
/dev/dsk/c0d1s1
/dev/dsk/c0d1s2
/dev/dsk/c0d1s3
/dev/dsk/c0d1s4
/dev/dsk/c0d1s5
/dev/dsk/c0d1s6
/dev/dsk/c0d1s7
```

Physical Disk Slice

A physical disk slice is always exported as a single-slice disk. In that case, virtual disk drivers (`vds` and `vdc`) forward I/O from the virtual disk and act as a pass-through to the physical disk slice.

A physical disk slice is exported from a service domain by exporting the corresponding slice device. If the device is different from slice 2 then it is automatically exported as a single-slice disk regardless of whether you specify the `slice` option. If the device is the slice 2 of the disk, you must set the `slice` option to export only slice 2 as a single-slice disk. Otherwise, the entire disk is exported as full disk.

▼ How to Export a Physical Disk Slice as a Virtual Disk

1. **Export a slice of a physical disk as a virtual disk.**

   For example, to export slice 0 of the physical disk `c1t57d0` as a virtual disk, you must export the device that corresponds to that slice (`c1t57d0s0`) as follows.

   ```
   primary# ldm add-vdsdev /dev/dsk/c1t57d0s0 c1t57d0s0@primary-vds0
   ```

   You do not need to specify the `slice` option because a slice is always exported as a single-slice disk.

2. **Assign the disk to a guest domain.**

   For example, assign the disk (`pslice`) to guest domain `ldg1`.

   ```
   primary# ldm add-vdisk pslice c1t57d0s0@primary-vds0 ldg1
   ```

3. **After the guest domain is started and running the Oracle Solaris OS, you can list the disk (`c0d13`, for example) and see that the disk is accessible.**

   ```
   ldg1# ls -1 /dev/dsk/c0d13s*
   /dev/dsk/c0d13s0
   /dev/dsk/c0d13s1
   /dev/dsk/c0d13s2
   /dev/dsk/c0d13s3
   /dev/dsk/c0d13s4
   /dev/dsk/c0d13s5
   /dev/dsk/c0d13s6
   /dev/dsk/c0d13s7
   ```

   Although there are eight devices, because the disk is a single-slice disk, only the first slice (`s0`) is usable.

▼ How to Export Slice 2

- **To export slice 2 (disk `c1t57d0s2`, for example) you must specify the `slice` option. Otherwise, the entire disk is exported.**

```
# ldm add-vdsdev options=slice /dev/dsk/c1t57d0s2 c1t57d0s2@primary-vds0
```

File and Volume Exporting

A file or volume (for example from ZFS or Solaris Volume Manager) is exported either as a full disk or as single-slice disk depending on whether the `slice` option is set.

File or Volume Exported as a Full Disk

If you do not set the `slice` option, a file or volume is exported as a full disk. In that case, virtual disk drivers (`vds` and `vdc`) forward I/O from the virtual disk and manage the partitioning of the virtual disk. The file or volume eventually becomes a disk image containing data from all slices of the virtual disk and the metadata used to manage the partitioning and disk structure.

When a blank file or volume is exported as full disk, it appears in the guest domain as an unformatted disk; that is, a disk with no partition. Then you need to run the `format` command in the guest domain to define usable partitions and to write a valid disk label. Any I/O to the virtual disk fails while the disk is unformatted.

Note – You must run the `format` command in the guest domain to create partitions.

▼ How to Export a File as a Full Disk

1. **From the service domain, create a file (`fdisk0` for example) to use as the virtual disk.**

```
service# mkfile 100m /ldoms/domain/test/fdisk0
```

   The size of the file defines the size of the virtual disk. This example creates a 100-Mbyte blank file to get a 100-Mbyte virtual disk.

2. **From the control domain, export the file as a virtual disk.**

```
primary# ldm add-vdsdev /ldoms/domain/test/fdisk0 fdisk0@primary-vds0
```

   In this example, the `slice` option is not set, so the file is exported as a full disk.

3. **From the control domain, assign the disk to a guest domain.**

   For example, assign the disk (`fdisk`) to guest domain `ldg1`.

```
primary# ldm add-vdisk fdisk fdisk0@primary-vds0 ldg1
```

4 After the guest domain is started and running the Oracle Solaris OS, verify that the disk is accessible and is a full disk.

A full disk is a regular disk with eight slices.

The following example shows how to list the disk, `c0d5`, and verify that it is accessible and is a full disk.

```
ldg1# ls -1 /dev/dsk/c0d5s*
/dev/dsk/c0d5s0
/dev/dsk/c0d5s1
/dev/dsk/c0d5s2
/dev/dsk/c0d5s3
/dev/dsk/c0d5s4
/dev/dsk/c0d5s5
/dev/dsk/c0d5s6
/dev/dsk/c0d5s7
```

▼ How to Export a ZFS Volume as a Full Disk

1 Create a ZFS volume to use as a full disk.

The following example shows how to create a ZFS volume, `zdisk0`, to use as a full disk:

```
service# zfs create -V 100m ldoms/domain/test/zdisk0
```

The size of the volume defines the size of the virtual disk. This example creates a 100-Mbyte volume to result in a 100-Mbyte virtual disk.

2 From the control domain, export the corresponding device to that ZFS volume.

```
primary# ldm add-vdsdev /dev/zvol/dsk/ldoms/domain/test/zdisk0 \
zdisk0@primary-vds0
```

In this example, the `slice` option is not set so the file is exported as a full disk.

3 From the control domain, assign the volume to a guest domain.

The following example shows how to assign the volume, `zdisk0`, to the guest domain `ldg1`:

```
primary# ldm add-vdisk zdisk0 zdisk0@primary-vds0 ldg1
```

4 After the guest domain is started and running the Oracle Solaris OS, verify that the disk is accessible and is a full disk.

A full disk is a regular disk with eight slices.

The following example shows how to list the disk, `c0d9`, and verify that it is accessible and is a full disk:

```
ldg1# ls -1 /dev/dsk/c0d9s*
/dev/dsk/c0d9s0
/dev/dsk/c0d9s1
/dev/dsk/c0d9s2
/dev/dsk/c0d9s3
/dev/dsk/c0d9s4
/dev/dsk/c0d9s5
```

```
/dev/dsk/c0d9s6
/dev/dsk/c0d9s7
```

File or Volume Exported as a Single-Slice Disk

If the `slice` option is set, then the file or volume is exported as a single-slice disk. In that case, the virtual disk has only one partition (`s0`), which is directly mapped to the file or volume back end. The file or volume only contains data written to the virtual disk with no extra data like partitioning information or disk structure.

When a file or volume is exported as a single-slice disk, the system simulates a fake disk partitioning which makes that file or volume appear as a disk slice. Because the disk partitioning is simulated, you do not create partitioning for that disk.

▼ How to Export a ZFS Volume as a Single-Slice Disk

1 Create a ZFS volume to use as a single-slice disk.

The following example shows how to create a ZFS volume, `zdisk0`, to use as a single-slice disk.

```
service# zfs create -V 100m ldoms/domain/test/zdisk0
```

The size of the volume defines the size of the virtual disk. This example creates a 100-Mbyte volume to get a 100-Mbyte virtual disk.

2 From the control domain, export the corresponding device to that ZFS volume, and set the `slice` option so that the volume is exported as a single-slice disk.

```
primary# ldm add-vdsdev options=slice /dev/zvol/dsk/ldoms/domain/test/zdisk0 \
zdisk0@primary-vds0
```

3 From the control domain, assign the volume to a guest domain.

The following shows how to assign the volume, `zdisk0`, to guest domain `ldg1`.

```
primary# ldm add-vdisk zdisk0 zdisk0@primary-vds0 ldg1
```

4 After the guest domain is started and running the Oracle Solaris OS, you can list the disk (`c0d9`, for example) and see that the disk is accessible and is a single-slice disk (`s0`).

```
ldg1# ls -1 /dev/dsk/c0d9s*
/dev/dsk/c0d9s0
/dev/dsk/c0d9s1
/dev/dsk/c0d9s2
/dev/dsk/c0d9s3
/dev/dsk/c0d9s4
/dev/dsk/c0d9s5
/dev/dsk/c0d9s6
/dev/dsk/c0d9s7
```

Exporting Volumes and Backward Compatibility

If you have a configuration exporting volumes as virtual disks, volumes are now exported as full disks instead of single-slice disks. To preserve the old behavior and to have your volumes exported as single-slice disks, you need to do either of the following:

- Use the `ldm set-vdsdev` command in Oracle VM Server for SPARC 3.1 software, and set the `slice` option for all volumes you want to export as single-slice disks. See the `ldm(1M)` man page.
- Add the following line to the `/etc/system` file on the service domain.

```
set vds:vd_volume_force_slice = 1
```

Note – Setting this tunable forces the export of all volumes as single-slice disks, and you cannot export any volume as a full disk.

Summary of How Different Types of Back Ends Are Exported

Back End	No Slice Option	Slice Option Set
Disk (disk slice 2)	Full disk[1]	Single-slice disk[2]
Disk slice (not slice 2)	Single-slice disk[3]	Single-slice disk
File	Full disk	Single-slice disk
Volume, including ZFS, Solaris Volume Manager, or VxVM	Full disk	Single-slice disk

[1] Export the entire disk.

[2] Export only slice 2

[3] A slice is always exported as a single-slice disk.

Guidelines for Exporting Files and Disk Slices as Virtual Disks

This section includes guidelines for exporting a file and a disk slice as a virtual disk.

Using the Loopback File (lofi) Driver

Using the loopback file (`lofi`) driver to export a file as a virtual disk adds an extra driver layer and affects performance of the virtual disk. Instead, you can directly export a file as a full disk or as a single-slice disk. See "File and Volume Exporting" on page 166.

Directly or Indirectly Exporting a Disk Slice

To export a slice as a virtual disk either directly or indirectly (for example through a Solaris Volume Manager volume), ensure that the slice does not start on the first block (block 0) of the physical disk by using the `prtvtoc` command.

If you directly or indirectly export a disk slice which starts on the first block of a physical disk, you might overwrite the partition table of the physical disk and make all partitions of that disk inaccessible.

Configuring Virtual Disk Multipathing

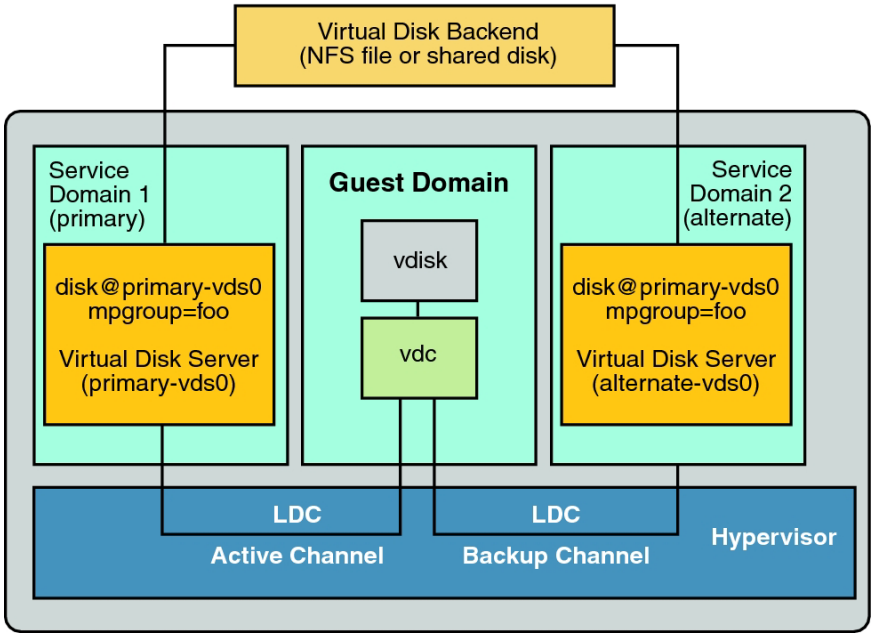
Virtual disk multipathing enables you to configure a virtual disk on a guest domain to access its back-end storage by more than one path. The paths lead through different service domains that provide access to the same back-end storage, such as a disk LUN. This feature enables a virtual disk in a guest domain to remain accessible even if one of the service domains goes down. For example, you might set up a virtual disk multipathing configuration to access a file on a network file system (NFS) server. Or, you can use this configuration to access a LUN from shared storage that is connected to more than one service domain. So, when the guest domain accesses the virtual disk, the virtual disk driver goes through one of the service domains to access the back-end storage. If the virtual disk driver cannot connect to the service domain, the virtual disk attempts to reach the back-end storage through a different service domain.

Note – The virtual disk multipathing feature can detect when the service domain cannot access the back-end storage. In such an instance, the virtual disk driver attempts to access the back-end storage by another path.

To enable virtual disk multipathing, you must export a virtual disk back end from each service domain and add the virtual disk to the same multipathing group (`mpgroup`). The `mpgroup` is identified by a name and is configured when you export the virtual disk back end.

The following figure shows a virtual disk multipathing configuration that is used as an example in the procedure "How to Configure Virtual Disk Multipathing" on page 171. In this example, a multipathing group named `foo` is used to create a virtual disk, whose back end is accessible from two service domains: `primary` and `alternate`.

FIGURE 7–2 Configuring Virtual Disk Multipathing



Virtual Disk Multipathing and Virtual Disk Timeout

With virtual disk multipathing, the path that is used to access the back end automatically changes if the back end becomes inaccessible by means of the currently active path. This path change occurs independently of the value of the virtual disk `timeout` property.

The virtual disk `timeout` property specifies the amount of time after which an I/O fails when no service domain is available to process the I/O. This timeout applies to all virtual disks, even those that use virtual disk multipathing.

As a consequence, setting a virtual disk timeout when virtual disk multipathing is configured can prevent multipathing from working correctly, especially with a small timeout value. So, avoid setting a virtual disk timeout for virtual disks that are part of a multipathing group.

For more information, see "Virtual Disk Timeout" on page 176.

▼ How to Configure Virtual Disk Multipathing

See Figure 7–2.

1 **Export the virtual disk back end from the `primary` service domain.**

```
# ldm add-vdsdev mpgroup=foo backend-path1 volume@primary-vds0
```

backend-path1 is the path to the virtual disk back end from the `primary` domain.

2 **Export the same virtual disk back end from the `alternate` service domain.**

```
# ldm add-vdsdev mpgroup=foo backend-path2 volume@alternate-vds0
```

backend-path2 is the path to the virtual disk back end from the `alternate` domain.

Note – *backend-path1* and *backend-path2* are paths to the same virtual disk back end, but from two different domains (`primary` and `alternate`). These paths might be the same or different, depending on the configuration of the `primary` and `alternate` domains. The *volume* name is a user choice. It might be the same or different for both commands.

---

3 **Export the virtual disk to the guest domain.**

```
# ldm add-vdisk disk-name volume@primary-vds0 ldom
```

Note – Although the virtual disk back end is exported several times through different service domains, you assign only one virtual disk to the guest domain and associate it with the virtual disk back end through any of the service domains.

More Information

Result of Virtual Disk Multipathing

After you configure the virtual disk with multipathing and start the guest domain, the virtual disk accesses its back end through one of the service domains it has been associated with. If this service domain becomes unavailable, the virtual disk attempts to access its back end through another service domain that is part of the same multipathing group.

Caution – When defining a multipathing group (`mpgroup`), ensure that the virtual disk back ends that are part of the same `mpgroup` are effectively the same virtual disk back end. If you add different back ends into the same `mpgroup`, you might see some unexpected behavior, and you can potentially lose or corrupt data stored on the back ends.

CD, DVD and ISO Images

You can export a compact disc (CD) or digital versatile disc (DVD) the same way you export any regular disk. To export a CD or DVD to a guest domain, export slice 2 of the CD or DVD device as a full disk; that is, without the `slice` option.

Note – You cannot export the CD or DVD drive itself. You can export only the CD or DVD that is inside the CD or DVD drive. Therefore, a CD or DVD must be present inside the drive before you can export it. Also, to be able to export a CD or DVD, that CD or DVD cannot be in use in the service domain. In particular, the Volume Management file system, `volfs` service must not use the CD or DVD. See "How to Export a CD or DVD From the Service Domain to the Guest Domain" on page 173 for instructions on how to remove the device from use by `volfs`.

If you have an International Organization for Standardization (ISO) image of a CD or DVD stored in file or on a volume and export that file or volume as a full disk, then it appears as a CD or DVD in the guest domain.

When you export a CD, DVD, or an ISO image, it automatically appears as a read-only device in the guest domain. However, you cannot perform any CD control operations from the guest domain; that is, you cannot start, stop, or eject the CD from the guest domain. If the exported CD, DVD, or ISO image is bootable, the guest domain can be booted on the corresponding virtual disk.

For example, if you export a Oracle Solaris OS installation DVD, you can boot the guest domain on the virtual disk that corresponds to that DVD and install the guest domain from that DVD. To do so, when the guest domain reaches the `ok` prompt, use the following command.

```
ok boot /virtual-devices@100/channel-devices@200/disk@n:f
```

Where *n* is the index of the virtual disk representing the exported DVD.

Note – If you export a Oracle Solaris OS installation DVD and boot a guest domain on the virtual disk that corresponds to that DVD to install the guest domain, then you cannot change the DVD during the installation. So, you might need to skip any step of the installation requesting a different CD/DVD, or you will need to provide an alternate path to access this requested media.

▼ How to Export a CD or DVD From the Service Domain to the Guest Domain

1 From the service domain, check whether the volume management daemon, `vold`, is running and online.

```
service# svcs volfs
STATE          STIME    FMRI
online         12:28:12 svc:/system/filesystem/volfs:default
```

2 **If the volume management daemon is running and online, as in the example in Step 1, do the following:**

   a. **In the `/etc/vold.conf` file, comment out the line starting with the following words:**

      ```
      use cdrom drive....
      ```

      See the `vold.conf`(4) man page.

   b. **Insert the CD or DVD in the CD or DVD drive.**

   c. **From the service domain, restart the volume management file system service.**

      ```
      service# svcadm refresh volfs
      service# svcadm restart volfs
      ```

3 **From the service domain, find the disk path for the CD-ROM device.**

```
service# cdrw -l
Looking for CD devices...
   Node                  Connected Device                 Device type
----------------------+--------------------------------+-----------------
/dev/rdsk/c1t0d0s2    | MATSHITA CD-RW  CW-8124   DZ13 | CD Reader/Writer
```

4 **Export the CD or DVD disk device as a full disk.**

```
primary# ldm add-vdsdev /dev/dsk/c1t0d0s2 cdrom@primary-vds0
```

5 **Assign the exported CD or DVD to the guest domain.**

The following command shows how to assign the exported CD or DVD to domain `ldg1`:

```
primary# ldm add-vdisk cdrom cdrom@primary-vds0 ldg1
```

More Information

Exporting a CD or DVD Multiple Times

A CD or DVD can be exported multiple times and assigned to different guest domains. See "How to Export a Virtual Disk Back End Multiple Times" on page 160 for more information.

▼ How to Export an ISO Image From the Control Domain to Install a Guest Domain

Before You Begin

This procedure assumes that both the `primary` domain and the guest domain are configured.

For example, the following `ldm list` shows that both the `primary` and `ldom1` domains are configured:

```
# ldm list
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   -n-cv   SP      4     4G       0.3%  15m
ldom1            active   -t---   5000    4     1G        25%  8m
```

1 Add a virtual disk server device to export the ISO image.

In this example, the ISO image is `/export/images/sol-10-u8-ga-sparc-dvd.iso`.

```
# ldm add-vdsdev /export/images/sol-10-u8-ga-sparc-dvd.iso dvd-iso@primary-vds0
```

2 Stop the guest domain.

In this example, the logical domain is `ldom1`.

```
# ldm stop-domain ldom1
LDom ldom1 stopped
```

3 Add the virtual disk for the ISO image to the logical domain.

In this example, the logical domain is `ldom1`.

```
# ldm add-vdisk s10-dvd dvd-iso@primary-vds0 ldom1
```

4 Restart the guest domain.

In this example, the logical domain is `ldom1`.

```
# ldm start-domain ldom1
LDom ldom1 started
# ldm list
NAME             STATE    FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active   -n-cv   SP      4     4G       0.4%  25m
ldom1            active   -t---   5000    4     1G       0.0%  0s
```

In this example, the `ldm list` command shows that the `ldom1` domain has just been started.

5 Connect to the guest domain.

```
# telnet localhost 5000
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Connecting to console "ldom1" in group "ldom1" ....
Press ~? for control options ..
```

6 Verify the existence of the ISO image as a virtual disk.

```
{0} ok show-disks
a) /virtual-devices@100/channel-devices@200/disk@1
b) /virtual-devices@100/channel-devices@200/disk@0
q) NO SELECTION
Enter Selection, q to quit: q
```

In this example, the newly added device is `/virtual-devices@100/channel-devices@200/disk@1`.

7 Boot the guest domain to install from the ISO image.

In this example, boot from the `f` slice of the `/virtual-devices@100/channel-devices@200/disk@1` disk.

```
{0} ok boot /virtual-devices@100/channel-devices@200/disk@1:f
```

Virtual Disk Timeout

By default, if the service domain providing access to a virtual disk back end is down, all I/O from the guest domain to the corresponding virtual disk is blocked. The I/O automatically is resumed when the service domain is operational and is servicing I/O requests to the virtual disk back end.

However, in some cases, file systems or applications might not want the I/O operation to block but rather to fail and report an error if the service domain is down for too long. You can now set a connection timeout period for each virtual disk, which can then be used to establish a connection between the virtual disk client on a guest domain and the virtual disk server on the service domain. When that timeout period is reached, any pending I/O and any new I/O will fail as long as the service domain is down and the connection between the virtual disk client and server is not reestablished.

Set this timeout by using one of the following methods:

- Using the `ldm add-vdisk` command.

  `ldm add-vdisk timeout=`*seconds disk-name volume-name@service-name ldom*
- Using the `ldm set-vdisk` command.

  `ldm set-vdisk timeout=`*seconds disk-name ldom*
- Adding the following line to the `/etc/system` file on the guest domain.

  `set vdc:vdc_timeout=`*seconds*

  Note – If this tunable is set, it overwrites any timeout setting done using the `ldm` CLI. Also, the tunable sets the timeout for all virtual disks in the guest domain.

Specify the timeout in seconds. If the timeout is set to `0`, the timeout is disabled and I/O is blocked while the service domain is down (this is the default setting and behavior).

Virtual Disk and SCSI

If a physical SCSI disk or LUN is exported as a full disk, the corresponding virtual disk supports the user SCSI command interface, `uscsi` and multihost disk control operations `mhd`. Other virtual disks, such as virtual disks having a file or a volume as a back end, do not support these interfaces.

As a consequence, applications or product features using SCSI commands (such as Solaris Volume Manager `metaset` or Oracle Solaris Cluster `shared devices`) can be used in guest domains only with virtual disks having a physical SCSI disk as a back end.

Note – SCSI operations are effectively executed by the service domain, which manages the physical SCSI disk or LUN used as a virtual disk back end. In particular, SCSI reservations are done by the service domain. Therefore, applications running in the service domain and in guest domains should not issue SCSI commands to the same physical SCSI disks. Doing so can lead to an unexpected disk state.

Virtual Disk and the `format` Command

The `format` command recognizes all virtual disks that are present in a domain. However, for virtual disks that are exported as single-slice disks, the `format` command cannot change the partition table of the virtual disk. Commands such as `label` will fail unless you try to write a disk label similar to the one that is already associated with the virtual disk.

Virtual disks whose back ends are SCSI disks support all `format`(1M) subcommands. Virtual disks whose back ends are not SCSI disks do not support some `format`(1M) subcommands, such as `repair` and `defect`. In that case, the behavior of `format`(1M) is similar to the behavior of Integrated Drive Electronics (IDE) disks.

Using ZFS With Virtual Disks

This section describes using the Zettabyte File System (ZFS) to store virtual disk back ends exported to guest domains. ZFS provides a convenient and powerful solution to create and manage virtual disk back ends. ZFS enables you to do the following:

- Store disk images in ZFS volumes or ZFS files
- Use snapshots to back up disk images
- Use clones to duplicate disk images and provision additional domains

Refer to *Oracle Solaris ZFS Administration Guide* for more information about using ZFS.

In the following descriptions and examples, the primary domain is also the service domain where disk images are stored.

Configuring a ZFS Pool in a Service Domain

To store the disk images, first create a ZFS storage pool in the service domain. For example, this command creates the ZFS storage pool `ldmpool` containing the disk `c1t50d0` in the `primary` domain.

```
primary# zpool create ldmpool c1t50d0
```

Storing Disk Images With ZFS

The following command creates a disk image for guest domain `ldg1`. A ZFS file system for this guest domain is created, and all disk images of this guest domain will be stored on that file system.

```
primary# zfs create ldmpool/ldg1
```

Disk images can be stored on ZFS volumes or ZFS files. Creating a ZFS volume, whatever its size, is quick using the `zfs create -V` command. On the other hand, ZFS files have to be created by using the `mkfile` command. This command can take some time to complete, especially if the file to be created is quite large, which is often the case when creating a disk image.

Both ZFS volumes and ZFS files can take advantage of ZFS features such as the snapshot and clone features, but a ZFS volume is a pseudo device while a ZFS file is a regular file.

If the disk image is to be used as a virtual disk onto which an OS is installed, the disk image must be large enough to accommodate the OS installation requirements. This size depends on the version of the OS and on the type of installation performed. If you install the Oracle Solaris OS, you can use a disk size of 20 Gbytes to accommodate any type of installation of any version of the Oracle Solaris OS.

Examples of Storing Disk Images With ZFS

The following examples show how to store disk images using a ZFS volume or a ZFS file. The syntax to export a ZFS volume or file is the same but the path to the back end is different.

When the guest domain is started, the ZFS volume or file appears as a virtual disk on which the Oracle Solaris OS can be installed.

EXAMPLE 7–1 Storing a Disk Image Using a ZFS Volume

First, create a 20-Gbyte image on a ZFS volume.

```
primary# zfs create -V 20gb ldmpool/ldg1/disk0
```

Then, export the ZFS volume as a virtual disk.

```
primary# ldm add-vdsdev /dev/zvol/dsk/ldmpool/ldg1/disk0 ldg1_disk0@primary-vds0
```

Assign the ZFS volume to the `ldg1` guest domain.

```
primary# ldm add-vdisk disk0 ldg1_disk0@primary-vds0 ldg1
```

EXAMPLE 7–2 Storing a Disk Image Using a ZFS File

First, create a 20-Gbyte disk image on a ZFS volume and create the ZFS file.

EXAMPLE 7–2 Storing a Disk Image Using a ZFS File *(Continued)*

```
primary# zfs create ldmpool/ldg1/disk0
primary# mkfile 20g /ldmpool/ldg1/disk0/file
```

Then, export the ZFS file as a virtual disk.

```
primary# ldm add-vdsdev /ldmpool/ldg1/disk0/file ldg1_dis0@primary-vds0
```

Assign the ZFS file to the `ldg1` guest domain.

```
primary# ldm add-vdisk disk0 ldg1_disk0@primary-vds0 ldg1
```

Creating a Snapshot of a Disk Image

When your disk image is stored on a ZFS volume or on a ZFS file, you can create snapshots of this disk image by using the ZFS `snapshot` command.

Before you create a snapshot of the disk image, ensure that the disk is not currently in use in the guest domain to ensure that data currently stored on the disk image are coherent. You can ensure that a disk is not in use in a guest domain in one of the following ways:

- Stop and unbind the guest domain. This solution is the safest, and is the only solution available if you want to create a snapshot of a disk image used as the boot disk of a guest domain.
- Unmount any slices of the disk you want to snapshot that are used in the guest domain, and ensure that no slice is in use in the guest domain.

In this example, because of the ZFS layout, the command to create a snapshot of the disk image is the same whether the disk image is stored on a ZFS volume or on a ZFS file.

EXAMPLE 7–3 Creating a Snapshot of a Disk Image

This example creates a snapshot of the disk image that was created for the `ldg1` domain.

```
primary# zfs snapshot ldmpool/ldg1/disk0@version_1
```

Using Clone to Provision a New Domain

Once you have created a snapshot of a disk image, you can duplicate this disk image by using the ZFS `clone` command. The cloned image then can be assigned to another domain. Cloning a boot disk image quickly creates a boot disk for a new guest domain without having to perform the entire Oracle Solaris OS installation process.

For example, if the `disk0` created was the boot disk of domain `ldg1`, do the following to clone that disk to create a boot disk for domain `ldg2`.

```
primary# zfs create ldmpool/ldg2
primary# zfs clone ldmpool/ldg1/disk0@version_1 ldmpool/ldg2/disk0
```

Then `ldompool/ldg2/disk0` can be exported as a virtual disk and assigned to the new `ldg2` domain. The domain `ldg2` can directly boot from that virtual disk without having to go through the OS installation process.

Note – ZFS snapshots and clones for boot images can use a lot of disk space, so periodically remove those images that you no longer require.

Cloning a Boot Disk Image

When a boot disk image is cloned, the new image is exactly the same as the original boot disk, and it contains any information that has been stored on the boot disk before the image was cloned, such as the host name, the IP address, the mounted file system table, or any system configuration or tuning.

Because the mounted file system table is the same on the original boot disk image and on the cloned disk image, the cloned disk image has to be assigned to the new domain in the same order as it was on the original domain. For example, if the boot disk image was assigned as the first disk of the original domain, then the cloned disk image has to be assigned as the first disk of the new domain. Otherwise, the new domain is unable to boot.

If the original domain was configured with a static IP address, then a new domain using the cloned image starts with the same IP address. In that case, you can change the network configuration of the new domain by using the Oracle Solaris 11 `sysconfig unconfigure` command or the Oracle Solaris 10 `sys-unconfig` command. To avoid this problem, you can also create a snapshot of a disk image of an unconfigured system.

If the original domain was configured with the Dynamic Host Configuration Protocol (DHCP), then a new domain using the cloned image also uses DHCP. In that case, you do not need to change the network configuration of the new domain because it automatically receives an IP address and its network configuration as it boots.

Note – The host ID of a domain is not stored on the boot disk, but rather is assigned by the Logical Domains Manager when you create a domain. Therefore, when you clone a disk image, the new domain does not keep the host ID of the original domain.

▼ How to Create a Snapshot of a Disk Image of an Unconfigured System

1. **Bind and start the original domain.**
2. **Unconfigure the system.**
   - **Oracle Solaris 11 OS: Run the `sysconfig unconfigure` command.**

- **Oracle Solaris 10 OS: Run the `sys-unconfig` command.**

When this operation completes, the domain halts.

3. **Stop and unbind the domain, do *not* reboot it.**

4. **Take a snapshot of the domain boot disk image.**

   For example:

   ```
   primary# zfs snapshot ldmpool/ldg1/disk0@unconfigured
   ```

   At this point, you have the snapshot of the boot disk image of an unconfigured system.

5. **Clone this image to create a new domain which, when first booted, asks for the configuration of the system.**

Using Volume Managers in an Oracle VM Server for SPARC Environment

This section describes using volume managers in an Oracle VM Server for SPARC environment.

Using Virtual Disks With Volume Managers

Any ZFS, Solaris Volume Manager, or Veritas Volume Manager (VxVM) volume can be exported from a service domain to a guest domain as a virtual disk. A volume can be exported either as a single-slice disk (if the `slice` option is specified with the `ldm add-vdsdev` command) or as a full disk.

Note – The remainder of this section uses a Solaris Volume Manager volume as an example. However, the discussion also applies to ZFS and VxVM volumes.

The following examples show how to export a volume as a single-slice disk.

The virtual disk in the guest domain (for example, `/dev/dsk/c0d2s0`) is directly mapped to the associated volume (for example, `/dev/md/dsk/d0`), and data stored onto the virtual disk from the guest domain are directly stored onto the associated volume with no extra metadata. Data stored on the virtual disk from the guest domain can therefore also be directly accessed from the service domain through the associated volume.

Examples

- If the Solaris Volume Manager volume `d0` is exported from the `primary` domain to `domain1`, then the configuration of `domain1` requires some extra steps.

```
primary# metainit d0 3 1 c2t70d0s6 1 c2t80d0s6 1 c2t90d0s6
primary# ldm add-vdsdev options=slice /dev/md/dsk/d0 vol3@primary-vds0
primary# ldm add-vdisk vdisk3 vol3@primary-vds0 domain1
```

- After `domain1` has been bound and started, the exported volume appears as `/dev/dsk/c0d2s0`, for example, and you can use it.

```
domain1# newfs /dev/rdsk/c0d2s0
domain1# mount /dev/dsk/c0d2s0 /mnt
domain1# echo test-domain1 > /mnt/file
```

- After `domain1` has been stopped and unbound, data stored on the virtual disk from `domain1` can be directly accessed from the primary domain through Solaris Volume Manager volume `d0`.

```
primary# mount /dev/md/dsk/d0 /mnt
primary# cat /mnt/file
test-domain1
```

Using Virtual Disks With Solaris Volume Manager

When a RAID or mirror Solaris Volume Manager volume is used as a virtual disk by another domain, then it has to be exported without setting the exclusive (`excl`) option. Otherwise, if there is a failure on one of the components of the Solaris Volume Manager volume, then the recovery of the Solaris Volume Manager volume using the `metareplace` command or using a hot spare does not start. The `metastat` command sees the volume as resynchronizing, but the resynchronization does not progress.

For example, `/dev/md/dsk/d0` is a RAID Solaris Volume Manager volume exported as a virtual disk with the `excl` option to another domain, and `d0` is configured with some hot-spare devices. If a component of `d0` fails, Solaris Volume Manager replaces the failing component with a hot spare and resynchronizes the Solaris Volume Manager volume. However, the resynchronization does not start. The volume is reported as resynchronizing, but the resynchronization does not progress.

```
# metastat d0
d0: RAID
    State: Resyncing
    Hot spare pool: hsp000
    Interlace: 32 blocks
    Size: 20097600 blocks (9.6 GB)
Original device:
    Size: 20100992 blocks (9.6 GB)
Device                                      Start Block  Dbase   State Reloc
c2t2d0s1                                           330  No       Okay  Yes
c4t12d0s1                                          330  No       Okay  Yes
/dev/dsk/c10t600C0FF0000000000015153295A4B100d0s1  330  No  Resyncing  Yes
```

In such a situation, the domain using the Solaris Volume Manager volume as a virtual disk has to be stopped and unbound to complete the resynchronization. Then the Solaris Volume Manager volume can be resynchronized using the `metasync` command.

```
# metasync d0
```

Using Virtual Disks When VxVM Is Installed

When the VxVM is installed on your system and Veritas Dynamic Multipathing (DMP) is enabled on a physical disk or partition you want to export as virtual disk, then you have to export that disk or partition without setting the (non-default) `excl` option. Otherwise, you receive an error in `/var/adm/messages` while binding a domain that uses such a disk.

```
vd_setup_vd():  ldi_open_by_name(/dev/dsk/c4t12d0s2) = errno 16
vds_add_vd():  Failed to add vdisk ID 0
```

You can check whether Veritas DMP is enabled by checking the multipathing information in the `vxdisk list` output. For example:

```
# vxdisk list Disk_3
Device:    Disk_3
devicetag: Disk_3
type:      auto
info:      format=none
flags:     online ready private autoconfig invalid
pubpaths:  block=/dev/vx/dmp/Disk_3s2 char=/dev/vx/rdmp/Disk_3s2
guid:      -
udid:      SEAGATE%5FST336753LSUN36G%5FDISKS%5F3032333948303144304E0000
site:      -
Multipathing information:
numpaths:  1
c4t12d0s2  state=enabled
```

Alternatively, if Veritas DMP is enabled on a disk or a slice that you want to export as a virtual disk with the `excl` option set, then you can disable DMP using the `vxdmpadm` command. For example:

```
# vxdmpadm -f disable path=/dev/dsk/c4t12d0s2
```

Using Volume Managers With Virtual Disks

This section describes using volume managers with virtual disks.

Using ZFS With Virtual Disks

Any virtual disk can be used with ZFS. A ZFS storage pool (`zpool`) can be imported in any domain that sees all the storage devices that are part of this `zpool`, regardless of whether the domain sees all these devices as virtual devices or real devices.

Using Solaris Volume Manager With Virtual Disks

Any virtual disk can be used in the Solaris Volume Manager local disk set. For example, a virtual disk can be used for storing the Solaris Volume Manager metadevice state database, `metadb`, of the local disk set or for creating Solaris Volume Manager volumes in the local disk set.

Any virtual disk whose back end is a SCSI disk can be used in a Solaris Volume Manager shared disk set, `metaset`. Virtual disks whose back ends are not SCSI disks cannot be added into a Solaris Volume Manager share disk set. Trying to add a virtual disk whose back end is not a SCSI disk into a Solaris Volume Manager shared disk set fails with an error similar to the following.

```
# metaset -s test -a c2d2
metaset: domain1: test: failed to reserve any drives
```

Using VxVM With Virtual Disks

For VxVM support in guest domains, refer to the VxVM documentation from Symantec.

◆ ◆ ◆ CHAPTER 8

Using Virtual Networks

This chapter describes how to use a virtual network with Oracle VM Server for SPARC software, and covers the following topics:

Oracle Solaris OS networking changed a great deal between the Oracle Solaris 10 OS and the Oracle Solaris 11 OS. For information about issues to consider, see "Oracle Solaris 10 Networking Overview" on page 186, "Oracle Solaris 11 Networking Overview" on page 188, and "Oracle Solaris 11 Networking-Specific Feature Differences" on page 233.

Introduction to a Virtual Network

A virtual network enables domains to communicate with each other without using any external physical networks. A virtual network also can enable domains to use the same physical network interface to access a physical network and communicate with remote systems. A virtual network is created by having a virtual switch to which you can connect virtual network devices.

Oracle Solaris networking differs greatly between the Oracle Solaris 10 OS and the Oracle Solaris 11 OS. The following two sections provide overview information about networking for each OS.

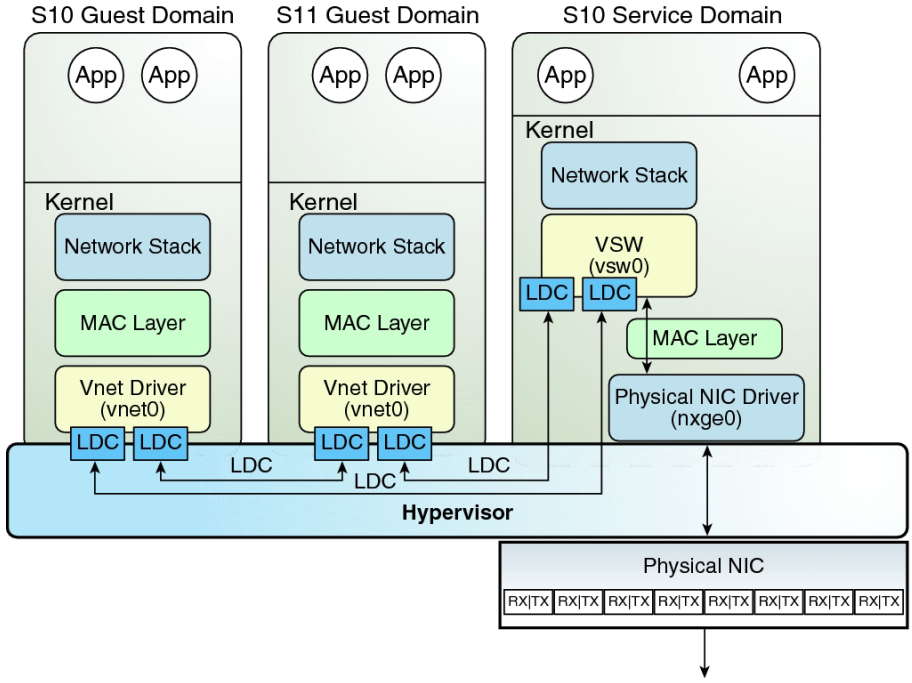
Note – Oracle Solaris 10 networking behaves the same as it would on a domain or a system. The same is true for Oracle Solaris 11 networking. For more information about Oracle Solaris OS networking, see Oracle Solaris 10 Documentation and Oracle Solaris 11.1 Documentation.

The feature differences between Oracle Solaris 10 and Oracle Solaris 11 networking are described in "Oracle Solaris 11 Networking Overview" on page 188.

Oracle Solaris 10 Networking Overview

The following diagram shows that a guest domain that runs the Oracle Solaris 11 OS is fully compatible with an Oracle Solaris 10 service domain. The only differences are features added or enhanced in the Oracle Solaris 11 OS.

FIGURE 8–1 Oracle VM Server for SPARC Network Overview for the Oracle Solaris 10 OS



The previous diagram shows interface names such as `nxge0`, `vsw0`, and `vnet0` which apply to the Oracle Solaris 10 OS only. Also note the following:

- The virtual switch in the service domain is connected to the guest domains, which enables guest domains to communicate with each other.
- The virtual switch is also connected to the physical network interface `nxge0`, which enables guest domains to communicate with the physical network.
- The virtual switch network interface `vsw0` is created in the service domain, which enables the two guest domains to communicate with the service domain.
- The virtual switch network interface `vsw0` in the service domain can be configured by using the Oracle Solaris 10 `ifconfig` command.
- The virtual network device `vnet0` in an Oracle Solaris 10 guest domain can be configured as a network interface by using the `ifconfig` command.
- The virtual network device `vnet0` in an Oracle Solaris 11 guest domain might appear with a generic link name, such as `net0`. It can be configured as a network interface by using the `ipadm` command.

The virtual switch behaves like a regular physical network switch and switches network packets between the different systems, such as guest domains, the service domain, and the physical

network, to which it is connected. The `vsw` driver provides the network device functionality that enables the virtual switch to be configured as a network interface.

Oracle Solaris 11 Networking Overview

The Oracle Solaris 11 OS introduced many new networking features, which are described in the Oracle Solaris 11 networking documentation at Oracle Solaris 11.1 Documentation.

The following Oracle Solaris 11 networking features are important to understand when you use the Oracle VM Server for SPARC software:

- All network configuration is performed by the `ipadm` and `dladm` commands.
- The "vanity name by default" feature generates generic link names, such as `net0`, for all physical network adapters. This feature also generates generic names for virtual switches (`vsw`*n*) and virtual network devices (`vnet`*n*), which appear like physical network adapters to the OS. To identify the generic link name that is associated with a physical network device, use the `dladm show-phys` command.

  By default in Oracle Solaris 11, physical network device names use generic "vanity" names. Generic names, such as `net0`, are used instead of device driver names, such as `nxge0`, which were used in Oracle Solaris 10.

  To determine which network device to use as the back-end device for the virtual switch, search for `vsw` in the `dladm show-phys` output.

  The following command creates a virtual switch for the `primary` domain by specifying the generic name, `net0`, instead of a driver name, such as `nxge0`:

  ```
  primary# ldm add-vsw net-dev=net0 primary-vsw0 primary
  ```
- The Oracle Solaris 11 OS uses virtual network interface cards (VNICs) to create internal virtual networks.

  A VNIC is a virtual instantiation of a physical network device that can be created from the physical network device and assigned to a zone.
- Use the Oracle Solaris 11 `DefaultFixed` network configuration profile (NCP) when configuring the Oracle VM Server for SPARC software.

  For Oracle Solaris 11 domains, use the `DefaultFixed` NCP. You can enable this profile during or after installation. During an Oracle Solaris 11 installation, select the Manual networking configuration.
- Do not replace the primary network interface with the virtual switch (`vsw`) interface. The control domain can use the existing primary network interface to communicate with the guest domains that have virtual network devices connected to the same virtual switch.
- Do not use the physical network adapter's MAC address for the virtual switch because using the physical adapter's MAC address for the virtual switch conflicts with the primary network interface.

Note – In this release, use the `DefaultFixed` NCP to configure datalinks and network interfaces on Oracle Solaris 11 systems.

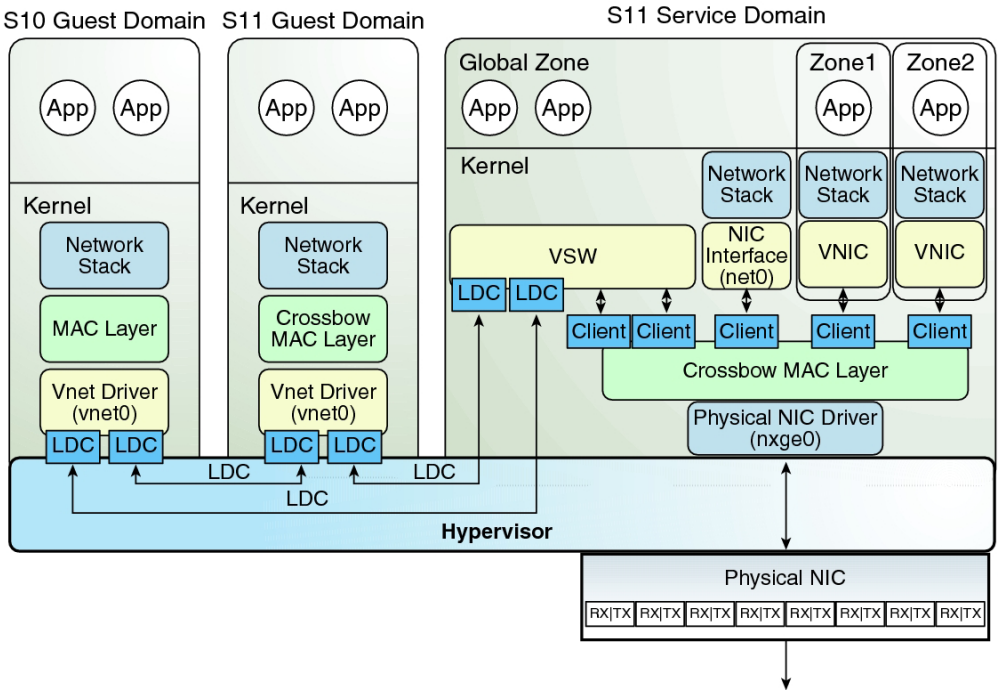
The Oracle Solaris 11 OS includes the following NCPs:

- `DefaultFixed` – Enables you to use the `dladm` or `ipadm` command to manage networking
- `Automatic` – Enables you to use the `netcfg` or `netadm` command to manage networking

Ensure that the `DefaultFixed` NCP is enabled by using the `netadm list` command. See Chapter 7, "Using Datalink and Interface Configuration Commands on Profiles," in *Oracle Solaris Administration: Network Interfaces and Network Virtualization*.

The following diagram shows that a guest domain that runs the Oracle Solaris 10 OS is fully compatible with an Oracle Solaris 11 service domain. The only differences are features added or enhanced in the Oracle Solaris 11 OS.

FIGURE 8–2 Oracle VM Server for SPARC Network Overview for the Oracle Solaris 11 OS



The diagram shows that network device names, such as `nxge0` and `vnet0`, can be represented by generic link names, such as `net`*n* in Oracle Solaris 11 domains. Also note the following:

- The virtual switch in the service domain is connected to the guest domains, which enables guest domains to communicate with each other.
- The virtual switch is also connected to the physical network device `nxge0`, which enables guest domains to communicate with the physical network.

  The virtual switch also enables guest domains to communicate with the service domain network interface `net0` and with VNICs on the same physical network device as `nxge0`. Therefore, you do not need to configure `vsw` as a network interface in an Oracle Solaris 11 service domain because of the networking enhancements in the Oracle Solaris 11 MAC layer.
- The virtual network device `vnet0` in an Oracle Solaris 10 guest domain can be configured as a network interface by using the `ifconfig` command.
- The virtual network device `vnet0` in an Oracle Solaris 11 guest domain might appear with a generic link name, such as `net0`. It can be configured as a network interface by using the `ipadm` command.

A virtual switch behaves like a regular physical network switch and switches network packets between the different systems to which it is connected. A system can be a guest domain, a service domain, or a physical network.

Maximizing Virtual Network Performance

You can achieve high transfer rates for guest and external networks and for guest-to-guest communications when you configure your platform and the domains as described in this section. The virtual network stack introduces support for large segment offload (LSO), which produces high TCP performance without requiring the use of jumbo frames.

Hardware and Software Requirements

Meet the following requirements to maximize the network performance for your domains:

- **Hardware requirements.** These performance improvements are available only for the SPARC T4, SPARC T5, SPARC M5, or SPARC M6 systems.
- **System firmware requirements.** The SPARC systems must be running system firmware that supports at least the Oracle VM Server for SPARC 3.1 software. See "Required Software to Enable the Latest Oracle VM Server for SPARC Features" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.
- **Oracle Solaris OS requirements.** Ensure that the service domain and guest domain run the following Oracle Solaris OS versions:

  - **Service domain.** At least the Oracle Solaris 11.1.9.0.0 OS or the Oracle Solaris 10 OS with the 150031-03 patch.
  - **Guest domain.** At least the Oracle Solaris 11.1.9.0.0 OS or the Oracle Solaris 10 OS with the 150031-03 patch.
- **CPU and memory requirements.** Ensure that you assign sufficient CPU and memory resources to the service domain and the guest domains.
  - **Service domain.** Because the service domain acts as a data proxy for the guest domains, assign at least 2 CPU cores and at least 4 Gbytes of memory to the service domain.
  - **Guest domain.** Configure each guest domain to be able to drive at least 10-Gbps performance. Assign at least 2 CPU cores and at least 4 Gbytes of memory to each guest domain.

Configuring Your Domains to Maximize the Performance of Your Virtual Network

In previous versions of Oracle VM Server for SPARC and the Oracle Solaris OS, you could improve your network performance by configuring jumbo frames. This configuration is no longer required and unless required for another reason, using the standard MTU value of 1500 for your service and guest domains is best.

To achieve the improved networking performance, set the `extended-mapin-space` property to `on` for the service domain and the guest domains, which is the default setting for the Oracle VM Server for SPARC 3.1 software and supported system firmware.

```
primary# ldm set-domain extended-mapin-space=on domain-name
```

To check the `extended-mapin-space` property value, run the following command:

```
primary# ldm ls -l domain-name |grep extended-mapin
extended-mapin-space=on
```

Note – A change to the `extended-mapin-space` property value triggers a delayed reconfiguration on the `primary` domain. This situation requires a `primary` domain reboot. You also must first stop the guest domains before you change this property value.

Virtual Switch

A virtual switch (`vsw`) is a component running in a service domain and managed by the virtual switch driver. A virtual switch can be connected to some guest domains to enable network communications between those domains. In addition, if the virtual switch is also associated with a physical network interface, network communication is permitted between guest domains and the physical network over the physical network interface. A virtual switch also has a network interface, `vsw`*n*, which permits the service domain to communicate with the other domains that are connected to that virtual switch. The virtual switch can be used like any regular network interface and configured with the Oracle Solaris 10 `ifconfig` command or the Oracle Solaris 11 `ipadm` command.

Note – When a virtual switch is added to an Oracle Solaris 10 service domain, its network interface is not created. So, by default, the service domain is unable to communicate with the guest domains connected to its virtual switch. To enable network communications between guest domains and the service domain, the network interface of the associated virtual switch must be created and configured in the service domain. See "Enabling Networking Between the Control/Service Domain and Other Domains" on page 63 for instructions.

This situation occurs *only* for the Oracle Solaris 10 OS and *not* for the Oracle Solaris 11 OS.

You can add a virtual switch to a domain, set options for a virtual switch, and remove a virtual switch by using the `ldm add-vsw`, `ldm set-vsw`, and `ldm rm-vsw` commands, respectively. See the `ldm`(1M) man page.

When you create a virtual switch on a VLAN tagged instance of a NIC or an aggregation, you must specify the NIC (`nxge0`), the aggregation (`aggr3`), or the vanity name (`net0`) as the value of the `net-dev` property when you use the `ldm add-vsw` or `ldm set-vsw` command.

You cannot add a virtual switch on top of an InfiniBand IP-over-InfiniBand (IPoIB) network device. Although the `ldm add-vsw` and `ldm add-vnet` commands appear to succeed, no data will flow because the MAC address format differs between IPoIB and Ethernet.

The following examples explain how to create a virtual switch on a physical network adapter:

- **Oracle Solaris 10 OS:** The following command creates a virtual switch on a physical network adapter called `nxge0`:

  ```
  primary# ldm add-vsw net-dev=nxge0 primary-vsw0 primary
  ```

  For more information about configuring a virtual switch as a network interface, see "Enabling Networking Between the Control/Service Domain and Other Domains" on page 63.
- **Oracle Solaris 11 OS:** The following command creates a virtual switch on a physical network adapter called `net0`:

```
primary# ldm add-vsw net-dev=net0 primary-vsw0 primary
```

Virtual Network Device

A virtual network device is a virtual device that is defined in a domain connected to a virtual switch. A virtual network device is managed by the virtual network driver, and it is connected to a virtual network through the hypervisor using logical domain channels (LDCs).

A virtual network device can be used as a network interface with the name `vnet`*n*, which can be used like any regular network interface and configured with the Oracle Solaris 10 `ifconfig` command or the Oracle Solaris 11 `ipadm` command.

Note – For Oracle Solaris 11, the devices are assigned generic names, so `vnet`*n* would use a generic name, such as `net0`.

You can add a virtual network device to a domain, set options for an existing virtual network device, and remove a virtual network device by using the `ldm add-vnet`, `ldm set-vnet`, and `ldm rm-vnet` commands, respectively. See the `ldm(1M)` man page.

See the information about Oracle VM Server for SPARC networking for Oracle Solaris 10 and Oracle Solaris 11 in Figure 8–1 and Figure 8–2, respectively.

Inter-Vnet LDC Channels

By default, the Logical Domains Manager would assign LDC channels in the following manner:

- An LDC channel would be assigned between the virtual network devices and the virtual switch device.
- An LDC channel would be assigned between each pair of virtual network devices that are connected to the same virtual switch device (inter-vnet).

The inter-vnet LDC channels are configured so that virtual network devices can communicate directly to achieve high guest-to-guest communications performance. However, as the number of virtual network devices in a virtual switch device increases, the number of required LDC channels for inter-vnet communications increases exponentially.

You can choose to enable or disable inter-vnet LDC channel allocation for all virtual network devices attached to a given virtual switch device. By disabling this allocation, you can reduce the consumption of LDC channels, which are limited in number.

Disabling this allocation is useful in the following situations:

- When guest-to-guest communications performance is not of primary importance
- When a large number of virtual network devices are required in a virtual switch device

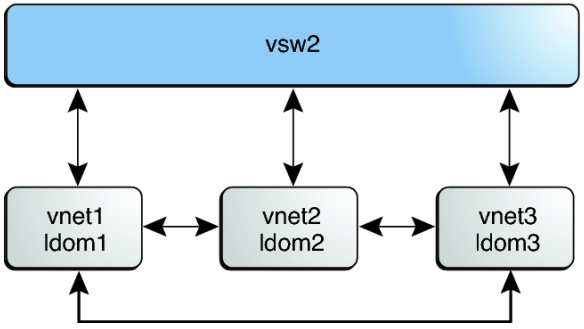
By not assigning inter-vnet channels, more LDC channels are available for use to add more virtual I/O devices to a guest domain.

Note – If guest-to-guest performance is of higher importance than increasing the number of virtual network devices in the system, do not disable inter-vnet LDC channel allocation.

You can use the `ldm add-vsw` and the `ldm set-vsw` commands to specify a value of `on` or `off` for the `inter-vnet-link` property.

The following figure shows a typical virtual switch that has three virtual network devices. The `inter-vnet-link` property is set to `on`, which means that inter-vnet LDC channels are allocated. The guest-to-guest communications between `vnet1` and `vnet2` is performed directly without going through the virtual switch.

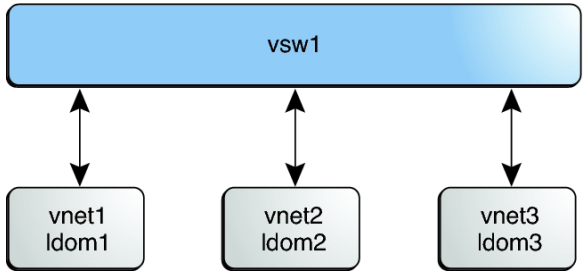
FIGURE 8–3 Virtual Switch Configuration That Uses Inter-Vnet Channels



The following figure shows the same virtual switch configuration with the `inter-vnet-link` property set to `off`. The inter-vnet LDC channels are not allocated. Fewer LDC channels are used than when the `inter-vnet-link` property is set to `on`. In this configuration, guest-to-guest communications between `vnet1` and `vnet2` must go through `vsw1`.

Note – Disabling the assignment of inter-vnet LDC channels does not prevent guest-to-guest communications. Instead, all guest-to-guest communications traffic goes through the virtual switch rather than directly from one guest domain to another guest domain.

FIGURE 8–4 Virtual Switch Configuration That Does Not Use Inter-Vnet Channels



Controlling the Amount of Physical Network Bandwidth That Is Consumed by a Virtual Network Device

The bandwidth resource control feature enables you to limit the physical network bandwidth consumed by a virtual network device. This feature is supported on a service domain that runs at least the Oracle Solaris 11 OS and is configured with a virtual switch. Oracle Solaris 10 service domains silently ignore network bandwidth settings. This feature ensures that one guest domain does not take over the available physical network bandwidth and leave none for the others.

Use the `ldm add-vnet` and `ldm set-vnet` commands to specify the bandwidth limit by providing a value for the `maxbw` property. Use the `ldm list-bindings` or the `ldm list-domain -o network` command to view the `maxbw` property value for an existing virtual network device. The minimum bandwidth limit is 10 Mbps.

Network Bandwidth Limitations

Note – This feature is not supported by a Hybrid I/O-enabled virtual network device. The `maxbw` property is not enforced for Hybrid mode virtual networks because the Hybrid I/O assigns a specific unit of hardware resource that cannot be changed to limit bandwidth. To limit a virtual network device's bandwidth, you must disable the Hybrid mode.

The bandwidth resource control applies only to the traffic that goes through the virtual switch. Thus, inter-vnet traffic is not subjected to this limit. If you do not have a physical backend device configured, you can ignore bandwidth resource control.

The minimum supported bandwidth limit depends on the Oracle Solaris network stack in the service domain. The bandwidth limit can be configured with any desired high value. There is no upper limit. The bandwidth limit ensures only that the bandwidth does not exceed the configured value. Thus, you can configure a bandwidth limit with a value greater than the link speed of the physical network device that is assigned to the virtual switch.

Setting the Network Bandwidth Limit

Use the `ldm add-vnet` command to create a virtual network device and specify the bandwidth limit by providing a value for the `maxbw` property.

```
# ldm add-vnet maxbw=limit  if-name  vswitch-name  domain-name
```

Use the `ldm set-vnet` command to specify the bandwidth limit for an existing virtual network device.

```
# ldm set-vnet maxbw=limit  if-name  domain-name
```

You can also clear the bandwidth limit by specifying a blank value for the `maxbw` property:

```
# ldm set-vnet maxbw=  if-name  domain-name
```

The following examples show how to use the `ldm` command to specify the bandwidth limit. The bandwidth is specified as an integer with a unit. The unit is `M` for megabits-per-second or `G` for gigabits-per-second. The unit is megabits-per-second if you do not specify a unit.

EXAMPLE 8–1 Setting the Bandwidth Limit When Creating a Virtual Network Device

The following command creates a virtual network device (`vnet0`) that has a bandwidth limit of 100 Mbps.

```
primary# ldm add-vnet maxbw=100M vnet0 primary-vsw0 ldg1
```

The following command would issue an error message when attempting to set a bandwidth limit below the minimum value, which is 10 Mbps.

```
primary# ldm add-vnet maxbw=1M vnet0 primary-vsw0 ldg1
```

EXAMPLE 8–2 Setting the Bandwidth Limit on an Existing Virtual Network Device

The following commands sets the bandwidth limit to 200 Mbps on the existing `vnet0` device.

Depending on the real-time network traffic pattern, the amount of bandwidth might not reach the specified limit of 200 Mbps. For example, the bandwidth might be 95 Mbps, which does not exceed the 200 Mbps limit.

```
primary# ldm set-vnet maxbw=200M vnet0 ldg1
```

The following command sets the bandwidth limit to 2 Gbps on the existing `vnet0` device.

Because there is no upper limit on bandwidth in the MAC layer, you can still set the limit to be 2 Gbps even if the underlying physical network speed is less than 2 Gbps. In such a case, there is no bandwidth limit effect.

```
primary# ldm set-vnet maxbw=2G vnet0 ldg1
```

EXAMPLE 8–3 Clearing the Bandwidth Limit on an Existing Virtual Network Device

The following command clears the bandwidth limit on the specified virtual network device (`vnet0`). By clearing this value, the virtual network device uses the maximum bandwidth available, which is provided by the underlying physical device.

```
primary# ldm set-vnet maxbw= vnet0 ldg1
```

EXAMPLE 8–4 Viewing the Bandwidth Limit of an Existing Virtual Network Device

The `ldm list-bindings` command shows the value of the `maxbw` property for the specified virtual network device, if defined.

The following command shows that the `vnet0` virtual network device has a bandwidth limit of 15 Mbps. If no bandwidth limit is set, the `MAXBW` field is blank.

```
primary# ldm list-bindings
...
VSW
  NAME         MAC               NET-DEV   ID   DEVICE   LINKPROP
  primary-vsw0 00:14:4f:f9:95:97 net0      0    switch@0 1

  DEFAULT-VLAN-ID PVID VID       MTU   MODE   INTER-VNET-LINK
  1               1              1500         on

  PEER       MAC               PVID VID MTU  MAXBW  LINKPROP INTERVNETLINK
  vnet0@ldg1 00:14:4f:fb:b8:c8 1        1500 15

...

  NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
  ldg1             bound      ------  5000    8     2G

  NETWORK
     NAME             SERVICE                     ID   DEVICE
     vnet0            primary-vsw0@primary        0    network@0

     MAC               MODE   PVID VID     MTU   MAXBW      LINKPROP
     00:14:4f:fb:b8:c8 1                   1500  15

     PEER                       MAC              MODE   PVID VID
     primary-vsw0@primary       00:14:4f:f9:95:97  1

     MTU   MAXBW      LINKPROP
     1500
```

You can also use the `dladm show-linkprop` command to view the `maxbw` property value as follows:

```
# dladm show-linkprop -p maxbw
LINK              PROPERTY PERM VALUE  EFFECTIVE DEFAULT POSSIBLE
...
ldoms-vsw0.vport0 maxbw    rw   15     15        --      --
```

Virtual Device Identifier and Network Interface Name

When you add a virtual switch or virtual network device to a domain, you can specify its device number by setting the `id` property.

```
# ldm add-vsw [id=switch-id] vswitch-name ldom
# ldm add-vnet [id=network-id] if-name vswitch-name ldom
```

Each virtual switch and virtual network device of a domain has a unique device number that is assigned when the domain is bound. If a virtual switch or virtual network device was added with an explicit device number (by setting the `id` property), the specified device number is used. Otherwise, the system automatically assigns the lowest device number available. In that case, the device number assigned depends on how virtual switch or virtual network devices were added to the system. The device number eventually assigned to a virtual switch or virtual network device is visible in the output of the `ldm list-bindings` command when a domain is bound.

The following example shows that the `primary` domain has one virtual switch, `primary-vsw0`. This virtual switch has a device number of `0` (`switch@0`).

```
primary# ldm list-bindings primary
...
VSW
    NAME         MAC               NET-DEV DEVICE   DEFAULT-VLAN-ID PVID VID MTU MODE
    primary-vsw0 00:14:4f:fb:54:f2 nxge0   switch@0 1               1    5,6 1500
...
```

The following example shows that the `ldg1` domain has two virtual network devices: `vnet` and `vnet1`. The `vnet` device has a device number of `0` (`network@0`) and the `vnet1` device has a device number of `1` (`network@1`).

```
primary# ldm list-bindings ldg1
...
NETWORK
    NAME  SERVICE              DEVICE    MAC               MODE   PVID VID MTU
    vnet  primary-vsw0@primary network@0 00:14:4f:fb:e0:4b hybrid 1        1500
    ...
    vnet1 primary-vsw0@primary network@1 00:14:4f:f8:e1:ea        1        1500
...
```

Similarly, when a domain with a virtual network device is running the Oracle Solaris OS, the virtual network device has a network interface, `vnet`*N*. However, the network interface number of the virtual network device, *N*, is not necessarily the same as the device number of the virtual network device, *n*.

Note – On Oracle Solaris 11 systems, generic link names in the form of `net`*n* are assigned to both `vsw`*n* and `vnet`*n*. Use the `dladm show-phys` command to identify which `net`*n* names map to the `vsw`*n* and `vnet`*n* devices.

Caution – The Oracle Solaris OS preserves the mapping between the name of a network interface and a virtual switch or a virtual network device based on the device number. If a device number is not explicitly assigned to a virtual switch or virtual network device, its device number can change when the domain is unbound and is later bound again. In that case, the network interface name assigned by the OS running in the domain can also change and make the existing system configuration unusable. This situation might happen, for example, when a virtual switch or a virtual network interface is removed from the configuration of the domain.

You cannot use the `ldm list-*` commands to directly determine the Oracle Solaris OS network interface name that corresponds to a virtual switch or virtual network device. However, you can obtain this information by using a combination of the output from `ldm list -l` command and from the entries under `/devices` on the Oracle Solaris OS.

▼ How to Find Oracle Solaris OS Network Interface Name

This procecure describes how to find the Oracle Solaris OS network interface name in `ldg1` that corresponds to `net-c`. This example also shows differences if you are looking for the network interface name of a virtual switch instead of a virtual network device. In this example procedure, guest domain `ldg1` contains two virtual network devices, `net-a` and `net-c`.

1 Use the `ldm` command to find the virtual network device number for `net-c`.

```
# ldm list -l ldg1
...
NETWORK
NAME         SERVICE                     DEVICE       MAC
net-a        primary-vsw0@primary        network@0    00:14:4f:f8:91:4f
net-c        primary-vsw0@primary        network@2    00:14:4f:f8:dd:68
...
```

The virtual network device number for `net-c` is 2 (`network@2`).

To determine the network interface name of a virtual switch, find the virtual switch device number, *n* as `switch@`*n*.

2 Find the corresponding network interface on `ldg1` by logging into `ldg1` and finding the entry for this device number under `/devices`.

```
# uname -n
ldg1
```

```
# find /devices/virtual-devices@100 -type c -name network@2\*
/devices/virtual-devices@100/channel-devices@200/network@2:vnet1
```

The network interface name is the part of the entry after the colon; that is, `vnet1`.

To determine the network interface name of a virtual switch, replace the argument to the `-name` option with `virtual-network-switch@`*n*`\*`. Then, find the network interface with the name `vsw`*N*.

3 Verify that `vnet1` has the MAC address `00:14:4f:f8:dd:68` as shown in the `ldm list -l` output for `net-c` in Step 1.

- **Oracle Solaris 10 OS:**

  ```
  # ifconfig vnet1
  vnet1: flags=1000842<BROADCAST,RUNNING,MULTICAST,IPv4> mtu 1500 index 3
            inet 0.0.0.0 netmask 0
            ether 0:14:4f:f8:dd:68
  ```

- **Oracle Solaris 11 OS:**

  First, you must determine the name of the interface to specify for `vnet1` by using the `dladm show-phys` command.

  ```
  primary# dladm show-phys |grep vnet1
  net2              Ethernet             up         0      unknown   vnet1
  ```

  Then use the following command to determine the MAC address of `net2`.

  ```
  primary# dladm show-linkprop -p mac-address net2
  LINK PROPERTY    PERM VALUE             EFFECTIVE         DEFAULT POSSIBLE
  net2 mac-address rw   00:14:4f:f8:dd:68 00:14:4f:f8:dd:68 --      --
  ```

Assigning MAC Addresses Automatically or Manually

You must have enough media access control (MAC) addresses to assign to the number of logical domains, virtual switches, and virtual networks you are going to use. You can have the Logical Domains Manager automatically assign MAC addresses to a logical domain, a virtual network, and a virtual switch, or you can manually assign MAC addresses from your own pool of assigned MAC addresses. The `ldm` subcommands that set MAC addresses are `add-domain`, `add-vsw`, `set-vsw`, `add-vnet`, and `set-vnet`. If you do not specify a MAC address in these subcommands, the Logical Domains Manager assigns one automatically.

The advantage to having the Logical Domains Manager assign the MAC addresses is that it uses the block of MAC addresses dedicated for use with logical domains. Also, the Logical Domains Manager detects and prevents MAC address collisions with other Logical Domains Manager instances on the same subnet. This behavior frees you from having to manually manage your pool of MAC addresses.

MAC address assignment happens as soon as a logical domain is created or a network device is configured into a domain. In addition, the assignment is persistent until the device, or the logical domain itself, is removed.

Range of MAC Addresses Assigned to Domains

Domains have been assigned the following block of 512K MAC addresses:

```
00:14:4F:F8:00:00 ~ 00:14:4F:FF:FF:FF
```

The lower 256K addresses are used by the Logical Domains Manager for automatic MAC address allocation, and you cannot manually request an address in this range:

```
00:14:4F:F8:00:00 - 00:14:4F:FB:FF:FF
```

You can use the upper half of this range for manual MAC address allocation:

```
00:14:4F:FC:00:00 - 00:14:4F:FF:FF:FF
```

Note – In Oracle Solaris 11, the allocation of MAC addresses for VNICs uses addresses outside these ranges.

Automatic Assignment Algorithm

When you do not specify a MAC address in creating logical domain or a network device, the Logical Domains Manager automatically allocates and assigns a MAC address to that logical domain or network device. To obtain this MAC address, the Logical Domains Manager iteratively attempts to select an address and then checks for potential collisions.

Before selecting a potential address, the Logical Domains Manager first looks to see if it has a recently freed, automatically assigned address saved in a database for this purpose (see "Freed MAC Addresses" on page 202). If so, the Logical Domains Manager selects its candidate address from the database.

If no recently freed addresses are available, the MAC address is randomly selected from the 256K range of addresses set aside for this purpose. The MAC address is selected randomly to lessen the chance of a duplicate MAC address being selected as a candidate.

The address selected is then checked against other Logical Domains Managers on other systems to prevent duplicate MAC addresses from actually being assigned. The algorithm employed is described in "Duplicate MAC Address Detection" on page 202. If the address is already assigned, the Logical Domains Manager iterates, choosing another address and again checking for collisions. This process continues until a MAC address is found that is not already allocated or a time limit of 30 seconds has elapsed. If the time limit is reached, then the creation of the device fails, and an error message similar to the following is shown.

```
Automatic MAC allocation failed.  Please set the vnet MAC address manually.
```

Duplicate MAC Address Detection

To prevent the same MAC address from being allocated to different devices, the Logical Domains Manager checks with other Logical Domains Managers on other systems by sending a multicast message over the control domain's default network interface, including the address that the Logical Domains Manager wants to assign to the device. The Logical Domains Manager attempting to assign the MAC address waits for one second for a response. If a different device on another Oracle VM Server for SPARC-enabled system has already been assigned that MAC address, the Logical Domains Manager on that system sends a response containing the MAC address in question. If the requesting Logical Domains Manager receives a response, it notes the chosen MAC address has already been allocated, chooses another, and iterates.

By default, these multicast messages are sent only to other managers on the same subnet. The default time-to-live (TTL) is `1`. The TTL can be configured using the Service Management Facilities (SMF) property `ldmd/hops`.

Each Logical Domains Manager is responsible for the following:

- Listening for multicast messages
- Keeping track of MAC addresses assigned to its domains
- Looking for duplicates
- Responding so that duplicates do not occur

If the Logical Domains Manager on a system is shut down for any reason, duplicate MAC addresses could occur while the Logical Domains Manager is down.

Automatic MAC allocation occurs at the time the logical domain or network device is created and persists until the device or the logical domain is removed.

Note – A detection check for duplicate MAC addresses is performed when the logical domain or network device is created, and the logical domain is started.

Freed MAC Addresses

When a logical domain or a device associated with an automatic MAC address is removed, that MAC address is saved in a database of recently freed MAC addresses for possible later use on that system. These MAC addresses are saved to prevent the exhaustion of Internet Protocol (IP) addresses from a Dynamic Host Configuration Protocol (DHCP) server. When DHCP servers allocate IP addresses, they do so for a period of time (the lease time). The lease duration is often configured to be quite long, generally hours or days. If network devices are created and removed at a high rate without the Logical Domains Manager reusing automatically allocated MAC addresses, the number of MAC addresses allocated could soon overwhelm a typically configured DHCP server.

When the Logical Domains Manager is requested to automatically obtain a MAC address for a logical domain or network device, it first looks to the freed MAC address database to determine whether there is a previously assigned MAC address it can reuse. If a MAC address is available from this database, the duplicate MAC address detection algorithm is run. If the MAC address had not been assigned to someone else since it was previously freed, it will be reused and removed from the database. If a collision is detected, the address is removed from the database. The Logical Domains Manager then either tries the next address in the database or if none is available, randomly picks a new MAC address.

Using Network Adapters With Domains

In an Oracle Solaris 10 logical domains environment, the virtual switch service running in a service domain can directly interact with GLDv3-compliant network adapters. Though non-GLDv3 compliant network adapters can be used in these systems, the virtual switch cannot interface with them directly. See "Configuring a Virtual Switch and the Service Domain for NAT and Routing" on page 204 for information about how to use non-GLDv3 compliant network adapters.

Note – GLDv3 compliance is not an issue for Oracle Solaris 11 environments.

For more information about using link aggregation, see "Using Link Aggregation With a Virtual Switch" on page 227.

▼ How to Determine Whether a Network Adapter Is GLDv3-Compliant (Oracle Solaris 10)

This procedure applies only to Oracle Solaris 10 domains.

- **Determine whether the network adapter is GLDv3-compliant.**

  The following example uses `bge0` as the network device name.

```
# dladm show-link bge0
bge0            type: non-vlan   mtu: 1500      device: bge0
```

  The value of the `type:` field is one of the following:

  - GLDv3-compliant drivers have a type of `non-vlan` or `vlan`.
  - Non-GLDv3-compliant drivers have a type of `legacy`.

Configuring a Virtual Switch and the Service Domain for NAT and Routing

In the Oracle Solaris 10 OS, the virtual switch (`vsw`) is a layer-2 switch, which also can be used as a network device in the service domain. The virtual switch can be configured to act only as a switch between the virtual network devices in the various logical domains but with no connectivity to a network outside the box through a physical device. In this mode, creating the `vsw` as a network device and enabling IP routing in the service domain enables virtual networks to communicate outside the box using the service domain as a router. This mode of operation is essential to provide external connectivity to the domains when the physical network adapter is not GLDv3-compliant.

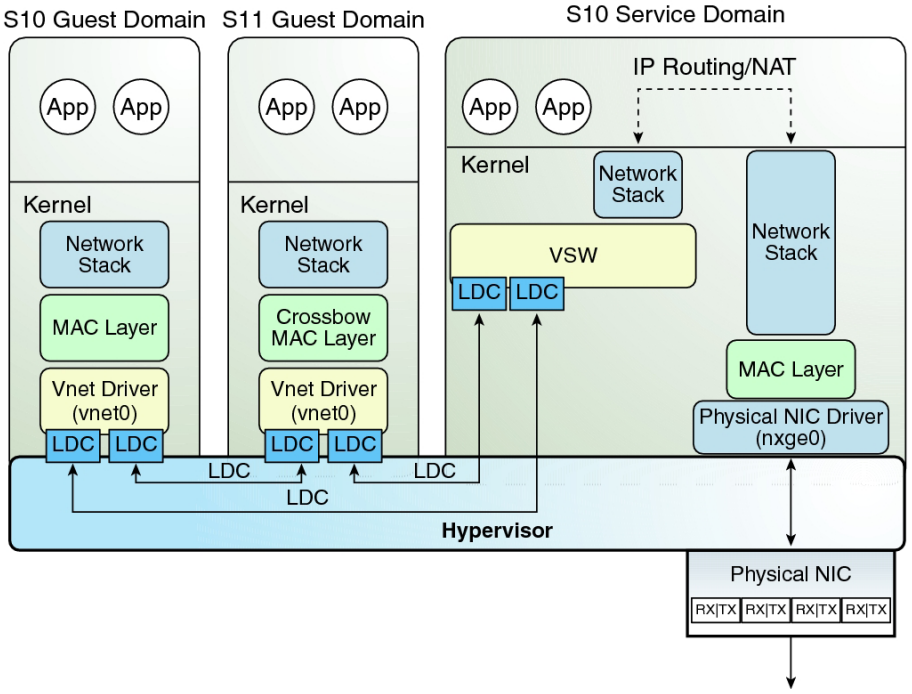
The advantages of this configuration are:

- The virtual switch does not need to use a physical device directly and can provide external connectivity even when the underlying device is not GLDv3-compliant.
- The configuration can take advantage of the IP routing and filtering capabilities of the Oracle Solaris OS.

Configuring NAT on an Oracle Solaris 10 System

The following diagram shows how a virtual switch can be used to configure Network Address Translation (NAT) in a service domain to provide external connectivity for guest domains.

FIGURE 8–5 Virtual Network Routing



How to Set Up a Virtual Switch to Provide External Connectivity to Domains (Oracle Solaris 10)

1. **Create a virtual switch that does not have an associated physical device.**

   If assigning an address, ensure that the virtual switch has a unique MAC address.

   ```
   primary# ldm add-vsw [mac-addr=xx:xx:xx:xx:xx:xx] primary-vsw0 primary
   ```

2. **Create the virtual switch as a network device in addition to the physical network device being used by the domain.**

   See "How to Configure the Virtual Switch as the Primary Interface" on page 64 for more information about creating the virtual switch.

3. **Configure the virtual switch device for DHCP, if needed.**

   See "How to Configure the Virtual Switch as the Primary Interface" on page 64 for more information about configuring the virtual switch device for DHCP.

4. **Create the `/etc/dhcp.vsw` file, if needed.**

5 **Configure IP routing in the service domain, and set up required routing tables in all the domains.**

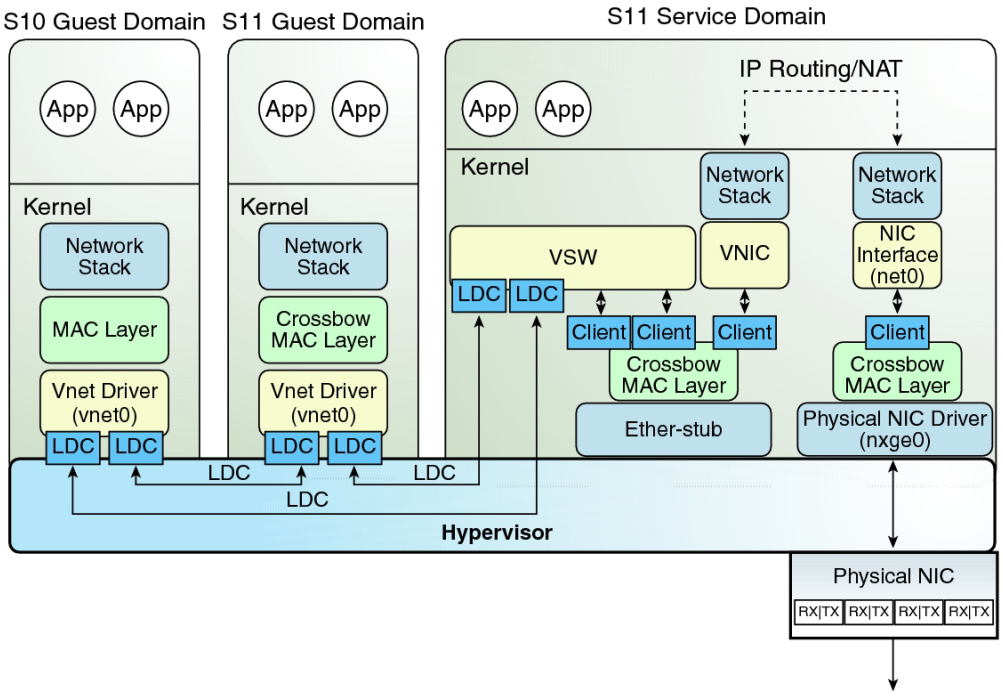
For more information about IP routing, see "Packet Forwarding and Routing on IPv4 Networks" in *System Administration Guide: IP Services*.

Configuring NAT on an Oracle Solaris 11 System

The Oracle Solaris 11 network virtualization features include `etherstub`, which is a pseudo network device. This device provides functionality similar to physical network devices but only for private communications with its clients. This pseudo device can be used as a network back-end device for a virtual switch that provides the private communications between virtual networks. By using the `etherstub` device as a back-end device, guest domains can also communicate with VNICs on the same `etherstub` device. Using the `etherstub` device in this way enables guest domains to communicate with zones in the service domain. Use the `dladm create-etherstub` command to create an `etherstub` device.

The following diagram shows how virtual switches, `etherstub` devices, and VNICs can be used to set up Network Address Translation (NAT) in a service domain.

FIGURE 8–6 Virtual Network Routing



▼ How to Set Up a Virtual Switch to Provide External Connectivity to Domains (Oracle Solaris 11)

1. **Create an Oracle Solaris 11 `etherstub` device.**

   ```
   primary# dladm create-etherstub stub0
   ```

2. **Create a virtual switch that uses `stub0` as the physical back-end device.**

   ```
   primary# ldm add-vsw net-dev=stub0 primary-stub-vsw0 primary
   ```

3. **Create a VNIC on the `stub0` device.**

   ```
   primary# dladm create-vnic -l stub0 vnic0
   ```

4. **Configure `vnic0` as the network interface.**

   ```
   primary# ipadm create-ip vnic0
   primary# ipadm create-addr -T static -a 192.168.100.1/24  vnic0/v4static
   ```

5. **Enable IPv4 forwarding and create NAT rules.**

   See "Setting IP Interface Properties" in *Connecting Systems Using Fixed Network Configuration in Oracle Solaris 11.1* and "Packet Forwarding and Routing on IPv4 Networks" in *System Administration Guide: IP Services*.

Configuring IPMP in an Oracle VM Server for SPARC Environment

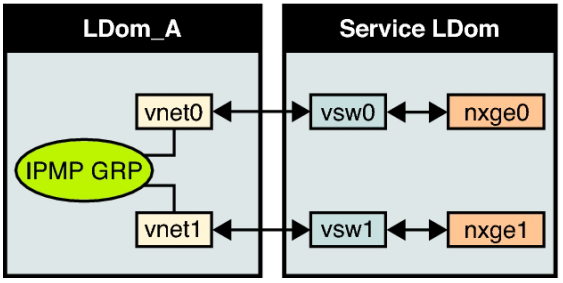
The Oracle VM Server for SPARC software supports link-based IP network multipathing (IPMP) with virtual network devices. When configuring an IPMP group with virtual network devices, configure the group to use link-based detection. If you are using older versions of the Oracle VM Server for SPARC (Logical Domains) software, you can only configure probe-based detection with virtual network devices.

Configuring Virtual Network Devices Into an IPMP Group in a Domain

The following diagram shows two virtual networks (`vnet0` and `vnet1`) connected to separate virtual switch instances (`vsw0` and `vsw1`) in the service domain, which in turn use two different physical interfaces. The physical interfaces are `nxge0` and `nxge1` in Oracle Solaris 10 and `net0` and `net1` in Oracle Solaris 11. The diagram shows the Oracle Solaris 10 physical interface names.

If a physical link failure occurs in the service domain, the virtual switch device that is bound to that physical device detects the link failure. Then, the virtual switch device propagates the failure to the corresponding virtual network device that is bound to this virtual switch. The virtual network device sends notification of this link event to the IP layer in the guest `LDom_A`, which results in failover to the other virtual network device in the IPMP group.

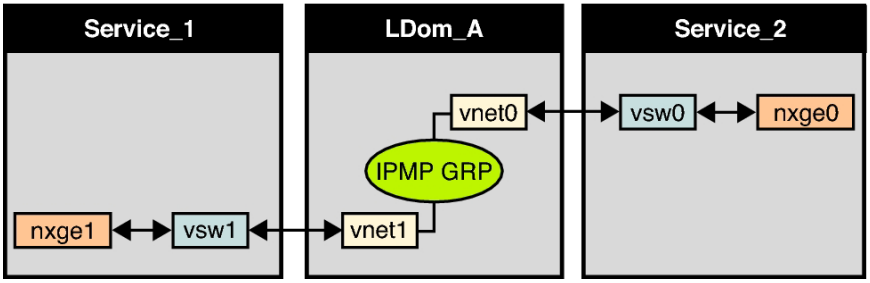
FIGURE 8–7 Two Virtual Networks Connected to Separate Virtual Switch Instances



Note – This diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` and `net1` for `nxge0` and `nxge1`, respectively.

You can achieve further reliability in the logical domain by connecting each virtual network device (`vnet0` and `vnet1`) to virtual switch instances in different service domains, as shown in the following diagram. In this case, in addition to physical network failure, `LDom_A` can detect virtual network failure and trigger a failover following a service domain crash or shutdown.

FIGURE 8–8 Virtual Network Devices Each Connected to Different Service Domains



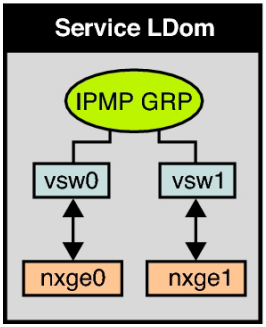
Note – This diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` and `net1` for `nxge0` and `nxge1`, respectively.

For more information, see the Oracle Solaris 10 *System Administration Guide: IP Services* or "Establishing an Oracle Solaris Network" in the Oracle Solaris 11.1 Information Library.

Configuring and Using IPMP in the Service Domain

You can configure IPMP in the service domain by configuring virtual switch interfaces into a group. The following diagram shows two virtual switch instances (`vsw0` and `vsw1`) that are bound to two different physical devices. The two virtual switch interfaces can then be created and configured into an IPMP group. In the event of a physical link failure, the virtual switch device that is bound to that physical device detects the link failure. Then, the virtual switch device sends notification of this link event to the IP layer in the service domain, which results in a failover to the other virtual switch device in the IPMP group. The two physical interfaces are `nxge0` and `nxge1` in Oracle Solaris 10 and `net0` and `net1` in Oracle Solaris 11. The diagram shows the Oracle Solaris 10 physical interface names.

FIGURE 8–9 Two Virtual Switch Interfaces Configured as Part of an IPMP Group



Note – The diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` and `net1` for `nxge0` and `nxge1`, respectively.

Using Link-Based IPMP in Oracle VM Server for SPARC Virtual Networking

The virtual network and virtual switch devices support link status updates to the network stack. By default, a virtual network device reports the status of its virtual link (its LDC to the virtual switch). This configuration is enabled by default and does not require you to perform additional configuration steps.

Sometimes detecting physical network link state changes might be necessary. For instance, if a physical device has been assigned to a virtual switch, even if the link from a virtual network device to its virtual switch device is up, the physical network link from the service domain to the external network might be down. In such a case, you might need to obtain and report the physical link status to the virtual network device and its stack.

You can use the `linkprop=phys-state` option to configure physical link state tracking for virtual network devices as well as for virtual switch devices. When this option is enabled, the virtual device (virtual network or virtual switch) reports its link state based on the physical link state while it is created as an interface in the domain. You can use standard Oracle Solaris network administration commands such as `dladm` and `ifconfig` to check the link status. In addition, the link status is also logged in the `/var/adm/messages` file.

For Oracle Solaris 10, see the `dladm(1M)` and `ifconfig(1M)` man pages. For Oracle Solaris 11, see the `dladm(1M)`, `ipadm(1M)`, and `ipmpstat(1M)` man pages.

Note – You can run both link-state-unaware and link-state-aware `vnet` and `vsw` drivers concurrently on an Oracle VM Server for SPARC system. However, if you intend to configure link-based IPMP, you must install the link-state-aware driver. If you intend to enable physical link state updates, upgrade both the `vnet` and `vsw` drivers to the Oracle Solaris 10 1/13 OS, and run at least version 1.3 of the Logical Domains Manager.

How to Configure Physical Link Status Updates

This procedure shows how to enable physical link status updates for virtual network devices.

You can also enable physical link status updates for a virtual switch device by following similar steps and specifying the `linkprop=phys-state` option to the `ldm add-vsw` and `ldm set-vsw` commands.

Note – You need to use the `linkprop=phys-state` option only if the virtual switch device itself is created as an interface. If `linkprop=phys-state` is specified and the physical link is down, the virtual network device reports its link status as down, even if the connection to the virtual switch is up. This situation occurs because the Oracle Solaris OS does not currently provide interfaces to report two distinct link states, such as virtual-link-state and physical-link-state.

1. **Become an administrator.**

   - **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in *System Administration Guide: Security Services*.**
   - **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in *Oracle Solaris 11.1 Administration: Security Services*.**

2. **Enable physical link status updates for the virtual device.**

   You can enable physical link status updates for a virtual network device in the following ways:

   - Create a virtual network device by specifying `linkprop=phys-state` when running the `ldm add-vnet` command.

     Specifying the `linkprop=phys-state` option configures the virtual network device to obtain physical link state updates and report them to the stack.

     Note – If `linkprop=phys-state` is specified and the physical link is down (even if the connection to the virtual switch is up), the virtual network device reports its link status as `down`. This situation occurs because the Oracle Solaris OS does not currently provide interfaces to report two distinct link states, such as virtual-link-state and physical-link-state.

     ```
     # ldm add-vnet linkprop=phys-state if-name vswitch-name ldom
     ```

The following example enables physical link status updates for `vnet0` connected to `primary-vsw0` on the logical domain `ldom1`:

```
# ldm add-vnet linkprop=phys-state vnet0 primary-vsw0 ldom1
```

- Modify an existing virtual network device by specifying `linkprop=phys-state` when running the `ldm set-vnet` command.

  ```
  # ldm set-vnet linkprop=phys-state if-name ldom
  ```

  The following example enables physical link status updates for `vnet0` on the logical domain `ldom1`:

  ```
  # ldm set-vnet linkprop=phys-state vnet0 ldom1
  ```

To disable physical link state updates, specify `linkprop=` by running the `ldm set-vnet` command.

The following example disables physical link status updates for `vnet0` on the logical domain `ldom1`:

```
# ldm set-vnet linkprop= vnet0 ldom1
```

Example 8–5 Configuring Link-Based IPMP

The following examples show how to configure link-based IPMP both with and without enabling physical link status updates:

- The following example configures two virtual network devices on a domain. Each virtual network device is connected to a separate virtual switch device on the service domain to use link-based IPMP.

  Note – Test addresses are not configured on these virtual network devices. Also, you do not need to perform additional configuration when you use the `ldm add-vnet` command to create these virtual network devices.

  The following commands add the virtual network devices to the domain. Note that because `linkprop=phys-state` is not specified, only the link to the virtual switch is monitored for state changes.

  ```
  # ldm add-vnet vnet0 primary-vsw0 ldom1
  # ldm add-vnet vnet1 primary-vsw1 ldom1
  ```

  The following commands configure the virtual network devices on the guest domain and assign them to an IPMP group. Note that test addresses are not configured on these virtual network devices because link-based failure detection is being used.

  - **Oracle Solaris 10 OS:** Use the `ifconfig` command.

    ```
    # ifconfig vnet0 plumb
    # ifconfig vnet1 plumb
    # ifconfig vnet0 192.168.1.1/24 up
    ```

```
# ifconfig vnet1 192.168.1.2/24 up
# ifconfig vnet0 group ipmp0
# ifconfig vnet1 group ipmp0
```

- **Oracle Solaris 11 OS:** Use the `ipadm` command.

  Note that `net0` and `net1` are the Oracle Solaris 11 vanity names for `vnet0` and `vnet1`, respectively.

```
# ipadm create-ip net0
# ipadm create-ip net1
# ipadm create-ipmp ipmp0
# ipadm add-ipmp -i net0 -i net1 ipmp0
# ipadm create-addr -T static -a 192.168.1.1/24 ipmp0/v4addr1
# ipadm create-addr -T static -a 192.168.1.2/24 ipmp0/v4addr2
```

- The following example configures two virtual network devices on a domain. Each domain is connected to a separate virtual switch device on the service domain to use link-based IPMP. The virtual network devices are also configured to obtain physical link state updates.

  Note that `net0` and `net1` are the Oracle Solaris 11 vanity names for `vnet0` and `vnet1`, respectively.

  - **Oracle Solaris 10 OS:** Use the following commands:

```
# ldm add-vnet linkprop=phys-state vnet0 primary-vsw0 ldom1
# ldm add-vnet linkprop=phys-state vnet1 primary-vsw1 ldom1
```

  - **Oracle Solaris 11 OS:** Use the following commands:

```
# ldm add-vnet linkprop=phys-state net0 primary-vsw0 ldom1
# ldm add-vnet linkprop=phys-state net1 primary-vsw1 ldom1
```

Note – The virtual switch must have a physical network device assigned for the domain to successfully bind. If the domain is already bound and the virtual switch does not have a physical network device assigned, the `ldm add-vnet` commands will fail.

  The following commands create the virtual network devices and assign them to an IPMP group:

  - **Oracle Solaris 10 OS:** Use the `ifconfig` command.

```
# ifconfig vnet0 plumb
# ifconfig vnet1 plumb
# ifconfig vnet0 192.168.1.1/24 up
# ifconfig vnet1 192.168.1.2/24 up
# ifconfig vnet0 group ipmp0
# ifconfig vnet1 group ipmp0
```

  - **Oracle Solaris 11 OS:** Use the `ipadm` command.

    Note that `net0` and `net1` are the vanity names for `vnet0` and `vnet1`, respectively.

```
# ipadm create-ip net0
# ipadm create-ip net1
# ipadm create-ipmp ipmp0
```

```
# ipadm add-ipmp -i net0 -i net1 ipmp0
# ipadm create-addr -T static -a 192.168.1.1/24 ipmp0/v4addr1
# ipadm create-addr -T static -a 192.168.1.2/24 ipmp0/v4addr2
```

Configuring and Using IPMP in Releases Prior to Logical Domains 1.3

In Logical Domains releases prior to 1.3, the virtual switch and the virtual network devices are not capable of performing link failure detection. In those releases, network failure detection and recovery can be set up by using probe-based IPMP.

Configuring IPMP in the Guest Domain

The virtual network devices in a guest domain can be configured into an IPMP group as shown in Figure 8–7 and Figure 8–8. The only difference is that probe-based failure detection is used by configuring test addresses on the virtual network devices. See *System Administration Guide: IP Services* for more information about configuring probe-based IPMP.

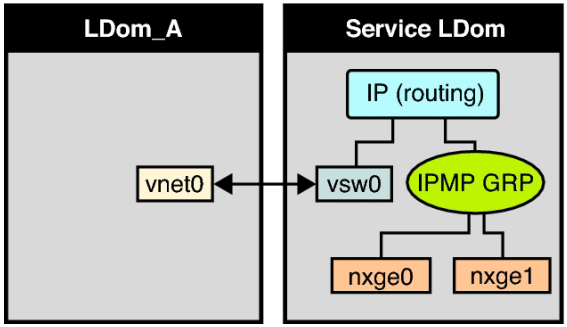
Configuring IPMP in the Service Domain

In Logical Domains releases prior to 1.3, the virtual switch device is not capable of physical link failure detection. In such cases, network failure detection and recovery can be set up by configuring the physical interfaces in the service domain into an IPMP group. To do this, configure the virtual switch in the service domain without assigning a physical network device to it. Namely, do not specify a value for the `net-dev` (`net-dev=`) property while you use the `ldm add-vswitch` command to create the virtual switch. Create the virtual switch interface in the service domain and configure the service domain itself to act as an IP router. Refer to the Oracle Solaris 10 *System Administration Guide: IP Services* for information about setting up IP routing.

Once configured, the virtual switch sends all packets originating from virtual networks (and destined for an external machine) to its IP layer instead of sending the packets directly by means of the physical device. In the event of a physical interface failure, the IP layer detects failure and automatically reroutes packets through the secondary interface.

Since the physical interfaces are directly being configured into an IPMP group, the group can be set up for either link-based or probe-based detection. The following diagram shows two network interfaces (`nxge0` and `nxge1`) configured as part of an IPMP group. The virtual switch instance (`vsw0`) has been created as a network device to send packets to its IP layer.

FIGURE 8–10 Two Network Interfaces Configured as Part of an IPMP Group



Note – This diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` and `net1` for `nxge0` and `nxge1`, respectively.

How to Configure a Host Route for Probe-Based IPMP

Note – This procedure only applies to guest domains and to releases prior to 1.3, where only probe-based IPMP is supported.

If no explicit route is configured for a router in the network corresponding to the IPMP interfaces, then one or more explicit host routes to target systems need to be configured for the IPMP probe-based detection to work as expected. Otherwise, probe detection can fail to detect the network failures.

- **Configure a host route.**

  ```
  # route add -host destination-IP gateway-IP -static
  ```

  For example:

  ```
  # route add -host 192.168.102.1 192.168.102.1 -static
  ```

  Refer to "Configuring Target Systems" in *System Administration Guide: IP Services* for more information.

Using VLAN Tagging

The Oracle VM Server for SPARC software supports 802.1Q VLAN-Tagging in the network infrastructure.

The virtual switch (`vsw`) and virtual network (`vnet`) devices support switching of Ethernet packets based on the virtual local area network (VLAN) identifier (ID) and handle the necessary tagging or untagging of Ethernet frames.

You can create multiple VLAN interfaces over a virtual network device in a guest domain. Use the Oracle Solaris 10 `ifconfig` command or the Oracle Solaris 11 `dladm` and `ipadm` commands to create a VLAN interface over a virtual network device. The creation method is the same as the method used to configure a VLAN interface over any other physical network device. The additional requirement in the Oracle VM Server for SPARC environment is that you must use the `ldm` command to assign the virtual network to the corresponding VLANs. See the `ldm(1M)` man page.

Similarly, you can configure VLAN interfaces over a virtual switch device in the service domain. VLAN IDs 2 through 4094 are valid; VLAN ID 1 is reserved as the `default-vlan-id`.

When you create a virtual network device on a guest domain, you must assign it to the required VLANs by specifying a port VLAN ID and zero or more VLAN IDs for this virtual network using the `pvid=` and `vid=` arguments to the `ldm add-vnet` command. This information configures the virtual switch to support multiple VLANs in the Oracle VM Server for SPARC network and switch packets using both MAC address and VLAN IDs in the network.

Similarly, any VLANs to which the `vsw` device itself should belong when created as a network interface must be configured in the `vsw` device using the `pvid=` and `vid=` arguments to the `ldm add-vsw` command.

You can change the VLANs to which a device belongs using `ldm set-vnet` or `ldm set-vsw` command.

Port VLAN ID

The Port VLAN ID (PVID) specifies the VLAN of which the virtual network device must be a member in untagged mode. In this case, the `vsw` device provides the necessary tagging or untagging of frames for the `vnet` device over the VLAN specified by its PVID. Any outbound frames from the virtual network that are untagged are tagged with its PVID by the virtual switch. Inbound frames tagged with this PVID are untagged by the virtual switch, before sending it to the `vnet` device. Thus, assigning a PVID to a virtual network implicitly means that the corresponding virtual network port on the virtual switch is marked untagged for the VLAN specified by the PVID. You can have only one PVID for a virtual network device.

The corresponding virtual network interface, when configured without a VLAN ID and using only its device instance, results in the interface being implicitly assigned to the VLAN specified by the virtual network's PVID.

For example, if you were to create virtual network instance `0` using one of the following commands and if the `pvid=` argument for the `vnet` has been specified as `10`, the `vnet0` interface would be implicitly assigned to belong to VLAN 10. Note that the following commands show the `vnet0` interface names, which pertain to Oracle Solaris 10. For Oracle Solaris 11, use the generic name instead, such as `net0`.

- **Oracle Solaris 10 OS:** Use the `ifconfig` command.

  ```
  # ifconfig vnet0 plumb
  ```

- **Oracle Solaris 11 OS:** Use the `ipadm` command.

  ```
  # ipadm create-ip net0
  ```

VLAN ID

The VID ID (VID) specifies the VLAN of which a virtual network device or virtual switch must be a member in tagged mode. The virtual network device sends and receives tagged frames over the VLANs specified by its VIDs. The virtual switch passes any frames that are tagged with the specified VID between the virtual network device and the external network.

▼ How to Assign VLANs to a Virtual Switch and Virtual Network Device

1 Assign the virtual switch (`vsw`) to two VLANs.

For example, configure VLAN 21 as untagged and VLAN 20 as tagged. Assign the virtual network (`vnet`) to three VLANs. Configure VLAN 20 as untagged and VLAN 21 and 22 as tagged.

```
# ldm add-vsw net-dev=nxge0 pvid=21 vid=20 primary-vsw0 primary
# ldm add-vnet pvid=20 vid=21,22 vnet01 primary-vsw0 ldom1
```

2 Create the VLAN interfaces.

This example assumes that the instance number of these devices is `0` in the domains, and the VLANs are mapped to these subnets:

VLAN 20 Subnet `192.168.1.0` (netmask: `255.255.255.0`)

VLAN 21 Subnet `192.168.2.0` (netmask: `255.255.255.0`)

VLAN 22 Subnet `192.168.3.0` (netmask: `255.255.255.0`)

a. Create the VLAN interface in the service (`primary`) domain.

- **Oracle Solaris 10 OS: Use the `ifconfig` command.**

```
primary# ifconfig vsw0 plumb
primary# ifconfig vsw0 192.168.2.100 netmask 0xffffff00 broadcast + up
primary# ifconfig vsw20000 plumb
primary# ifconfig vsw20000 192.168.1.100 netmask 0xffffff00 broadcast + up
```

- **Oracle Solaris 11 OS: Use the `dladm` and `ipadm` commands.**

```
primary# dladm create-vlan -l net0 -v20 vlan20
primary# ipadm create-ip vlan20
primary# ipadm create-addr -T static -a 192.168.1.100/24 vlan20/ipv4
```

b. Create the VLAN interface in the guest (`ldom1`) domain.

- **Oracle Solaris 10 OS: Use the `ifconfig` command.**

```
ldom1# ifconfig vnet0 plumb
ldom1# ifconfig vnet0 192.168.1.101 netmask 0xffffff00 broadcast + up
ldom1# ifconfig vnet21000 plumb
ldom1# ifconfig vnet21000 192.168.2.101 netmask 0xffffff00 broadcast + up
ldom1# ifconfig vnet22000 plumb
ldom1# ifconfig vnet22000 192.168.3.101 netmask 0xffffff00 broadcast + up
```

For more information about how to configure VLAN interfaces in the Oracle Solaris 10 OS, refer to "Administering Virtual Local Area Networks" in *System Administration Guide: IP Services*.

- **Oracle Solaris 11 OS: Use the `dladm` and `ipadm` commands.**

```
ldom1# dladm create-vlan -l net0 -v21
ldom1# ipadm create-ip net0
ldom1# ipadm create-addr -T static -a 192.168.1.101/24 net0/ipv4
ldom1# ipadm create-ip net21000
ldom1# ipadm create-addr -T static -a 192.168.2.101/24 net21000/ipv4
ldom1# ipadm create-ip net22000
ldom1# ipadm create-addr -T static -a 192.168.3.101/24 net22000/ipv4
```

For more information about how to configure VLAN interfaces in the Oracle Solaris 11 OS, refer to "Administering VLANs" in *Managing Oracle Solaris 11.1 Network Performance*.

▼ How to Install a Guest Domain When the Install Server Is in a VLAN

Be careful when using the Oracle Solaris JumpStart feature to install a guest domain over the network when the installation server is in a VLAN. This feature is supported only on Oracle Solaris 10 systems.

For more information about using the Oracle Solaris JumpStart feature to install a guest domain, see "How to Use the Oracle Solaris JumpStart Feature on an Oracle Solaris 10 Guest Domain" on page 73.

1. **Initially configure the network device in untagged mode.**

   For example, if the install server is in VLAN 21, configure the virtual network initially as follows:

   ```
   primary# ldm add-vnet pvid=21 vnet01 primary-vsw0 ldom1
   ```

   Do not configure any tagged VLANs (`vid`) for that virtual network device. You must do this because the OpenBoot PROM (OBP) is not aware of VLANs and cannot handle VLAN-tagged network packets.

2. **After the installation is complete and the Oracle Solaris OS boots, configure the virtual network in tagged mode.**

   ```
   primary# ldm set-vnet pvid= vid=21, 22, 23 vnet01 primary-vsw0 ldom1
   ```

   You can now add the virtual network device to additional VLANs in tagged mode.

Using Private VLANs

The private VLAN (PVLAN) mechanism enables you to divide a regular VLAN into sub-VLANs to isolate network traffic. The PVLAN mechanism is defined in RFC 5517 (`http://tools.ietf.org/html/rfc5517`). Usually, a regular VLAN is a single broadcast domain, but when configured with PVLAN properties, the single broadcast domain is partitioned into smaller broadcast sub-domains while keeping the existing Layer 3 configuration. When you configure a PVLAN, the regular VLAN is called the *primary VLAN* and the sub-VLANs are called *secondary VLANs*. The secondary VLANs can be either isolated VLANs or community VLANs.

When two virtual networks use the same VLAN ID on a physical link, all broadcast traffic is passed between the two virtual networks. However, when you create virtual networks that use PVLAN properties, the packet-forwarding behavior might not apply to all situations.

The following table shows the broadcast packet-forwarding rules for isolated and community PVLANs.

TABLE 8–1 Broadcast Packet-Forwarding Rules

	Isolated	Community A	Community B
Isolated	No	No	No
Community A	No	Yes	No
Community B	No	No	Yes

The inter-vnet-links feature supports the communication restrictions of isolated and community PVLANs. Inter-vnet-links are disabled for isolated PVLANs and are enabled only for virtual networks that are in the same community for community PVLANs. Direct traffic from other virtual networks outside of the community is not permitted.

PVLAN Configuration Information

To configure a PVLAN, you must provide the following information:

- **Primary VLAN ID.** The primary VLAN ID is the port VLAN ID (PVID) that is used to configure a PVLAN for a single virtual network device. This configuration ensures that a guest domain does receive VLAN packets. Note that you cannot configure VIDs with a PVLAN.
- **Secondary VLAN ID.** A secondary VLAN ID is used by a particular VLAN to provide PVLAN functionality. *secondary-vid* is the secondary VLAN ID and is an integer value in the range of 1-4094. A primary VLAN can have many secondary VLANs, with the following restrictions:
  - Neither the primary VLAN ID nor the secondary VLAN ID can be the same as the default VLAN ID.
  - The primary VLAN ID and the secondary VLAN ID cannot have the same values for both isolated and community PVLAN types.
  - Each primary VLAN can have a single isolated PVLAN associated with it. All virtual networks configured with this secondary PVLAN ID are isolated from each other and from any configured community PVLANs.
  - A primary VLAN can have multiple community VLANs with the following restrictions:
    - A primary VLAN ID cannot be used as secondary VLAN ID create another community PVLAN.

      For example, you have a community PVLAN with a primary VLAN ID of `3` and a secondary VLAN ID of `100`, you cannot create another community PVLAN that uses `3` as the secondary VLAN ID.
    - A secondary VLAN ID cannot be used as primary VLAN ID to create a community PVLAN.

For example, you have a community PVLAN with a primary VLAN ID of `3` and a secondary VLAN ID of `100`, you cannot create another community PVLAN that uses `100` as the primary VLAN ID.

- The secondary VLAN ID cannot be used already as a VLAN ID for regular virtual networks or VNICs.

Caution – The Logical Domains Manager can validate only the configuration of the virtual networks on a particular virtual switch. If a PVLAN configuration is set up for Oracle Solaris VNICs on the same back-end device, ensure that the same requirements are met across all VNICs and virtual networks.

- **PVLAN type.** The available PLVAN types are `isolated` and `community`.
  - `isolated`**.** The ports that are associated with an isolated PVLAN are isolated from all of the peer virtual networks and Oracle Solaris virtual NICs on the back-end network device. The packets reach only the external network based on the values you specified for the PVLAN.
  - `community`**.** The ports that are associated with a community PVLAN can communicate with other ports that are in the same community PVLAN but are isolated from all other ports. The packets reach the external network based on the values you specified for the PVLAN.

Creating and Removing PVLANs

This section describes how to create and remove PVLANs.

Creating a PVLAN

You can configure a PVLAN by setting the `pvlan` property value through the `ldm add-vnet` or `ldm set-vnet` command. The syntax for both commands when used for this purpose are the same. See the `ldm(1M)` man page.

You can use the following commands to create a PVLAN:

```
ldm add-vnet pvid=port-VLAN-ID pvlan=secondary-vid,pvlan-type
  if-name vswitch-name domain-name

ldm set-vnet pvid=port-VLAN-ID pvlan=secondary-vid,pvlan-type
  if-name domain-name
```

The following command shows how to create a virtual network with the PVLAN configuration that has a primary *VLAN-ID* of `4`, a secondary *VLAN-ID* of `200`, and a *pvlan-type* of `isolated`.

```
primary# ldm add-vnet pvid=4 pvlan=200,isolated vnet1 primary-vsw0 ldg1
```

For information about the `ldm add-vnet` and `ldm set-vnet` commands, see the `ldm(1M)` man page.

The following command shows how to change an existing VLAN into a PVLAN that has a primary *VLAN-ID* of `3`, a secondary *VLAN-ID* of `300`, and a *pvlan-type* of `community`.

```
primary# ldm set-vnet pvid=3 pvlan=300,community vnet1 ldg1
```

Removing a PVLAN

Use the `ldm set-vnet` command to remove a PVLAN.

`ldm set-vnet pvlan=` *if-name vswitch-name domain-name*

The following command removes the PVLAN configuration for the `vnet0` virtual network. The result of this command is that the specified virtual network is a regular VLAN that uses the *VLAN-ID* that you specified when you configured the PVLAN.

```
primary# ldm set-vnet pvlan= vnet0 primary-vsw0 ldg1
```

Viewing PVLAN Information

You can view information about a PVLAN by using several of the Logical Domains Manager listing subcommands. See the `ldm(1M)` man page.

- Use `ldm list-domain -o network` to list PVLAN information.

  `ldm list-domain [-e] [-l] -o network [-p] [`*domain-name*`...]`

  The following examples show information about PVLAN configuration on the `ldg1` domain by using the `ldm list-domain -o network` command.

  - The following `ldm list-domain` command shows information about the PVLAN configuration on the `ldg1` domain.

    ```
    primary# ldm list-domain -o network ldg1
    NAME
    ldg1

    MAC
        00:14:4f:fa:bf:0f

    NETWORK
    NAME   SERVICE                 ID   DEVICE     MAC
    vnet0  primary-vsw0@primary    0    network@0  00:14:4f:f8:03:ed
    MODE   PVID VID                MTU  MAXBW      LINKPROP
           3                         1500  1700
       PVLAN : 200,community
    ```

  - The following example lists parseable configuration information. Use the `-p` option to show PVLAN configuration information in a parseable form for the `ldg1` domain.

```
primary# ldm list-domain -o network -p ldg1
VERSION 1.13
DOMAIN|name=ldg1|
MAC|mac-addr=00:14:4f:fa:bf:0f
VNET|name=vnet0|dev=network@0|service=primary-vsw0@primary|
  mac-addr=00:14:4f:f8:03:ed|mode=|pvid=3|vid=|mtu=1500|linkprop=|id=0|
  alt-mac-addrs=|maxbw=1700|protect=|priority=|cos=|pvlan=200,community
```

- Use `ldm list-bindings` to list PVLAN information.

  ```
  ldm list-bindings [-e] [-p] [domain-name...]
  ```

  The following examples show information about PVLAN configuration on the `ldg1` domain by using the `ldm list-bindings` command.

  - The following `ldm list-bindings` command shows information about the PVLAN configuration on the `ldg1` domain.

    ```
    primary# ldm list-bindings
    ...
    NETWORK
    NAME  SERVICE                     ID   DEVICE     MAC
    vnet0 primary-vsw0@primary        0    network@0  00:14:4f:f8:03:ed
    MODE   PVID VID                   MTU  MAXBW      LINKPROP
           3                          1500 1700
       PVLAN :200,community
    PEER                MAC                 MODE  PVID VID  MTU  MAXBW LINKPROP
    primary-vsw0@primary 00:14:4f:f8:fe:5e        1
    ```

  - The following `ldm list-bindings` command shows PVLAN configuration information in a parseable form for the `ldg1` domain.

    ```
    primary# ldm list-bindings -p
    ...
    VNET|name=vnet0|dev=network@0|service=primary-vsw0@primary|
      mac-addr=00:14:4f:f8:03:ed|mode=|pvid=3|vid=|mtu=1500|linkprop=|id=0|
      alt-mac-addrs=|maxbw=1700|protect=|priority=|cos=|pvlan=200,community|
      peer=primary-vsw0@primary|mac-addr=00:14:4f:f8:fe:5e|mode=|pvid=1|vid=|
      mtu=1500|maxbw=
    ```

- Use `ldm list-constraints` to list PVLAN information.

  ```
  ldm list-constraints [-x] [domain-name...]
  ```

  The following shows the output generated by running the `ldm list-constraints` command:

  ```
  primary# ldm list-constraints -x ldg1
  ...
  <Section xsi:type="ovf:VirtualHardwareSection_Type">
    <Item>
      <rasd:OtherResourceType>network</rasd:OtherResourceType>
      <rasd:Address>auto-allocated</rasd:Address>
      <gprop:GenericProperty key="vnet_name">vnet0</gprop:GenericProperty>
      <gprop:GenericProperty key="service_name">primary-vsw0</gprop:GenericProperty>
      <gprop:GenericProperty key="pvid">3</gprop:GenericProperty>
      <gprop:GenericProperty key="pvlan">200,community</gprop:GenericProperty>
      <gprop:GenericProperty key="maxbw">1700000000</gprop:GenericProperty>
      <gprop:GenericProperty key="device">network@0</gprop:GenericProperty>
  ```

```
  <gprop:GenericProperty key="id">0</gprop:GenericProperty>
</Item>
```

Using NIU Hybrid I/O

The virtual I/O framework implements a *hybrid* I/O model for improved functionality and performance. The hybrid I/O model combines direct and virtualized I/O to enable flexible deployment of I/O resources to virtual machines. It is particularly useful when direct I/O does not provide full capability for the virtual machine, or direct I/O is not persistently or consistently available to the virtual machine due to resource availability or virtual machine migration.

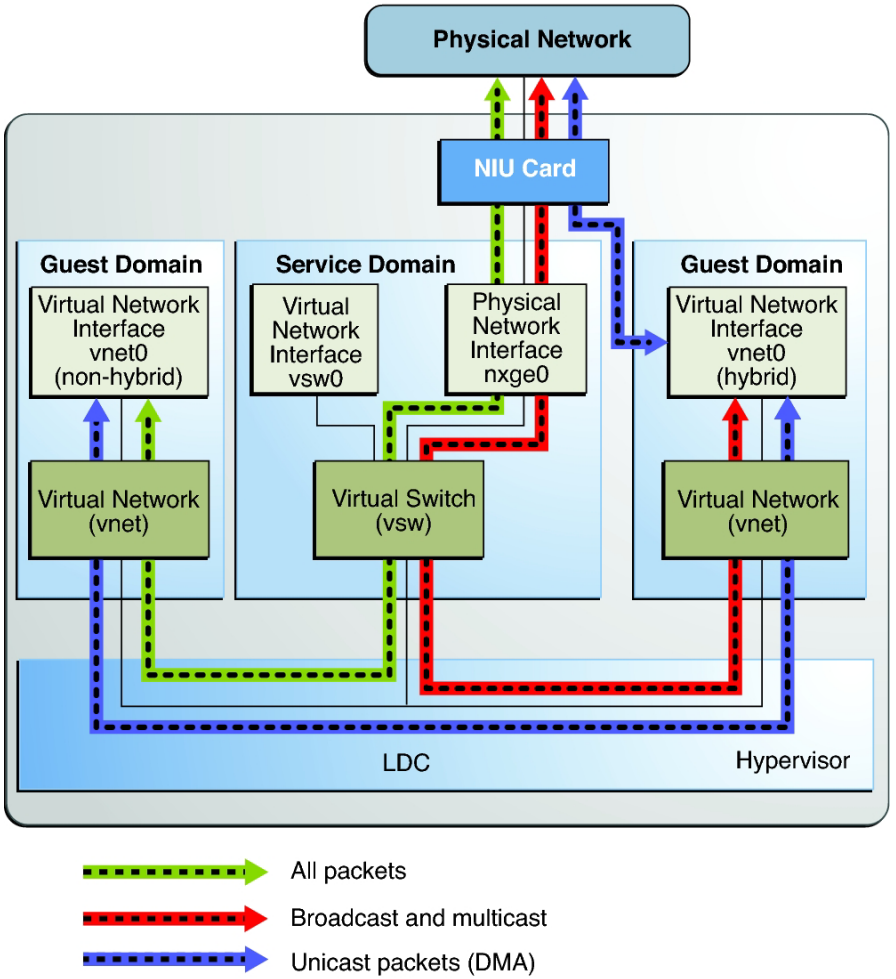
The hybrid I/O architecture is well-suited for the Network Interface Unit (NIU) on Oracle Sun UltraSPARC T2, SPARC T3, and SPARC T4 platforms. An NIU is a network I/O interface that is integrated on the chip. This architecture enables the dynamic assignment of Direct Memory Access (DMA) resources to virtual networking devices and, thereby, provides consistent performance to applications in the domain.

Note – The NIU Hybrid I/O feature is deprecated in favor of SR-IOV.

NIU hybrid I/O is available for Oracle Sun UltraSPARC T2, SPARC T3, and SPARC T4 platforms. This feature is enabled by an optional hybrid mode that provides for a virtual network (`vnet`) device where the DMA hardware resources are loaned to a `vnet` device in a guest domain for improved performance. In the hybrid mode, a vnet device in a guest domain can send and receive unicast traffic from an external network directly into the guest domain using the DMA hardware resources. The broadcast or multicast traffic and unicast traffic to the other guest domains in the same system continue to be sent using the virtual I/O communication mechanism.

Note – NIU hybrid I/O is not available on UltraSPARC T2 Plus platforms.

FIGURE 8–11 Hybrid Virtual Networking



Note – This diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` for `nxge0`.

The hybrid mode applies only for the `vnet` devices that are associated with a virtual switch (`vsw`) configured to use an NIU network device. Because the shareable DMA hardware resources are limited, up to only three `vnet` devices per `vsw` can have DMA hardware resources assigned at a given time. If more than three `vnet` devices have the hybrid mode enabled, the assignment is

done on a first-come, first-served basis. Because there are two NIU network devices in a system, there can be a total of six vnet devices on two different virtual switches with DMA hardware resources assigned.

Note the following points when using this feature:

- Hybrid mode option for a vnet device is treated as a suggestion only, so DMA resources are assigned only when they are available and the device is capable of using them.
- Logical Domains Manager CLI commands do not validate the hybrid mode option; that is, you can set the hybrid mode on any vnet or any number of vnet devices.
- Guest domains and the service domain need to run Oracle Solaris 10 10/08 OS at a minimum.
- Up to a maximum of only three vnet devices per vsw can have DMA hardware resources loaned at a given time. Because there are two NIU network devices, there can be a total of six vnet devices with DMA hardware resources loaned.

Note – Set the hybrid mode only for three vnet devices per vsw so that they are guaranteed to have DMA hardware resources assigned.

- The hybrid mode option cannot be changed dynamically while the guest domain is active.
- The DMA hardware resources are assigned only when an active vnet device is created in the guest domain.
- The NIU 10-gigabit Ethernet driver (nxge) is used for the NIU card. The same driver is also used for other 10-gigabit network cards. However, the NIU hybrid I/O feature is available for NIU network devices only.

▼ How to Configure a Virtual Switch With an NIU Network Device

1 Determine an NIU network device.

The following example shows the output on an UltraSPARC T2 server.

```
# grep nxge /etc/path_to_inst
"/niu@80/network@0" 0 "nxge"
"/niu@80/network@1" 1 "nxge"
```

The following example shows the output on a SPARC T3-1 or SPARC T4-1 server.

```
# grep nxge /etc/path_to_inst
"/niu@480/network@0" 0 "nxge"
"/niu@480/network@1" 1 "nxge"
```

2. **Oracle Solaris 11 OS only: Identify the link name that corresponds to the NIU network device, such as `nxge0`.**

```
primary# dladm show-phys -L |grep nxge0
net2              nxge0         /SYS/MB
```

3. **Configure a virtual switch.**

   - **Oracle Solaris 10 OS:**

     ```
     # ldm add-vsw net-dev=nxge0 primary-vsw0 primary
     ```

   - **Oracle Solaris 11 OS:**

     The following example uses `net2` instead of `nxge0`.

     ```
     # ldm add-vsw net-dev=net2 primary-vsw0 primary
     ```

▼ How to Enable or Disable Hybrid Mode

Hybrid mode is disabled by default for a `vnet` device and must be explicitly enabled.

- **Use the `ldm` command to enable and disable hybrid mode.**

  - **To enable a hybrid mode for a `vnet` device while it is being created:**

    ```
    # ldm add-vnet mode=hybrid vnet01 primary-vsw0 ldom01
    ```

  - **To disable hybrid mode for a `vnet` device:**

    ```
    # ldm set-vnet mode= vnet01 ldom01
    ```

Using Link Aggregation With a Virtual Switch

A virtual switch can be configured to use a link aggregation. A link aggregation is used as the virtual switch's network device to connect to the physical network. This configuration enables the virtual switch to leverage the features provided by the IEEE 802.3ad Link Aggregation Standard. Such features include increased bandwidth, load balancing, and failover. For information about how to configure link aggregation, see the *System Administration Guide: IP Services*.

After you create a link aggregation, you can assign it to the virtual switch. Making this assignment is similar to assigning a physical network device to a virtual switch. Use the `ldm add-vswitch` or `ldm set-vswitch` command to set the `net-dev` property.

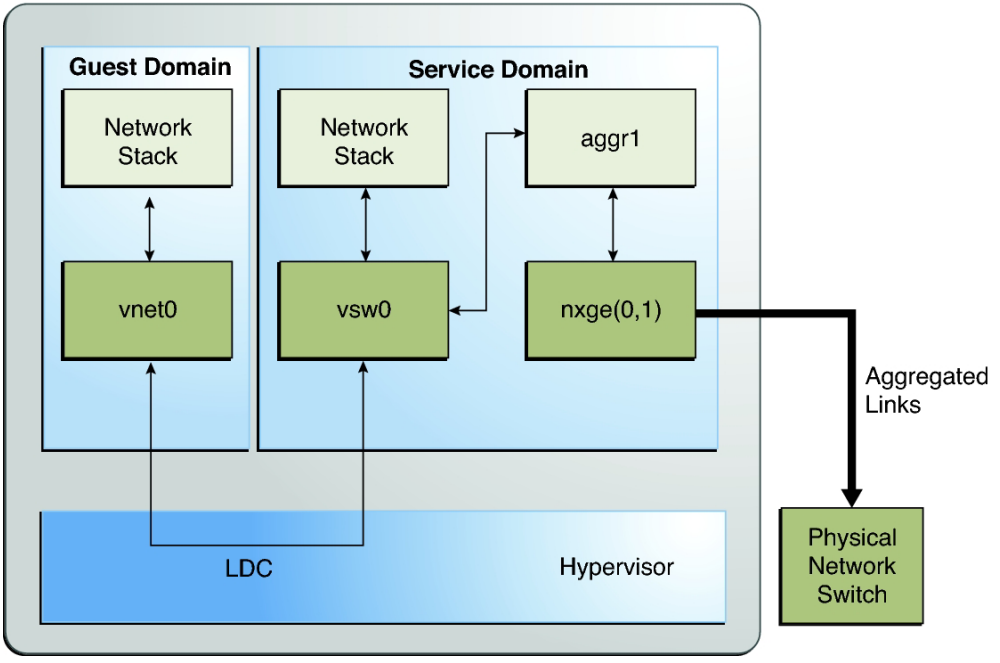
When the link aggregation is assigned to the virtual switch, traffic to and from the physical network flows through the aggregation. Any necessary load balancing or failover is handled transparently by the underlying aggregation framework. Link aggregation is completely transparent to the virtual network (`vnet`) devices that are on the guest domains and that are bound to a virtual switch that uses an aggregation.

Note – You cannot group the virtual network devices (`vnet` and `vsw`) into a link aggregation.

You can create and use the virtual switch that is configured to use a link aggregation in the service domain. See "How to Configure the Virtual Switch as the Primary Interface" on page 64.

The following figure illustrates a virtual switch configured to use an aggregation, `aggr1`, over physical interfaces `nxge0` and `nxge1`.

FIGURE 8–12 Configuring a Virtual Switch to Use a Link Aggregation



Note – This diagram shows the configuration on an Oracle Solaris 10 system. For an Oracle Solaris 11 system, only the interface names change to use the generic names, such as `net0` and `net1` for `nxge0` and `nxge1`, respectively.

Configuring Jumbo Frames

The Oracle VM Server for SPARC virtual switch (`vsw`) and virtual network (`vnet`) devices can now support Ethernet frames with payload sizes larger than 1500 bytes. These drivers are therefore now able to increase network throughput.

You enable jumbo frames by specifying the maximum transmission unit (MTU) for the virtual switch device. In such cases, the virtual switch device and all virtual network devices that are bound to the virtual switch device use the specified MTU value.

If the required MTU value for the virtual network device should be less than that supported by the virtual switch, you can specify an MTU value directly on a virtual network device.

Note – On the Oracle Solaris 10 5/09 OS, the MTU of a physical device must be configured to match the MTU of the virtual switch. For information about configuring particular drivers, see the man page that corresponds to that driver in Section 7D of the Oracle Solaris reference manual. For example, to obtain information about the Oracle Solaris 10 `nxge` driver, see the `nxge(7D)` man page.

In rare circumstances, you might need to use the `ldm add-vnet` or `ldm set-vnet` command to specify an MTU value for a virtual network device that differs from the MTU value of the virtual switch. For example, you might change the virtual network device's MTU value if you configure VLANs over a virtual network device and the largest VLAN MTU is less than the MTU value on the virtual switch. A `vnet` driver that supports jumbo frames might not be required for domains where only the default MTU value is used. However, if the domains have virtual network devices bound to a virtual switch that uses jumbo frames, ensure that the `vnet` driver supports jumbo frames.

If you use the `ldm set-vnet` command to specify an `mtu` value on a virtual network device, future updates to the MTU value of the virtual switch device are not propagated to that virtual network device. To re-enable the virtual network device to obtain the MTU value from the virtual switch device, run the following command:

```
# ldm set-vnet mtu= vnet-name ldom
```

Note that enabling jumbo frames for a virtual network device automatically enables jumbo frames for any hybrid I/O resource that is assigned to that virtual network device.

On the control domain, the Logical Domains Manager updates the MTU values that are initiated by the `ldm set-vsw` and `ldm set-vnet` commands as delayed reconfiguration operations. To make MTU updates to domains other than the control domain, you must stop a domain prior to running the `ldm set-vsw` or `ldm set-vnet` command to modify the MTU value.

How to Configure Virtual Network and Virtual Switch Devices to Use Jumbo Frames

1. **Log in to the control domain.**
2. **Become an administrator.**
   - **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in** *System Administration Guide: Security Services***.**
   - **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in** *Oracle Solaris 11.1 Administration: Security Services***.**
3. **Determine the value of MTU that you want to use for the virtual network.**

   You can specify an MTU value from 1500 to 16000 bytes. The specified MTU must match the MTU of the physical network device that is assigned to the virtual switch.
4. **Specify the MTU value of a virtual switch device or virtual network device.**

   Do one of the following:
   - Enable jumbo frames on a new virtual switch device in the service domain by specifying its MTU as a value of the `mtu` property.

     ```
     # ldm add-vsw net-dev=device mtu=value vswitch-name ldom
     ```

     In addition to configuring the virtual switch, this command updates the MTU value of each virtual network device that will be bound to this virtual switch.
   - Enable jumbo frames on an existing virtual switch device in the service domain by specifying its MTU as a value of the `mtu` property.

     ```
     # ldm set-vsw net-dev=device mtu=value vswitch-name
     ```

     In addition to configuring the virtual switch, this command updates the MTU value of each virtual network device that will be bound to this virtual switch.

Example 8–6 Configuring Jumbo Frames on Virtual Switch and Virtual Network Devices

- The following example shows how to add a new virtual switch device that uses an MTU value of `9000`. This MTU value is propagated from the virtual switch device to all of the client virtual network devices.

  First, the `ldm add-vsw` command creates the virtual switch device, `primary-vsw0`, with an MTU value of `9000`. Note that instance 0 of the network device `nxge0` is specified as a value of the `net-dev` property.

  ```
  # ldm add-vsw net-dev=nxge0 mtu=9000 primary-vsw0 primary
  ```

Next, the `ldm add-vnet` command adds a client virtual network device to this virtual switch, `primary-vsw0`. Note that the MTU of the virtual network device is implicitly assigned from the virtual switch to which it is bound. As a result, the `ldm add-vnet` command does not require that you specify a value for the `mtu` property.

```
# ldm add-vnet vnet01 primary-vsw0 ldom1
```

Depending on the version of the Oracle Solaris OS that is running, do the following:

- **Oracle Solaris 10 OS:** The `ifconfig` command creates the virtual switch interface in the service domain, `primary`. The `ifconfig vsw0` command output shows that the value of the `mtu` property is `9000`.

  ```
  # ifconfig vsw0 plumb
  # ifconfig vsw0 192.168.1.100/24 up
  # ifconfig vsw0
  vsw0: flags=201000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4,CoS> mtu 9000 index 5
          inet 192.168.1.100 netmask ffffff00 broadcast 192.168.1.255
          ether 0:14:4f:fa:0:99
  ```

  The `ifconfig` command creates the virtual network interface in the guest domain, `ldom1`. The `ifconfig vnet0` command output shows that the value of the `mtu` property is `9000`.

  ```
  # ifconfig vnet0 plumb
  # ifconfig vnet0 192.168.1.101/24 up
  # ifconfig vnet0
  vnet0: flags=201000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4,CoS> mtu 9000 index 4
          inet 192.168.1.101 netmask ffffff00 broadcast 192.168.1.255
          ether 0:14:4f:f9:c4:13
  ```

- **Oracle Solaris 11 OS:** Use the `ipadm` command to view the `mtu` property value of the primary interface.

  ```
  # ipadm show-ifprop -p mtu net0
  IFNAME PROPERTY PROTO PERM CURRENT PERSISTENT DEFAULT POSSIBLE
  net0   mtu      ipv4  rw   9000    --           9000    68-9000
  ```

  The `ipadm` command creates the virtual network interface in the guest domain, `ldom1`. The `ipadm show-ifprop` command output shows that the value of the `mtu` property is `9000`.

  ```
  # ipadm create-ip net0
  # ipadm create-addr -T static -a 192.168.1.101/24 net0/ipv4
  # ipadm show-ifprop -p mtu net0
  IFNAME PROPERTY PROTO PERM CURRENT PERSISTENT DEFAULT POSSIBLE
  net0   mtu      ipv4  rw   9000    --         9000    68-9000
  ```

- The following example shows how to change the MTU of the interface to `4000`.

  Note that the MTU of an interface can only be changed to a value that is less than the MTU of the device that is assigned by the Logical Domains Manager. This method is useful when VLANs are configured and each VLAN interface requires a different MTU.

  - **Oracle Solaris 10 OS:** Use the `ifconfig` command.

```
# ifconfig vnet0 mtu 4000
# ifconfig vnet0
vnet0: flags=1201000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4,CoS,FIXEDMTU>
mtu 4000 index 4
        inet 192.168.1.101 netmask ffffff00 broadcast 192.168.1.255
        ether 0:14:4f:f9:c4:13
```

- **Oracle Solaris 11 OS:** Use the `ipadm` command.

```
# ipadm set-ifprop -p mtu=4000 net0
# ipadm show-ifprop -p mtu net0
IFNAME PROPERTY PROTO PERM CURRENT PERSISTENT DEFAULT POSSIBLE
net0   mtu      ipv4  rw   4000    --         9000    68-9000
```

Compatibility With Older (Jumbo-Unaware) Versions of the `vnet` and `vsw` Drivers (Oracle Solaris 10)

Note – This section applies only to the Oracle Solaris 10 OS.

Drivers that support jumbo frames can interoperate with drivers that do not support jumbo frames on the same system. This interoperability is possible as long as jumbo frame support is not enabled when you create the virtual switch.

Note – Do not set the `mtu` property if any guest or service domains that are associated with the virtual switch do not use Oracle VM Server for SPARC drivers that support jumbo frames.

Jumbo frames can be enabled by changing the `mtu` property of a virtual switch from the default value of 1500. In this instance, older driver versions ignore the `mtu` setting and continue to use the default value. Note that the `ldm list` output will show the MTU value you specified and not the default value. Any frames larger than the default MTU are not sent to those devices and are dropped by the new drivers. This situation might result in inconsistent network behavior with those guests that still use the older drivers. This limitation applies to both client guest domains and the service domain.

Therefore, while jumbo frames are enabled, ensure that all virtual devices in the Oracle VM Server for SPARC network are upgraded to use the new drivers that support jumbo frames. You must be running at least Logical Domains 1.2 to configure jumbo frames.

Oracle Solaris 11 Networking-Specific Feature Differences

Some of the Oracle VM Server for SPARC networking features work differently when a domain runs the Oracle Solaris 10 OS as compared to the Oracle Solaris 11 OS. The feature differences for the Oracle VM Server for SPARC virtual network device and virtual switch when the Oracle Solaris 11 OS is run in a domain are as follows:

- **Configuring the `vsw`*n* device as the primary network interface to enable a service domain to communicate with guest domains**

  This configuration is required only for domains that run the Oracle Solaris 10 OS. For Oracle Solaris 11, a virtual switch uses the Oracle Solaris 11 network stack, automatically enabling its virtual network devices to communicate with the network interface that corresponds to its back-end device, such as `net0`.

- **Using an Oracle Solaris 11 `etherstub` device as a back-end device to create a private virtual switch**

  Using this device enables a guest domain to communicate with a zone that is configured in an Oracle Solaris 11 service domain.

- **Using generic names for the virtual switch and virtual network devices**

  The Oracle Solaris 11 OS assigns generic names for `vsw`*n* and `vnet`*n* devices. Ensure that you do not create a virtual switch with the back-end device that is another `vsw` or `vnet` device. Use the `dladm show-phys` command to see the actual physical devices that are associated with generic network device names.

- **Using VNICs on the virtual switch and virtual network devices**

  You *cannot* use VNICs on `vsw`*n* devices. An attempt to create a VNIC on `vsw`*n* fails. See "Oracle Solaris 11: Zones Configured With an Automatic Network Interface Might Fail to Start" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

◆ ◆ ◆ CHAPTER 9

Migrating Domains

This chapter describes how to migrate domains from one host machine to another host machine.

This chapter covers the following topics:

Note – To use the migration features described in this chapter, you must be running the most recent versions of the Logical Domains Manager, system firmware, and Oracle Solaris OS. For information about migration using previous versions of Oracle VM Server for SPARC, see *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes* and related versions of the administration guide.

Introduction to Domain Migration

Domain migration enables you to migrate a guest domain from one host machine to another host machine. The machine on which the migration is initiated is the *source machine*. The machine to which the domain is migrated is the *target machine*.

While a migration operation is in progress, the *domain to be migrated* is transferred from the source machine to the *migrated domain* on the target machine.

The *live migration* feature provides performance improvements that enable an active domain to be migrated while it continues to run. In addition to live migration, you can migrate bound or inactive domains, which is called *cold migration*.

You might use domain migration to perform tasks such as the following:

- Balancing the load between machines
- Performing hardware maintenance while a guest domain continues to run

Overview of a Migration Operation

The Logical Domains Manager on the source machine accepts the request to migrate a domain and establishes a secure network connection with the Logical Domains Manager that runs on the target machine. The migration occurs after this connection has been established. The migration operation is performed in the following phases:

Phase 1: After the source machine connects with the Logical Domains Manager that runs in the target machine, information about the source machine and the domain to be migrated are transferred to the target machine. This information is used to perform a series of checks to determine whether a migration is possible. The checks to perform are based on the state of the domain to be migrated. For example, if the domain to be migrated is active, a different set of checks are performed than if that domain is bound or inactive.

Phase 2: When all checks in Phase 1 have passed, the source and target machines prepare for the migration. On the target machine, a domain is created to receive the domain to be migrated. If the domain to be migrated is inactive or bound, the migration operation proceeds to Phase 5.

Phase 3: If the domain to be migrated is active, its runtime state information is transferred to the target machine. The domain to be migrated continues to run, and the Logical Domains Manager simultaneously tracks the modifications being made by the OS to this domain. This information is retrieved from the hypervisor on the source machine and installed in the hypervisor on the target machine.

Phase 4: The domain to be migrated is suspended. At this time, all of the remaining modified state information is recopied to the target machine. In this way, there is little or no perceivable interruption to the domain. The amount of interruption depends on the workload.

Phase 5: A handoff occurs from the Logical Domains Manager on the source machine to the Logical Domains Manager on the target machine. The handoff occurs when the migrated domain resumes execution (if the domain to be migrated was active) and the domain on the source machine is destroyed. From this point forward, the migrated domain is the sole version of the domain running.

Software Compatibility

For a migration to occur, both the source and target machines must be running compatible software, as follows:

- The Logical Domains Manager version running on both machines must be either the current version or the most recent previously released version.
- Both the source and target machines must have a compatible version of firmware installed to support live migration. Both machines must be running at least the minimum version of the firmware supported with this release of the Oracle VM Server for SPARC software.

For more information, see "Version Restrictions for Migration" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Security for Migration Operations

Oracle VM Server for SPARC provides the following security features for migration operations:

- **Authentication.** Because the migration operation executes on two machines, a user must be authenticated on both the source and target machines. In particular, a user other than superuser must use the `LDoms Management` rights profile.

  The `ldm migrate-domain` command permits you to optionally specify an alternate user name for authentication on the target machine. If this alternate user name is not specified, the user name of the user who is executing the migration command is used. See Example 9–2. In either case, the user is prompted for a password for the target machine, unless the `-p` option is used to initiate a non-interactive migration. See "Performing Non-Interactive Migrations" on page 238.
- **Encryption.** Oracle VM Server for SPARC uses SSL to encrypt migration traffic to protect sensitive data from exploitation and to eliminate the requirement for additional hardware and dedicated networks.

  On platforms that have cryptographic units, the speed of the migration operation increases when the `primary` domain on the source and target machines has cryptographic units assigned. This increase in speed occurs because the SSL operations can be off-loaded to the cryptographic units.

  The speed of a migration operation is automatically improved on platforms that have cryptographic instructions in the CPU. This improvement occurs because the SSL operations can be carried out by the cryptographic instructions rather than in software.

Migrating a Domain

You can use the `ldm migrate-domain` command to initiate the migration of a domain from one host machine to another host machine.

For information about migrating an active domain while it continues to run, see "Migrating an Active Domain" on page 239. For information about migrating a bound or inactive domain, see "Migrating Bound or Inactive Domains" on page 245.

For information about the migration options and operands, see the `ldm(1M)` man page.

Note – After a domain migration completes, save a new configuration to the SP of both the source and target systems. As a result, the state of the migrated domain is correct if either the source or target system undergoes a power cycle.

Performing a Dry Run

When you provide the `-n` option to the `ldm migrate-domain` command, migration checks are performed but the domain is not migrated. Any requirement that is not satisfied is reported as an error. The dry run results enable you to correct any configuration errors before you attempt an actual migration.

Note – Because of the dynamic nature of logical domains, a dry run could succeed and an actual migration fail, and vice versa.

Performing Non-Interactive Migrations

You can use the `ldm migrate-domain -p` *filename* command to initiate a non-interactive migration operation.

The file name you specify as an argument to the `-p` option must have the following characteristics:

- The first line of the file must contain the password.
- The password must be plain text.
- The password must not exceed 256 characters in length.

A newline character at the end of the password and all lines that follow the first line are ignored.

The file in which you store the target machine's password must be properly secured. If you plan to store passwords in this manner, ensure that the file permissions are set so that only the root owner or a privileged user can read or write the file (400 or 600).

Migrating an Active Domain

Certain requirements and restrictions are imposed on the domain to be migrated, the source machine, and the target machine when you attempt to migrate an active domain. For more information, see "Domain Migration Restrictions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Tip – You can reduce the overall migration time by adding more virtual CPUs to the `primary` domain on both the source and target machines. Having at least two whole cores in each `primary` domain is recommended but not required.

A domain "loses time" during the migration process. To mitigate this time-loss issue, synchronize the domain to be migrated with an external time source, such as a Network Time Protocol (NTP) server. When you configure a domain as an NTP client, the domain's date and time are corrected shortly after the migration completes.

To configure a domain as an Oracle Solaris 10 NTP client, see "Managing Network Time Protocol (Tasks)" in *System Administration Guide: Network Services*. To configure a domain as an Oracle Solaris 11 NTP client, see "Managing Network Time Protocol (Tasks)" in *Introduction to Oracle Solaris 11 Network Services*.

Note – During the suspend phase at the end of a migration, a guest domain might experience a slight delay. This delay should not result in any noticeable interrupt to network communications, especially if the protocol includes a retry mechanism such as TCP or if a retry mechanism exists at the application level such as NFS over UDP. However, if the guest domain runs a network-sensitive application such as Routing Information Protocol (RIP), the domain might experience a short delay or interrupt when attempting an operation. This delay would occur during the short period when the guest network interface is being torn down and re-created during the suspension phase.

Domain Migration Requirements for CPUs

Following are the requirements and restrictions on CPUs when you perform a migration:

- The target machine must have sufficient free virtual CPUs to accommodate the number of virtual CPUs in use by the domain to be migrated.
- Setting the `cpu-arch` property enables you to migrate between systems that have different processor types. The supported `cpu-arch` property values are as follows:
  - `native` uses CPU-specific hardware features to enable a guest domain to migrate *only* between platforms that have the same CPU type. `native` is the default value.

- `migration-class1` is a cross-CPU migration family for SPARC platforms starting with the SPARC T4. These platforms support hardware cryptography during and after these migrations so that there is a lower bound to the supported CPUs.

  This value is not compatible with UltraSPARC T2, UltraSPARC T2 Plus, or SPARC T3 platforms, or Fujitsu M10 systems.

- `sparc64-class1` is a cross-CPU migration family for SPARC64 platforms. Because the `sparc64-class1` value is based on SPARC64 instructions, it has a greater number of instructions than the `generic` value. Therefore, it does not have a performance impact compared to the `generic` value.

  This value is compatible only with Fujitsu M10 systems.

- `generic` uses the lowest common CPU hardware features that are used by all platforms to enable a guest domain to perform a CPU-type-independent migration.

The following `isainfo -v` commands show the instructions that are available on a system when `cpu-arch=generic` and when `cpu-arch=migration-class1`.

- `cpu-arch=generic`

```
# isainfo -v
64-bit sparcv9 applications
        asi_blk_init vis2 vis popc
32-bit sparc applications
        asi_blk_init vis2 vis popc v8plus div32 mul32
```

- `cpu-arch=migration-class1`

```
# isainfo -v
64-bit sparcv9 applications
        crc32c cbcond pause mont mpmul sha512 sha256 sha1 md5
        camellia des aes ima hpc vis3 fmaf asi_blk_init vis2
        vis popc
32-bit sparc applications
        crc32c cbcond pause mont mpmul sha512 sha256 sha1 md5
        camellia des aes ima hpc vis3 fmaf asi_blk_init vis2
        vis popc v8plus div32 mul32
```

Using the `generic` value might result in reduced performance compared to the `native` value. The possible performance degradation occurs because the guest domain uses only generic CPU features that are available on all supported CPU types instead of using the native hardware features of a particular CPU. By not using these features, the `generic` value enables the flexibility of migrating the domain between systems that use CPUs that support different features.

Use the `psrinfo -pv` command when the `cpu-arch` property is set to `native` to determine the processor type, as follows:

```
# psrinfo -pv
The physical processor has 2 virtual processors (0 1)
  SPARC-T5 (chipid 0, clock 3600 MHz)
```

Note that when the `cpu-arch` property is set to a value other than `native`, the `psrinfo -pv` output does not show the platform type. Instead, the command shows that the `sun4v-cpu` CPU module is loaded.

```
# psrinfo -pv
The physical processor has 2 cores and 13 virtual processors (0-12)
  The core has 8 virtual processors (0-7)
  The core has 5 virtual processors (8-12)
    sun4v-cpu (chipid 0, clock 3600 MHz)
```

Migration Requirements for Memory

The target machine must have sufficient free memory to accommodate the migration of a domain. In addition, the following properties must be maintained across the migration:

- You must be able to create the same number of identically sized memory blocks.
- The physical addresses of the memory blocks do not need to match but the same real addresses must be maintained across the migration.

In addition, the layout of the available memory on the target machine must be compatible with the memory layout of the domain to be migrated or the migration will fail. In particular, if the memory on the target machine is fragmented into multiple small address ranges but the domain to be migrated requires a single large address range, the migration will fail. The following example illustrates this scenario.

The domain to be migrated, `ldg1`, also has 8 Gbytes of free memory that is laid out in two memory blocks. The target has the memory laid out in three memory blocks some of which are too small.

```
source# ldm ls -o memory ldg1
NAME
ldg1

MEMORY
    RA               PA               SIZE
    0x80000000       0x400000000      2G
    0x400000000      0x880000000      6G

target# ldm ls-devices mem
MEMORY
    PA                   SIZE
    0x180880000000       5632M
    0x301f70000000       2G
    0x381b20000000       512M
```

Given this memory layout situation, the migration fails:

```
source# ldm migrate -n ldg1 target
Target Password:
Free memory layout and congruency requirements prevent binding the
```

```
memory block with PA 0x880000000, RA 0x400000000, and size 6G
Domain Migration of LDom ldg1 would fail if attempted
```

Migration Requirements for Physical I/O Devices

Domains that have direct access to physical devices cannot be migrated. For example, you cannot migrate I/O domains. However, virtual devices that are associated with physical devices can be migrated.

For more information, see "Migration Requirements for PCIe Endpoint Devices" on page 243 and "Migration Requirements for PCIe SR-IOV Virtual Functions" on page 243.

Migration Requirements for Virtual I/O Devices

All virtual I/O services that are used by the domain to be migrated must be available on the target machine. In other words, the following conditions must exist:

- Each virtual disk back end that is used in the domain to be migrated must be defined on the target machine. This shared storage can be a SAN disk, or storage that is available by means of the NFS or iSCSI protocols. The virtual disk back end you define must have the same volume and service names as on the source machine. Paths to the back end might be different on the source and target machines, but they *must* refer to the same back end.

Caution – A migration will succeed even if the paths to a virtual disk back end on the source and target machines do not refer to the same storage. However, the behavior of the domain on the target machine will be unpredictable, and the domain is likely to be unusable. To remedy the situation, stop the domain, correct the configuration issue, and then restart the domain. If you do not perform these steps, the domain might be left in an inconsistent state.

- Each virtual network device in the domain to be migrated must have a corresponding virtual network switch on the target machine. Each virtual network switch must have the same name as the virtual network switch to which the device is attached on the source machine.

  For example, if `vnet0` in the domain to be migrated is attached to a virtual switch service named `switch-y`, a domain on the target machine must provide a virtual switch service named `switch-y`.

Note – The physical network on the target machine must be correctly configured so that the migrated domain can access the network resources it requires. Otherwise, some network services might become unavailable on the domain after the migration completes.

For example, you might want to ensure that the domain can access the correct network subnet. Also, you might want to ensure that gateways, routers, or firewalls are properly configured so that the domain can reach the required remote systems from the target machine.

MAC addresses used by the domain to be migrated that are in the automatically allocated range must be available for use on the target machine.

- A virtual console concentrator (`vcc`) service must exist on the target machine and have at least one free port. Explicit console constraints are ignored during the migration. The console for the migrated domain is created by using the migrated domain name as the console group and by using any available port on any available `vcc` device in the control domain. If no available ports are available in the control domain, the console is created by using an available port on an available `vcc` device in a service domain. The migration fails if there is a conflict with the default group name.

Migration Requirements for PCIe Endpoint Devices

You cannot perform a domain migration on an I/O domain that is configured with PCIe endpoint devices.

For information about the direct I/O feature, see "Creating an I/O Domain by Assigning PCIe Endpoint Devices" on page 82.

Migration Requirements for PCIe SR-IOV Virtual Functions

You cannot perform a domain migration on an I/O domain that is configured with PCIe SR-IOV virtual functions.

For information about the SR-IOV feature, see "Creating an I/O Domain by Assigning PCIe SR-IOV Virtual Functions" on page 95.

Migration Requirements for NIU Hybrid I/O

You can migrate a domain that uses NIU Hybrid I/O resources. A constraint that specifies NIU Hybrid I/O resources is not a hard requirement of a domain. If such a domain is migrated to a machine that does not have available NIU resources, the constraint is preserved but not fulfilled.

Note that the NIU Hybrid I/O feature is deprecated in favor of SR-IOV.

Migration Requirements for Cryptographic Units

On platforms that have cryptographic units, you can migrate a guest domain that has bound cryptographic units if it runs an operating system that supports cryptographic unit dynamic reconfiguration (DR).

At the start of the migration, the Logical Domains Manager determines whether the domain to be migrated supports cryptographic unit DR. If supported, the Logical Domains Manager attempts to remove any cryptographic units from the domain. After the migration completes, the cryptographic units are re-added to the migrated domain.

Note – If the constraints for cryptographic units cannot be met on the target machine, the migration operation will not be blocked. In such a case, the migrated domain might have fewer cryptographic units than it had prior to the migration operation.

Delayed Reconfiguration in an Active Domain

Any active delayed reconfiguration operations on the source or target machine prevent a migration from starting. You are not permitted to initiate a delayed reconfiguration operation while a migration is in progress.

Migrating While an Active Domain Has the Power Management Elastic Policy in Effect

You can perform a live migration when the power management (PM) elastic policy is in effect on either the source machine or the target machine.

For Oracle VM Server for SPARC releases prior to 3.0, domain migrations are not supported for a source or target machine that has the PM elastic policy in effect. If the PM policy on the source or target machine is switched from performance to elastic while a migration is in progress, the policy switch is deferred until the migration completes. The migration command returns an error if a domain migration is attempted while either the source or target machine has the elastic policy in effect.

Operations on Other Domains

While a migration is in progress on a machine, any operation that might result in the modification of the state or configuration of the domain being migrated is blocked. All operations on the domain itself, as well as operations such as bind and stop on other domains on the machine, are blocked.

Migrating a Domain From the OpenBoot PROM or a Domain That Is Running in the Kernel Debugger

Performing a domain migration requires coordination between the Logical Domains Manager and the OS that is running in the domain to be migrated. When a domain to be migrated is running in OpenBoot or in the kernel debugger (`kmdb`), this coordination is not possible. As a result, the migration attempt fails, unless the domain to be migrated has only a single CPU. When the domain to be migrated has a single CPU, the migration proceeds when certain requirements and restrictions are met. See "Domain Migration Restrictions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

When a domain to be migrated is running in OpenBoot or in the kernel debugger (`mdb`), the migration attempt always fails if the source machine or the target machine is the Fujitsu M10 system. If the domain to be migrated has only a single CPU, you might see the following message:

```
primary# ldm migrate ldg1 system2
Non-cooperative migration is not supported on this platform.
```

Migrating Bound or Inactive Domains

Only a few domain migration restrictions apply to a bound or inactive domain because such domains are not executing at the time of the migration. Therefore, you can migrate between different platform types, such as SPARC T3 to SPARC T5 platforms or Fujitsu M10 systems, because no runtime state is being copied across.

The migration of a bound domain requires that the target machine is able to satisfy the CPU, memory, and I/O constraints of the domain to be migrated. If these constraints cannot be met, the migration will fail.

Caution – When you migrate a bound domain, the virtual disk back-end `options` and `mpgroup` values are not checked because no runtime state information is exchanged with the target machine. This check *does* occur when you migrate an active domain.

The migration of an inactive domain does not have such requirements. However, the target machine must satisfy the migrated domain's constraints when a bind is later attempted or the domain binding will fail.

Note – After a domain migration completes, save a new configuration to the SP of both the source and target systems. As a result, the state of the migrated domain is correct if either the source or target system undergoes a power cycle.

Migration Requirements for Virtual I/O Devices

For an inactive domain, no checks are performed of the virtual I/O (VIO) constraints. Therefore, the VIO servers do not need to exist for the migration to succeed. As with any inactive domain, the VIO servers must exist and be available at the time the domain is bound.

Migration Requirements for PCIe Endpoint Devices

You cannot perform a domain migration on an I/O domain that is configured with PCIe endpoint devices. This requirement applies to bound domains but not to inactive domains.

For information about the direct I/O (DIO) feature, see "Creating an I/O Domain by Assigning PCIe Endpoint Devices" on page 82.

Migration Requirements for PCIe SR-IOV Virtual Functions

You cannot perform a domain migration on an I/O domain that is configured with PCIe SR-IOV virtual functions. This requirement applies to bound domains but not to inactive domains.

For information about the SR-IOV feature, see "Creating an I/O Domain by Assigning PCIe SR-IOV Virtual Functions" on page 95.

Monitoring a Migration in Progress

When a migration is in progress, the domain being migrated and the migrated domain are shown differently in the status output. The output of the `ldm list` command indicates the state of the migrating domain.

The sixth column in the FLAGS field shows one of the following values:

- s – The domain that is the source of the migration.
- + – The migrated domain that is the target of the migration.
- e – An error has occurred that requires user intervention.

The following command shows that the ldg-src domain is the source of the migration:

```
# ldm list ldg-src
NAME       STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
ldg-src    suspended  -n---s          1     1G       0.0%  2h 7m
```

The following command shows that the ldg-tgt domain is the target of the migration:

```
# ldm list ldg-tgt
NAME       STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
ldg-tgt    bound      -----t  5000    1     1G
```

The long form of the status output shows additional information about the migration. On the source machine, the status output shows the completion percentage of the operation as well as the names of the target machine and the migrated domain. Similarly, on the target machine, the status output shows the completion percentage of the operation as well as the names of the source machine and the domain being migrated.

The following command shows the progress of a migration operation for the ldg-src domain:

```
# ldm list -o status ldg-src
NAME
ldg-src

STATUS
    OPERATION    PROGRESS    TARGET
    migration    17%         t5-sys-2
```

Canceling a Migration in Progress

After a migration starts, the migration operation is terminated if the ldm command is interrupted by a KILL signal. When the migration operation is terminated, the migrated domain is destroyed and the domain to be migrated is resumed if it was active. If the controlling shell of the ldm command is lost, the migration continues in the background.

A migration operation can also be canceled externally by using the ldm cancel-operation command. This command terminates the migration in progress and the domain being migrated resumes as the active domain. The ldm cancel-operation command must be initiated from the source machine. On a given machine, any migration-related command affects the migration operation that was started from that machine. A target machine cannot control a migration operation.

Note – After a migration has been initiated, suspending the `ldm` process does not pause the operation. The operation is not paused because the Logical Domains Manager daemon (`ldmd`) on the source and target machines affects the migration rather than the `ldm` process. The `ldm` process awaits a signal from `ldmd` that the migration has completed before returning.

Recovering From a Failed Migration

The migration operation terminates if the network connection is lost after the domain being migrated has completed sending all the runtime state information to the migrated domain but before the migrated domain can acknowledge that the domain has been resumed.

You must determine whether the migration completed successfully by taking the following steps:

1. Determine whether the migrated domain has successfully resumed operations. The migrated domain will be in one of two states:
   - If the migration completed successfully, the migrated domain is in the normal state.
   - If the migration failed, the target machine cleans up and destroys the migrated domain.
2. If the migrated domain successfully resumed operations, you can safely destroy the domain on the source machine that is in the error state. However, if the migrated domain is not present, the domain on the source machine is still the master version of the domain and must be recovered. To recover this domain, run the `ldm cancel-operation` command on the source machine. This command clears the error state and restores the domain to its original condition.

Migration Examples

EXAMPLE 9–1 Migrating a Guest Domain

This example shows how to migrate the `ldg1` domain to a machine called `t5-sys-2`.

```
# ldm migrate-domain ldg1 t5-sys-2
Target Password:
```

To perform this migration without being prompted for the target machine password, use the following command:

```
# ldm migrate-domain -p pfile ldg1 t5-sys-2
```

The `-p` option takes a file name as an argument. The specified file contains the superuser password for the target machine. In this example, `pfile` contains the password for the target machine, `t5-sys-2`.

EXAMPLE 9–2 Migrating and Renaming a Guest Domain

This example shows how to rename a domain as part of the migration operation. The `ldg-src` domain on the source machine is renamed to `ldg-tgt` on the target machine (`t5-sys-2`) as part of the migration. In addition, the `ldm-admin` user is used for authentication on the target machine.

```
# ldm migrate ldg-src ldm-admin@t5-sys-2:ldg-tgt
Target Password:
```

EXAMPLE 9–3 Migration Failure Message

This example shows the error message that you might see if the target machine does not support the latest migration functionality.

```
# ldm migrate ldg1 dt212-346
Target Password:
The target machine is running an older version of the domain
manager that does not support the latest migration functionality.

Upgrading to the latest software will remove restrictions on
a migrated domain that are in effect until it is rebooted.
Consult the product documentation for a full description of
these restrictions.

The target machine is running an older version of the domain manager
that is not compatible with the version running on the source machine.

Domain Migration of LDom ldg1 failed
```

EXAMPLE 9–4 Obtaining the Migration Status for the Domain on the Target Machine

This example shows how to obtain the status on a migrated domain while a migration is in progress. In this example, the source machine is `t5-sys-1`.

```
# ldm list -o status ldg-tgt
NAME
ldg-tgt

STATUS
    OPERATION    PROGRESS    SOURCE
    migration    55%         t5-sys-1
```

EXAMPLE 9–5 Obtaining the Parseable Migration Status for the Domain on the Source Machine

This example shows how to obtain the parseable status on the domain being migrated while a migration is in progress. In this example, the target machine is `t5-sys-2`.

```
# ldm list -o status -p ldg-src
VERSION 1.6
DOMAIN|name=ldg-src|
STATUS
|op=migration|progress=42|error=no|target=t5-sys-2
```

◆ ◆ ◆ CHAPTER 10

Managing Resources

This chapter contains information about performing resource management on Oracle VM Server for SPARC systems.

This chapter covers the following topics:

Resource Reconfiguration

A system that runs the Oracle VM Server for SPARC software is able to configure resources, such as virtual CPUs, virtual I/O devices, cryptographic units, and memory. Some resources can be configured dynamically on a running domain, while others must be configured on a stopped domain. If a resource cannot be dynamically configured on the control domain, you must first initiate a delayed reconfiguration. The delayed reconfiguration postpones the configuration activities until after the control domain has been rebooted.

Dynamic Reconfiguration

Dynamic reconfiguration (DR) enables resources to be added or removed while the operating system (OS) is running. The capability to perform DR of a particular resource type is dependent on having support in the OS running in the logical domain.

Dynamic reconfiguration is supported for the following resources:

- **Virtual CPUs –** Supported in all versions of the Oracle Solaris 10 OS and the Oracle Solaris 11 OS
- **Virtual I/O devices –** Supported in at least the Oracle Solaris 10 10/08 OS and the Oracle Solaris 11 OS
- **Cryptographic units –** Supported in at least the Oracle Solaris 10 1/13 OS and the Oracle Solaris 11 OS
- **Memory –** See "Using Memory Dynamic Reconfiguration" on page 268
- **CPU whole cores –** See "Required Oracle Solaris OS Versions" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*
- **Physical I/O devices –** Not supported

To use the DR capability, the Logical Domains DR daemon, `drd`, must be running in the domain that you want to change. See the `drd`(1M) man page.

Delayed Reconfiguration

In contrast to DR operations that take place immediately, delayed reconfiguration operations take effect in the following circumstances:

- After the next reboot of the OS
- After a stop and start of a logical domain if no OS is running

In general, delayed reconfiguration operations are restricted to the control domain. For all other domains, you must stop the domain to modify the configuration unless the resource can be dynamically reconfigured.

Delayed reconfiguration operations are restricted to the control domain. You can run a limited number of commands while a delayed reconfiguration on the root domain is in progress to support operations that cannot be completed dynamically. These subcommands are `add-io`, `set-io`, `rm-io`, `create-vf`, and `destroy-vf`. You can also run the `ldm start-reconf` command on the root domain. For all other domains, you must stop the domain to modify the configuration unless the resource can be dynamically reconfigured.

While a delayed reconfiguration is in progress, other reconfiguration requests for that domain are deferred until it is rebooted or stopped and started.

The `ldm cancel-reconf` command cancels delayed reconfiguration operations on the domain. For more information about how to use the delayed reconfiguration feature, see the `ldm`(1M) man page.

Note – You cannot use the `ldm cancel-reconf` command if any other `ldm remove-*` commands have already performed a delayed reconfiguration operation on virtual I/O devices. The `ldm cancel-reconf` command fails in this circumstance.

You can use delayed reconfiguration to decrease resources on the control domain. To remove a large number of CPUs from the control domain, see "Removing a Large Number of CPUs From the Control Domain Fails" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*. To remove large amounts of memory from the control domain, see "Decrease the Control Domain's Memory" on page 269.

Resource Allocation

The resource allocation mechanism uses resource allocation constraints to assign resources to a domain at bind time.

A *resource allocation constraint* is a hard requirement that the system must meet when you assign a resource to a domain. If the constraint cannot be met, both the resource allocation and the binding of the domain fail.

CPU Allocation

When you run threads from the same core in separate domains, you might experience unpredictable and poor performance. The Oracle VM Server for SPARC software uses the CPU affinity feature to optimize CPU allocation during the logical domain binding process, which occurs before you can start the domain. This feature attempts to keep threads from the same core allocated to the same logical domain because this type of allocation improves cache sharing between the threads within the same core.

CPU affinity attempts to avoid the sharing of cores among domains unless there is no other recourse. When a domain has been allocated a partial core and requests more strands, the strands from the partial core are bound first, and then another free core is located to fulfill the request, if necessary.

The CPU allocation mechanism uses the following constraints for CPU resources:

- **Whole-core constraint.** This constraint specifies that CPU cores are allocated to a domain rather than virtual CPUs. As long as the domain does not have the max-cores constraint enabled, the whole-core constraint can be added or removed by using the `ldm set-core` or `ldm set-vcpu` command, respectively. The domain can be inactive, bound, or active. However, enough cores must be available to satisfy the request to apply the constraint. As a worst-case example, if a domain that shares cores with another domain requests the whole-core constraint, cores from the free list would need to be available to satisfy the request. As a best-case example, all the virtual CPUs in the core are already on core boundaries, so the constraint is applied without changes to CPU resources.
- **Maximum number of cores (max-cores) constraint.** This constraint specifies the maximum number of cores that can be assigned to a bound or active domain.

How to Apply the Whole-Core Constraint

Ensure that the domain has the whole-core constraint enabled prior to setting the max-cores constraint.

1 Apply the whole-core constraint on the domain.

```
# ldm set-core 1 domain
```

2 Verify that the domain has the whole-core constraint enabled.

```
# ldm ls -o resmgmt domain
```

Notice that `max-cores` is set to `unlimited`. The domain cannot be used in conjunction with hard partitioning until the max-cores constraint is enabled.

Example 10–1 Applying the Whole-Core Constraint

This example shows how to apply the whole-core constraint on the `ldg1` domain. The first command applies the constraint, while the second command verifies that it is enabled.

```
# ldm set-core 1 ldg1
# ldm ls -o resmgmt ldg1
NAME
ldg1

CONSTRAINT
    cpu=whole-core
    max-cores=unlimited
    threading=max-throughput
```

How to Apply the Max-Cores Constraint

Ensure that the domain has the whole-core constraint enabled prior to setting the max-cores constraint.

You can only enable, modify, or disable the max-cores constraint on an inactive domain, not on a domain that is bound or active. Before you update the max-cores constraint on the control domain, you must first initiate a delayed reconfiguration.

1 Enable the max-cores constraint on the domain.

```
# ldm set-domain max-cores=max-number-of-CPU-cores  domain
```

Note – The cryptographic units that are associated with those cores are unaffected by core additions. So, the system does not automatically add the associated cryptographic units to the domain. However, a cryptographic unit is automatically removed *only* when the last virtual CPU of the core is being removed. This action prevents a cryptographic unit from being "orphaned."

---

2 Verify that the whole-core constraint is enabled.

```
# ldm ls -o resmgmt domain
```

3 Bind and restart the domain.

```
# ldm bind domain
# ldm start domain
```

Now, you can use the domain with hard partitioning.

Example 10–2 Applying the Max-Cores Constraint

This example shows how to constrain max-cores to three cores by setting the `max-cores` property, and verifying that the constraint is enabled:

```
# ldm set-domain max-cores=3 ldg1
# ldm ls -o resmgmt ldg1
NAME
ldg1

CONSTRAINT
    cpu=whole-core
    max-cores=3
    threading=max-throughput
```

Now, you can use the domain with hard partitioning.

The following example removes the max-cores constraint from the unbound and inactive `ldg1` domain, but leaves the whole-core constraint as-is.

```
# ldm stop ldg1
# ldm unbind ldg1
# ldm set-domain max-cores=unlimited ldg1
```

Alternately, to remove both the max-cores constraint and the whole-core constraint from the `ldg1` domain, assign virtual CPUs instead of cores, as follows:

```
# ldm set-vcpu 8 ldg1
```

In either case, bind and restart the domain.

```
# ldm bind ldg1
# ldm start ldg1
```

Interactions Between the Whole-Core Constraint and Other Domain Features

This section describes the interactions between the whole-core constraint and the following features:

- "CPU Dynamic Reconfiguration" on page 256
- "Dynamic Resource Management" on page 256

CPU Dynamic Reconfiguration

The whole-core constraint is fully compatible with CPU dynamic reconfiguration (DR). When a domain is defined with the whole-core constraint, you can use the `ldm add-core`, `ldm set-core`, or `ldm remove-core` command to change the number of cores on an active domain.

However, if a bound or active domain is not in delayed reconfiguration mode, its number of cores cannot exceed the maximum number of cores. This maximum is set with the maximum core constraint, which is automatically enabled when the whole-core constraint is enabled. Any CPU DR operation that does not satisfy the maximum core constraint fails.

Dynamic Resource Management

The whole-core constraint is not compatible with dynamic resource management (DRM). When a DRM policy is enabled on a domain that uses the whole-core constraint, the policy is automatically disabled. The whole-core constraint remains enabled.

Even though a DRM policy cannot be enabled when the whole-core constraint is in effect, you can still define a DRM policy for the domain. Note that when a policy is automatically disabled, it still remains active. The policy is automatically re-enabled if the domain is restarted without the whole-core constraint.

The expected interactions between the whole-core constraint and DRM are as follows:

- If the whole-core constraint is set on a domain, a warning message is issued when you attempt to enable a DRM policy on that domain.
- If a DRM policy is in effect on an inactive domain, you are permitted to enable the whole-core constraint on the domain. When the domain becomes active and the policy is enabled, the system automatically disables the DRM policy for the domain.
- If a DRM policy is enabled on an active or bound domain, you are not permitted to enable the whole-core constraint.

Configuring the System With Hard Partitions

This section describes hard partitioning with the Oracle VM Server for SPARC software, and how to use hard partitioning to conform to the Oracle CPU licensing requirements.

For information about Oracle's hard partitioning requirements for software licenses, see Partitioning: Server/Hardware Partitioning (`http://www.oracle.com/us/corporate/pricing/partitioning-070609.pdf`).

- **CPU cores and CPU threads.** The Oracle VM Server for SPARC software runs on SPARC T-Series and SPARC M5 platforms, and Fujitsu M10 systems. The processors that are used in these systems have multiple CPU cores, each of which contains multiple CPU threads.
- **Hard partitioning and CPU whole cores.** Beginning with the Oracle VM Server for SPARC 2.0 release, hard partitioning is enforced by using CPU whole-core configurations. A CPU whole-core configuration has domains that are allocated CPU whole cores instead of individual CPU threads. By default, a domain is configured to use CPU threads.

  When binding a domain in a whole-core configuration, the system provisions the specified number of CPU cores and all its CPU threads to the domain. Using a CPU whole-core configuration limits the number of CPU cores that can be dynamically assigned to a bound or active domain.
- **Oracle hard partition licensing.** To conform to the Oracle hard partition licensing requirement, you must use at least the Oracle VM Server for SPARC 2.0 release. You must also use CPU whole cores as follows:
  - A domain that runs applications that use Oracle hard partition licensing must be configured with CPU whole cores.
  - A domain that does not run applications that use Oracle hard partition licensing is not required to be configured with CPU whole cores. For example, if you do not run any Oracle applications in the control domain, that domain is not required to be configured with CPU whole cores.

Checking the Configuration of a Domain

You use the `ldm list-o` command to determine whether a domain is configured with CPU whole cores and how to list the CPU cores that are assigned to a domain.

- To determine whether the domain is configured with CPU whole cores:

  # ldm list -o resmgmt *domain*

  Verify that the whole-core constraint appears in the output and that the `max-cores` property specifies the maximum number of CPU cores that are configured for the domain. See the `ldm(1M)` man page.

  The following command shows that the `ldg1` domain is configured with CPU whole cores and a maximum of five cores:

```
# ldm list -o resmgmt ldg1
NAME
ldg1

CONSTRAINT
   whole-core
   max-cores=5
```

- When a domain is bound, CPU cores are assigned to the domain. To list the CPU cores that are assigned to a domain:

  # ldm list -o core *domain*

  The following command shows the cores that are assigned to the `ldg1` domain:

```
# ldm list -o core ldg1
NAME
ldg1

CORE
CID    PCPUSET
1    (8, 9, 10, 11, 12, 13, 14, 15)
2    (16, 17, 18, 19, 20, 21, 22, 23)
```

Configuring a Domain With CPU Whole Cores

The tasks in this section explain how to create a new domain with CPU whole cores, how to configure an existing domain with CPU whole cores, and how to configure the `primary` domain with CPU whole cores.

Note – The `ldm` subcommands that are used to assign whole cores changed in the Oracle VM Server for SPARC 2.2 release.

The tasks and examples in this section use the new commands that were introduced with the Oracle VM Server for SPARC 2.2 software.

If you are using version 2.0 or 2.1 of the Logical Domains Manager to assign whole cores to domains, use the `ldm add-vcpu -c`, `ldm set-vcpu -c`, and `ldm remove-vcpu -c` commands instead of the `ldm add-core`, `ldm set-core`, and `ldm remove-core` commands, respectively.

Use the following command to configure a domain to use CPU whole cores:

`ldm set-core` *number-of-CPU-cores domain*

This command also specifies the maximum number of CPU cores for the domain, which is the CPU cap. See the `ldm(1M)` man page.

The CPU cap and the allocation of CPU cores is handled by separate commands. By using these commands, you can independently allocate CPU cores, set a cap, or both. The allocation unit can be set to cores even when no CPU cap is in place. However, running the system in this mode is *not* acceptable for configuring hard partitioning on your Oracle VM Server for SPARC system.

- Allocate the specified number of CPU cores to a domain by using the `add-core`, `set-core`, or `rm-core` subcommand.
- Set the CPU cap by using the `create-domain` or `set-domain` subcommand to specify the `max-cores` property value.

  You must set the cap if you want to configure hard partitioning on your Oracle VM Server for SPARC system.

▼ How to Create a New Domain With CPU Whole Cores

Note – You only need to stop and unbind the domain if you optionally set the max-cores constraint.

1 Create the domain.

```
# ldm create domain
```

2 Set the number of CPU whole cores for the domain.

```
# ldm set-core number-of-CPU-cores domain
```

3 (Optional) Set the `max-cores` property for the domain.

```
# ldm set-domain max-cores=max-number-of-CPU-cores domain
```

4 **Configure the domain.**

During this configuration, ensure that you use the `ldm add-core`, `ldm set-core`, or `ldm rm-core` command.

5 **Bind and start the domain.**

```
# ldm bind domain
# ldm start domain
```

Example 10–3 Creating a New Domain With Two CPU Whole Cores

This example creates a domain, `ldg1`, with two CPU whole cores. The first command creates the `ldg1` domain. The second command configures the `ldg1` domain with two CPU whole cores.

At this point, you can perform further configuration on the domain, subject to the restrictions described in Step 3 in "How to Create a New Domain With CPU Whole Cores" on page 259.

The third and fourth commands show how to bind and start the `ldg1` domain, at which time you can use the `ldg1` domain.

```
# ldm create ldg1
# ldm set-core 2 ldg1
...
# ldm bind ldg1
# ldm start ldg1
```

▼ How to Configure an Existing Domain With CPU Whole Cores

If a domain already exists and is configured to use CPU threads, you can change its configuration to use CPU whole cores.

1 **(Optional) Stop and unbind the domain.**

This step is required only if you also set the max-cores constraint.

```
# ldm stop domain
# ldm unbind domain
```

2 **Set the number of CPU whole cores for the domain.**

```
# ldm set-core number-of-CPU-cores domain
```

3 **(Optional) Set the `max-cores` property for the domain.**

```
# ldm set-domain max-cores=max-number-of-CPU-cores domain
```

4 **(Optional) Rebind and restart the domain.**

This step is required only if you also set the max-cores constraint.

```
# ldm bind domain
# ldm start domain
```

Example 10–4 Configuring an Existing Domain With Four CPU Whole Cores

This example updates the configuration of an existing domain, `ldg1` by configuring it with four CPU whole cores.

```
# ldm set-core 4 ldg1
```

▼ How to Configure the Primary Domain With CPU Whole Cores

If the `primary` domain is configured to use CPU threads, you can change its configuration to use CPU whole cores.

1. **(Optional) Place the `primary` domain in delayed reconfiguration mode.**

   You need to initiate a delayed reconfiguration only if you want to modify the `max-cores` property.

   ```
   # ldm start-reconf primary
   ```

2. **Set the number of CPU whole cores for the `primary` domain.**

   ```
   # ldm set-core number-of-CPU-cores primary
   ```

3. **(Optional) Set the `max-cores` property for the `primary` domain.**

   ```
   # ldm set-domain max-cores=max-number-of-CPU-cores primary
   ```

4. **(Optional) Reboot the `primary` domain.**

   Use the appropriate procedure to reboot the `primary` domain depending on the system configuration. See "Rebooting the Root Domain" on page 87.

   You need to reboot the domain only if you want to modify the `max-cores` property.

Example 10–5 Configuring the Control Domain With Two CPU Whole Cores

This example configures CPU whole cores on the `primary` domain. The first command initiates delayed reconfiguration mode on the `primary` domain. The second command configures the `primary` domain with two CPU whole cores. The third command sets the `max-cores` property to 2, and the fourth command reboots the `primary` domain.

```
# ldm start-reconf primary
# ldm set-core 2 primary
# ldm set-domain max-cores=2 primary
# shutdown -i 5
```

The optional Steps 1 and 4 are required only if you want to modify the `max-cores` property.

Interaction of Hard Partitioned Systems With Other Oracle VM Server for SPARC Features

This section describes how hard partitioned systems interact with other Oracle VM Server for SPARC features.

CPU Dynamic Reconfiguration

You can use CPU dynamic reconfiguration with domains that are configured with CPU whole cores. However, you can add or remove only entire CPU cores, not individual CPU threads. The hard partitioning state of the system is maintained by the CPU dynamic reconfiguration feature. In addition, if CPU cores are dynamically added to a domain, the maximum is enforced. Therefore, the CPU DR command would fail if it attempted to exceed the maximum number of CPUs.

Note – The `max-cores` property cannot be altered unless the domain is stopped and unbound. So, to increase the maximum number of cores from the value specified at the time the whole-core constraint was set, you must first stop and unbind the domain.

Use the following commands to dynamically add to or remove CPU whole cores from a bound or active domain and to dynamically set the number of CPU whole cores for a bound or active domain:

`ldm add-core` *number-of-CPU-cores domain*
`ldm rm-core` *number-of-CPU-cores domain*
`ldm set-core` *number-of-CPU-cores domain*

Note – If the domain is not active, these commands also adjust the maximum number of CPU cores for the domain. If the domain is bound or active, these commands do not affect the maximum number of CPU cores for the domain.

EXAMPLE 10–6 Dynamically Adding Two CPU Whole Cores to a Domain

This example shows how to dynamically add two CPU whole cores to the `ldg1` domain. The `ldg1` domain is an active domain that has been configured with CPU whole cores. The first command shows that the `ldg1` domain is active. The second command shows that the `ldg1` domain is configured with CPU whole cores and a maximum of four CPU cores. The third and fifth commands show the CPU cores that are assigned to the domain before and after the addition of two CPU whole cores. The fourth command dynamically adds two CPU whole cores to the `ldg1` domain.

```
# ldm list ldg1
NAME    STATE   FLAGS   CONS  VCPU  MEMORY UTIL  UPTIME
ldg1    active  -n----  5000  16    2G     0.4%  5d 17h 49m
```

EXAMPLE 10–6 Dynamically Adding Two CPU Whole Cores to a Domain *(Continued)*

```
# ldm list -o resmgmt ldg1
NAME
ldg1

CONSTRAINT
   whole-core
        max-cores=4
# ldm list -o core ldg1
NAME
ldg1

CORE
CID    PCPUSET
1    (8, 9, 10, 11, 12, 13, 14, 15)
2    (16, 17, 18, 19, 20, 21, 22, 23)
# ldm add-core 2 ldg1
# ldm list -o core ldg1
NAME
ldg1

CORE
CID    PCPUSET
1    (8, 9, 10, 11, 12, 13, 14, 15)
2    (16, 17, 18, 19, 20, 21, 22, 23)
3    (24, 25, 26, 27, 28, 29, 30, 31)
4    (32, 33, 34, 35, 36, 37, 38, 39)
```

CPU Dynamic Resource Management

Dynamic resource management (DRM) can be used to automatically manage CPU resources on some domains. If DRM is used, the DRM policies do not apply to domains that are configured with CPU whole cores.

A DRM policy can include a domain that is configured with CPU whole cores. However, when such a policy is activated, it is automatically disabled for that domain. The domain remains configured with CPU whole cores unless and until the domain is later reconfigured with CPU threads instead of CPU whole cores. When the domain is configured to use CPU threads, the DRM policy is automatically re-enabled for that domain.

Power Management

You can set a separate power management (PM) policy for each hard-partitioned domain.

Domain Reboot or Rebind

A domain that is configured with CPU whole cores remains configured with CPU whole cores when the domain is restarted, or if the entire system is restarted. A domain uses the same physical CPU cores for the entire time it remains bound. For example, if a domain is rebooted, it uses the same physical CPU cores both before and after the reboot. Or, if the entire system is powered off while a domain is bound, that domain will be configured with the same physical

CPU cores when the system is powered on again. If you unbind a domain and then rebind it, or if the entire system is restarted with a new configuration, the domain might use different physical CPU cores.

Assigning Physical Resources to Domains

The Logical Domains Manager automatically selects the physical resources to be assigned to a domain. The Oracle VM Server for SPARC 3.1 software also enables expert administrators to explicitly choose the physical resources to assign to or remove from a domain.

Resources that you explicitly assign are called *named resources*. Resources that are automatically assigned are called *anonymous resources*.

Caution – Do *not* assign named resources unless you are an expert administrator.

You can explicitly assign physical resources to the control domain and to guest domains. Because the control domain remains active, the control domain might optionally be in a delayed reconfiguration before you make physical resource assignments. Or, a delayed reconfiguration is automatically triggered when you make physical assignments. See "Managing Physical Resources on the Control Domain" on page 267. For information about physical resource restrictions, see "Restrictions for Managing Physical Resources on Domains" on page 267.

You can explicitly assign the following physical resources to the control domain and to guest domains:

- **Physical CPUs.** Assign the physical core IDs to the domain by setting the `cid` property.

  The `cid` property should be used *only* by an administrator who is knowledgeable about the topology of the system to be configured. This advanced configuration feature enforces specific allocation rules and might affect the overall performance of the system.

  You can set this property by running any of the following commands:

  ```
  # ldm add-core cid=core-ID[,core-ID[,...]] ldom
  # ldm set-core cid=core-ID[,core-ID[,...]] ldom
  # ldm rm-core [-f] cid=core-ID[,core-ID[,...]] ldom
  ```

  If you specify a core ID as the value of the `cid` property, *core-ID* is explicitly assigned to or removed from the domain.

- **Physical memory.** Assign a set of contiguous physical memory regions to a domain by setting the `mblock` property. Each physical memory region is specified as a physical memory start address and a size.

Caution – You cannot use this feature to specify the physical addresses of DIMMs.

The `mblock` property should be used *only* by an administrator who is knowledgeable about the topology of the system to be configured. This advanced configuration feature enforces specific allocation rules and might affect the overall performance of the system.

You can set this property by running any of the following commands:

```
# ldm add-mem mblock=PA-start:size[,PA-start:size[,...]] ldom
# ldm set-mem mblock=PA-start:size[,PA-start:size[,...]] ldom
# ldm rm-mem mblock=PA-start:size[,PA-start:size[,...]] ldom
```

To assign a memory block to or remove it from a domain, set the `mblock` property. A valid value includes a physical memory starting address (*PA-start*) and a memory block size (*size*), separated by a colon (`:`).

Note – You cannot use dynamic reconfiguration (DR) to move memory or core resources between running domains when you set the `mblock` or `cid` property. To move resources between domains, ensure that the domains are in a bound or inactive state. For information about managing physical resources on the control domain, see "Managing Physical Resources on the Control Domain" on page 267.

You can use the `ldm list-constraints` command to view the resource constraints for domains. The `physical-bindings` constraint specifies which resource types have been physically assigned to a domain. When a domain is created, the `physical-bindings` constraint is unset until a physical resource is assigned to that domain.

The `physical-bindings` constraint is set to particular values in the following cases:

- `memory` when the `mblock` property is specified
- `core` when the `cid` property is specified
- `core,memory` when both the `cid` and `mblock` properties are specified

How to Remove the physical-bindings Constraint

To remove the `physical-bindings` constraint for a guest domain, you must first remove all physically bound resources.

1. **Unbind the domain.**

   ```
   # ldm unbind domain
   ```

2. **Remove the named resources.**

- To remove named cores:

  # **ldm set-core cid=***core-ID domain*
- To remove named memory:

  # **ldm set-mem mblock=***PA-start***:***size domain*

3 Add CPU or memory resources.

- To add a CPU resource:

  # **ldm add-vcpu** *number domain*
- To add a memory resource:

  # **ldm add-mem** *size***[***unit***]** *domain*

4 Rebind the domain.

ldm bind *domain*

How to Remove All Non-Physically Bound Resources

To constrain guest domains that do not have the `physical-bindings` constraint, you must first remove all non-physically bound resources.

1 Unbind the domain.

ldm unbind *domain*

2 Set the number of resources to `0`.

- To set the CPU resource:

  # **ldm set-core 0** *domain*
- To set the memory resource:

  # **ldm set-mem 0** *domain*

3 Add CPU or memory resources that are physically bound.

- To add a CPU resource:

  # **ldm add-core cid=***core-ID domain*
- To add a memory resource:

  # **ldm add-mem mblock=***PA-start***:***size domain*

4 Rebind the domain.

ldm bind *domain*

Managing Physical Resources on the Control Domain

To constrain or remove the `physical-bindings` constraint from the control domain, follow the appropriate steps in the previous section. However, instead of unbinding the domain, place the control domain in a delayed reconfiguration.

A change of constraint between anonymous resources and physically bound named resources auto-triggers a delayed reconfiguration. You can still explicitly enter a delayed reconfiguration by using the `ldm start-reconf primary` command.

As with any delayed reconfiguration change, you must perform a reboot of the domain, in this case the control domain, to complete the process.

Note – When the control domain is in delayed reconfiguration mode, you can perform unlimited memory assignments by using the `ldm add-mem` and `ldm rm-mem` commands on the control domain. However, you can perform only *one* core assignment to the control domain by using the `ldm set-core` command.

Restrictions for Managing Physical Resources on Domains

The following restrictions apply to the assignment of physical resources:

- You cannot make physical and non-physical memory bindings, or physical and non-physical core bindings, in the same domain.
- You can have non-physical memory and physical core bindings, or non-physical core and physical memory bindings, in the same domain.
- When you add a physical resource to a domain, the corresponding resource type becomes constrained as a physical binding.
- Attempts to add anonymous CPUs to or remove them from a domain where `physical-bindings=core` will fail.
- For unbound resources, the allocation and checking of the resources can occur *only* when you run the `ldm bind` command.
- When removing physical memory from a domain, you must remove the *exact* physical memory block that was previously added.
- Physical memory ranges must *not* overlap.
- You can use only the `ldm add-core cid=` or `ldm set-core cid=` command to assign a physical resource to a domain.
- If you use the `ldm add-mem mblock=` or `ldm set-mem mblock=` command to assign multiple physical memory blocks, the addresses and sizes are checked immediately for collisions with other bindings.

- A domain that has partial cores assigned to it can use the whole-core semantics if the remaining CPUs of those cores are free and available.

Using Memory Dynamic Reconfiguration

The Oracle VM Server for SPARC 2.0 release introduces memory dynamic reconfiguration (DR). This feature is capacity-based and enables you to add an arbitrary amount of memory to or remove it from an active logical domain.

The requirements and restrictions for using the memory DR feature are as follows:

- You can perform memory DR operations on any domain. However, only a single memory DR operation can be in progress on a domain at a given time.
- The memory DR feature enforces 256-Mbyte alignment on the address and size of the memory involved in a given operation. See "Memory Alignment" on page 270.
- Unaligned memory in the free memory pool cannot be assigned to a domain by using the memory DR feature. See "Adding Unaligned Memory" on page 271.

If the memory of a domain cannot be reconfigured by using a memory DR operation, the domain must be stopped before the memory can be reconfigured. If the domain is the control domain, you must first initiate a delayed reconfiguration.

Adding Memory

If a domain is active, you can use the `ldm add-memory` command to dynamically add memory to the domain. The `ldm set-memory` command can also dynamically add memory if the specified memory size is greater than the current memory size of the domain.

Removing Memory

If a domain is active, you can use the `ldm remove-memory` command to dynamically remove memory from the domain. The `ldm set-memory` command can also dynamically remove memory if the specified memory size is smaller than the current memory size of the domain.

Memory removal can be a long-running operation. You can track the progress of an `ldm remove-memory` command by running the `ldm list -l` command for the specified domain.

You can cancel a removal request that is in progress by interrupting the `ldm remove-memory` command (by pressing Control-C) or by issuing the `ldm cancel-operation memdr` command. If you cancel a memory removal request, only the outstanding portion of the removal request is affected; namely, the amount of memory still to be removed from the domain.

Partial Memory DR Requests

A request to dynamically add memory to or remove memory from a domain might only be partially fulfilled. This result depends on the availability of suitable memory to add or remove, respectively.

Note – Memory is cleared after it is removed from a domain and before it is added to another domain.

Memory Reconfiguration of the Control Domain

You can use the memory DR feature to reconfigure the memory of the control domain. If a memory DR request cannot be performed on the control domain, you must first initiate a delayed reconfiguration.

Using memory DR might not be appropriate for removing large amounts of memory from an active domain because memory DR operations might be long running. In particular, during the initial configuration of the system, you should use delayed reconfiguration to decrease the memory in the control domain.

Decrease the Control Domain's Memory

Use a delayed reconfiguration instead of a memory DR to decrease the control domain's memory from an initial factory default configuration. In such a case, the control domain owns all of the host system's memory. The memory DR feature is not well suited for this purpose because an active domain is not guaranteed to add, or more typically give up, all of the requested memory. Rather, the OS running in that domain makes a best effort to fulfill the request. In addition, memory removal can be a long-running operation. These issues are amplified when large memory operations are involved, as is the case for the initial decrease of the control domain's memory.

For these reasons, use a delayed reconfiguration by following these steps:

1. Use the `ldm start-reconf primary` command to put the control domain in delayed reconfiguration mode.
2. Partition the host system's resources that are owned by the control domain, as necessary.
3. Use the `ldm cancel-reconf` command to undo the operations in Step 2, if necessary, and start over.
4. Reboot the control domain to make the reconfiguration changes take effect.

Dynamic and Delayed Reconfiguration

If a delayed reconfiguration is pending in the control domain, a memory reconfiguration request is rejected for any other domain. If a delayed reconfiguration is not pending in the control domain, a memory reconfiguration request is rejected for any domain that does not support memory DR. For those domains, the request is converted to a delayed reconfiguration request.

Memory Alignment

Memory reconfiguration requests have different alignment requirements that depend on the state of the domain to which the request is applied.

Memory Alignment for Active Domains

- **Dynamic addition and removal.** The address and size of a memory block are 256-Mbyte-aligned for dynamic addition and dynamic removal. The minimum operation size is 256 Mbytes.

  A nonaligned request or a removal request that is larger than the bound size is rejected.

  Use the following commands to adjust memory allocations:

  - `ldm add-memory`**.** If you specify the `--auto-adj` option with this command, the amount of memory to be added is 256-Mbyte-aligned, which might increase the amount of memory actually added to the domain.
  - `ldm remove-memory`**.** If you specify the `--auto-adj` option with this command, the amount of memory to be removed is 256-Mbyte-aligned, which might decrease the amount of memory actually removed from the domain.
  - `ldm set-memory`**.** This command is treated as an addition or a removal operation. If you specify the `--auto-adj` option, the amount of memory to be added or removed is 256-Mbyte-aligned as previously described. Note that this alignment might increase the resulting memory size of the domain.
- **Delayed reconfiguration.** The address and size of a memory block are 4-Mbyte-aligned. If you make a nonaligned request, the request is rounded up to be 4-Mbyte-aligned.

Memory Alignment for Bound Domains

The address and size of a memory block are 4-Mbyte-aligned for bound domains. If you make a nonaligned request, the request is rounded up to be 4-Mbyte-aligned. Therefore, the resulting memory size of the domain might be more than you specified.

For the `ldm add-memory`, `ldm set-memory`, and `ldm remove-memory` commands, the `--auto-adj` option rounds up the size of the resulting memory to be 256-Mbyte-aligned. Therefore, the resulting memory might be more than you specified.

Memory Alignment for Inactive Domains

For the `ldm add-memory`, `ldm set-memory`, and `ldm remove-memory` commands, the `--auto-adj` option rounds up the size of the resulting memory to be 256-Mbyte-aligned. There is no alignment requirement for an inactive domain. The restrictions described in "Memory Alignment for Bound Domains" on page 270 take effect after such a domain is bound.

Adding Unaligned Memory

The memory DR feature enforces 256-Mbyte memory alignment on the address and size of the memory that is dynamically added to or removed from an active domain. Therefore, any unaligned memory in an active domain cannot be removed by using memory DR.

Also, any unaligned memory in the free memory pool cannot be added to an active domain by using memory DR.

After all the aligned memory has been allocated, you can use the `ldm add-memory` command to add the remaining unaligned memory to a bound or inactive domain. You can also use this command to add the remaining unaligned memory to the control domain by means of a delayed reconfiguration operation.

The following example shows how to add the two remaining 128-Mbyte memory blocks to the `primary` and `ldom1` domains. The `ldom1` domain is in the bound state.

The following command initiates a delayed reconfiguration operation on the control domain.

```
# ldm start-reconf primary
Initiating a delayed reconfiguration operation on the primary domain.
All configuration changes for other domains are disabled until the
primary domain reboots, at which time the new configuration for the
primary domain also takes effect.
```

The following command adds one of the 128-Mbyte memory blocks to the control domain.

```
# ldm add-memory 128M primary
------------------------------------------------------------------------------
Notice: The primary domain is in the process of a delayed reconfiguration.
Any changes made to the primary domain will only take effect after it reboots.
------------------------------------------------------------------------------

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -ndcv-  SP      8     2688M    0.1%  23d 8h 8m

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      8     2560M    0.5%  23d 8h 9m
ldom1            bound      ------  5000    1     524M
```

The following command adds the other 128-Mbyte memory block to the `ldom1` domain.

```
# ldm add-mem 128M ldom1
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      8     2560M    0.1%  23d 8h 9m
ldom1            bound      ------  5000    1     652M
```

Memory DR Examples

The following examples show how to perform memory DR operations. For information about the related CLI commands, see the `ldm(1M)` man page.

EXAMPLE 10–7 Memory DR Operations on Active Domains

This example shows how to dynamically add memory to and remove it from an active domain, `ldom1`.

The `ldm list` output shows the memory for each domain in the Memory field.

```
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.4%  1d 22h 53m
ldom1            active     -n----  5000    2     2G       0.4%  1d 1h 23m
ldom2            bound      ------  5001    2     200M
```

The following `ldm add-mem` command exits with an error because you must specify memory in multiples of 256 Mbytes. The next `ldm add-mem` command uses the `--auto-adj` option so that even though you specify `200M` as the amount of memory to add, the amount is rounded up to 256 Mbytes.

```
# ldm add-mem 200M ldom1
The size of memory must be a multiple of 256MB.

# ldm add-mem --auto-adj 200M ldom1
Adjusting request size to 256M.
The ldom1 domain has been allocated 56M more memory
than requested because of memory alignment constraints.

# ldm list
NAME             STATE    FLAGS   CONS    VCPU    MEMORY  UTIL    UPTIME
primary          active   -n-cv-  SP      4       27392M  5.0%    8m
ldom1            active   -n----  5000    2       2304M   0.5%    1m
ldom2            bound    ------  5001    2       200M
```

The `ldm rm-mem` command exits with an error because you must specify memory in multiples of 256 Mbytes. When you add the `--auto-adj` option to the same command, the memory removal succeeds because the amount of memory is rounded down to the next 256-Mbyte boundary.

```
# ldm rm-mem --auto-adj 300M ldom1
Adjusting requested size to 256M.
The ldom1 domain has been allocated 44M more memory
than requested because of memory alignment constraints.
```

EXAMPLE 10–7 Memory DR Operations on Active Domains *(Continued)*

```
# ldm list
NAME             STATE   FLAGS   CONS    VCPU    MEMORY  UTIL    UPTIME
primary          active  -n-cv-  SP      4       27392M  0.3%    8m
ldom1            active  -n----  5000    2       2G      0.2%    2m
ldom2            bound   ------  5001    2       200M
```

EXAMPLE 10–8 Memory DR Operations on Bound Domains

This example shows how to add memory to and remove it from a bound domain, `ldom2`.

The `ldm list` output shows the memory for each domain in the Memory field. The first `ldm add-mem` command adds 100 Mbytes of memory to the `ldom2` domain. The next `ldm add-mem` command specifies the `--auto-adj` option, which causes an additional 112 Mbytes of memory to be dynamically added to `ldom2`.

The `ldm rm-mem` command dynamically removes 100 Mbytes from the `ldom2` domain. If you specify the `--auto-adj` option to the same command to remove 300 Mbytes of memory, the amount of memory is rounded down to the next 256-Mbyte boundary.

```
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.4%  1d 22h 53m
ldom1            active     -n----  5000    2     2G       0.4%  1d 1h 23m
ldom2            bound      ------  5001    2     200M

# ldm add-mem 100M ldom2

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.5%  1d 22h 54m
ldom1            active     -n----  5000    2     2G       0.2%  1d 1h 25m
ldom2            bound      ------  5001    2     300M

# ldm add-mem --auto-adj 100M ldom2
Adjusting request size to 256M.
The ldom2 domain has been allocated 112M more memory
than requested because of memory alignment constraints.

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.4%  1d 22h 55m
ldom1            active     -n----  5000    2     2G       0.5%  1d 1h 25m
ldom2            bound      ------  5001    2     512M

# ldm rm-mem 100M ldom2
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   3.3%  1d 22h 55m
ldom1            active     -n----  5000    2     2G       0.2%  1d 1h 25m
ldom2            bound      ------  5001    2     412M

# ldm rm-mem --auto-adj 300M ldom2
```

EXAMPLE 10–8 Memory DR Operations on Bound Domains *(Continued)*

```
Adjusting request size to 256M.
The ldom2 domain has been allocated 144M more memory
than requested because of memory alignment constraints.

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.5%  1d 22h 55m
ldom1            active     -n----  5000    2     2G       0.2%  1d 1h 26m
ldom2            bound      ------  5001    2     256M
```

EXAMPLE 10–9 Setting Domain Memory Sizes

This example shows how to use the `ldm set-memory` command to add memory to and remove it from a domain.

The `ldm list` output shows the memory for each domain in the Memory field.

```
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     27392M   0.5%  1d 22h 55m
ldom1            active     -n----  5000    2     2G       0.2%  1d 1h 26m
ldom2            bound      ------  5001    2     256M
```

The following `ldm set-mem` command attempts to set the `primary` domain's size to 3400 Mbytes. The resulting error states that the specified value is not on a 256-Mbyte boundary. Adding the `--auto-adj` option to the same command enables you to successfully remove some memory and stay on the 256-Mbyte boundary. This command also issues a warning to state that not all of the requested memory could be removed as the domain is using that memory.

```
# ldm set-mem 3400M primary
An ldm set-mem 3400M command would remove 23992MB, which is not a multiple
of 256MB. Instead, run ldm rm-mem 23808MB to ensure a 256MB alignment.

# ldm set-mem --auto-adj 3400M primary
Adjusting request size to 3.4G.
The primary domain has been allocated 184M more memory
than requested because of memory alignment constraints.
Only 9472M of memory could be removed from the primary domain
because the rest of the memory is in use.
```

The next `ldm set-mem` command sets the memory size of the `ldom2` domain, which is in the bound state, to 690 Mbytes. If you add the `--auto-adj` option to the same command, an additional 78 Mbytes of memory is dynamically added to `ldom2` to stay on a 256-Mbyte boundary.

```
# ldm set-mem 690M ldom2
# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     17920M   0.5%  1d 22h 56m
ldom1            active     -n----  5000    2     2G       0.6%  1d 1h 27m
ldom2            bound      ------  5001    2     690M
```

EXAMPLE 10–9 Setting Domain Memory Sizes *(Continued)*

```
# ldm set-mem --auto-adj 690M ldom2
Adjusting request size to 256M.
The ldom2 domain has been allocated 78M more memory
than requested because of memory alignment constraints.

# ldm list
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
primary          active     -n-cv-  SP      4     17920M   2.1%  1d 22h 57m
ldom1            active     -n----  5000    2     2G       0.2%  1d 1h 27m
ldom2            bound      ------  5001    2     768M
```

Using Power Management

To enable power management (PM), you first need to set the PM policy in at least version 3.0 of the ILOM firmware. This section summarizes the information that you need to be able to use PM with the Oracle VM Server for SPARC software.

For more information about PM features and ILOM features, see the following:

- Chapter 16, "Using Power Management"
- "Monitoring Power Consumption" in the *Oracle Integrated Lights Out Manager (ILOM) 3.0 CLI Procedures Guide*
- *Oracle Integrated Lights Out Manager (ILOM) 3.0 Feature Updates and Release Notes*

Using Dynamic Resource Management

You can use policies to determine how to automatically perform DR activities. At this time, you can create policies *only* to govern the dynamic resource management of virtual CPUs.

Caution – The following restrictions affect CPU dynamic resource management (DRM):

- On UltraSPARC T2 and UltraSPARC T2 Plus platforms, DRM cannot be enabled when the PM elastic policy is set.
- On UltraSPARC T2 and UltraSPARC T2 Plus platforms, any change from the performance policy to the elastic policy is delayed while DRM is enabled.
- Ensure that you disable CPU DRM prior to performing a domain migration operation, or you will see an error message.
- DRM policies do not apply to domains that are configured with the `whole-core` constraint. If you attempt to use DRM on a domain that has the `whole-core` constraint set, you will see an error message.
- When the PM elastic policy is set, you can use DRM only when the firmware supports normalized utilization (8.2.0).

A *resource management policy* specifies the conditions under which virtual CPUs can be automatically added to and removed from a logical domain. A policy is managed by using the `ldm add-policy`, `ldm set-policy`, and `ldm remove-policy` commands:

```
ldm add-policy [enable=yes|no] [priority=value] [attack=value] [decay=value]
  [elastic-margin=value] [sample-rate=value] [tod-begin=hh:mm[:ss]]
  [tod-end=hh:mm[:ss]] [util-lower=percent] [util-upper=percent] [vcpu-min=value]
  [vcpu-max=value] name=policy-name ldom...
ldm set-policy [enable=[yes|no]] [priority=[value]] [attack=[value]] [decay=[value]]
  [elastic-margin=[value]] [sample-rate=[value]] [tod-begin=[hh:mm:ss]]
  [tod-end=[hh:mm:ss]] [util-lower=[percent]] [util-upper=[percent]] [vcpu-min=[value]]
  [vcpu-max=[value]] name=policy-name ldom...
ldm remove-policy [name=]policy-name... ldom
```

For information about these commands and about creating resource management policies, see the `ldm`(1M) man page.

A policy is in effect during the times specified by the `tod-begin` and `tod-end` properties. The time specified by `tod-begin` must be earlier than the time specified by `tod-end` in a 24-hour period. By default, values for the `tod-begin` and `tod-end` properties are 00:00:00 and 23:59:59, respectively. When the default values are used, the policy is always in effect.

The policy uses the value of the `priority` property to specify a priority for a dynamic resource management (DRM) policy. Priority values are used to determine the relationship between DRM policies on a single domain and between DRM-enabled domains on a single system. Lower numerical values represent higher (better) priorities. Valid values are between 1 and 9999. The default value is 99.

The behavior of the `priority` property depends on the availability of a pool of free CPU resources, as follows:

- **Free CPU resources are available in the pool.** In this case, the `priority` property determines which DRM policy will be in effect when more than one overlapping policy is defined for a single domain.
- **No free CPU resources are available in the pool.** In this case, the `priority` property specifies whether a resource can be dynamically moved from a lower-priority domain to a higher-priority domain on the same system. The priority of a domain is the priority specified by the DRM policy that is in effect for that domain.

  For example, a higher-priority domain can acquire CPU resources from another domain that has a DRM policy with a lower priority. This resource-acquisition capability pertains only to domains that have DRM policies enabled. Domains that have equal `priority` values are unaffected by this capability. So, if the default priority is used for all policies, domains cannot obtain resources from lower-priority domains. To take advantage of this capability, adjust the `priority` property values so that they have unequal values.

For example, the `ldg1` and `ldg2` domains both have DRM policies in effect. The `priority` property for the `ldg1` domain is `1`, which is more favorable than the `priority` property value of the `ldg2` domain (`2`). The `ldg1` domain can dynamically remove a CPU resource from the `ldg2` domain and assign it to itself in the following circumstances:

- The `ldg1` domain requires another CPU resource.
- The pool of free CPU resources has been exhausted.

The policy uses the `util-high` and `util-low` property values to specify the high and low thresholds for CPU utilization. If the utilization exceeds the value of `util-high`, virtual CPUs are added to the domain until the number is between the `vcpu-min` and `vcpu-max` values. If the utilization drops below the `util-low` value, virtual CPUs are removed from the domain until the number is between the `vcpu-min` and `vcpu-max` values. If `vcpu-min` is reached, no more virtual CPUs can be dynamically removed. If the `vcpu-max` is reached, no more virtual CPUs can be dynamically added.

EXAMPLE 10–10 Adding Resource Management Policies

For example, after observing the typical utilization of your systems over several weeks, you might set up policies to optimize resource usage. The highest usage is daily from 9:00 a.m. to 6:00 p.m. Pacific, and the low usage is daily from 6:00 p.m. to 9:00 a.m. Pacific.

Based on this system utilization observation, you decide to create the following high and low policies based on overall system utilization:

- **High:** Daily from 9:00 a.m. to 6:00 p.m. Pacific
- **Low:** Daily from 6:00 p.m. to 9:00 a.m. Pacific

The following `ldm add-policy` command creates the `high-usage` policy to be used during the high utilization period on the `ldom1` domain.

EXAMPLE 10–10 Adding Resource Management Policies *(Continued)*

The following `high-usage` policy does the following:

- Specifies that the beginning and ending times are 9:00 a.m. and 6:00 p.m. by setting the `tod-begin` and `tod-end` properties, respectively.
- Specifies that the lower and upper limits at which to perform policy analysis are 25 percent and 75 percent by setting the `util-lower` and `util-upper` properties, respectively.
- Specifies that the minimum and maximum number of virtual CPUs is 2 and 16 by setting the `vcpu-min` and `vcpu-max` properties, respectively.
- Specifies that the maximum number of virtual CPUs to be added during any one resource control cycle is 1 by setting the `attack` property.
- Specifies that the maximum number of virtual CPUs to be removed during any one resource control cycle is 1 by setting the `decay` property.
- Specifies that the priority of this policy is 1 by setting the `priority` property. A priority of 1 means that this policy will be enforced even if another policy can take effect.
- Specifies that the name of the policy file is `high-usage` by setting the `name` property.
- Uses the default values for those properties that are not specified, such as `enable` and `sample-rate`. See the `ldm(1M)` man page.

```
# ldm add-policy tod-begin=09:00 tod-end=18:00 util-lower=25 util-upper=75 \
vcpu-min=2 vcpu-max=16 attack=1 decay=1 priority=1 name=high-usage ldom1
```

The following `ldm add-policy` command creates the `med-usage` policy to be used during the low utilization period on the `ldom1` domain.

The following `med-usage` policy does the following:

- Specifies that the beginning and ending times are 6:00 p.m. and 9:00 a.m. by setting the `tod-begin` and `tod-end` properties, respectively.
- Specifies that the lower and upper limits at which to perform policy analysis are 10 percent and 50 percent by setting the `util-lower` and `util-upper` properties, respectively.
- Specifies that the minimum and maximum number of virtual CPUs is 2 and 16 by setting the `vcpu-min` and `vcpu-max` properties, respectively.
- Specifies that the maximum number of virtual CPUs to be added during any one resource control cycle is 1 by setting the `attack` property.
- Specifies that the maximum number of virtual CPUs to be removed during any one resource control cycle is 1 by setting the `decay` property.
- Specifies that the priority of this policy is 1 by setting the `priority` property. A priority of 1 means that this policy will be enforced even if another policy can take effect.
- Specifies that the name of the policy file is `high-usage` by setting the `name` property.

EXAMPLE 10–10 Adding Resource Management Policies *(Continued)*

- Uses the default values for those properties that are not specified, such as `enable` and `sample-rate`. See the `ldm(1M)` man page.

```
# ldm add-policy tod-begin=18:00 tod-end=09:00 util-lower=10 util-upper=50 \
 vcpu-min=2 vcpu-max=16 attack=1 decay=1 priority=1 name=med-usage ldom1
```

Listing Domain Resources

This section shows the syntax usage for the `ldm` subcommands, defines some output terms, such as flags and utilization statistics, and provides examples that are similar to what appears as output.

Machine-Readable Output

If you are creating scripts that use `ldm list` command output, always use the `-p` option to produce the machine-readable form of the output.

To view syntax usage for all `ldm` subcommands, use the following command:

```
# ldm --help
```

For more information about the `ldm` subcommands, see the `ldm(1M)` man page.

Flag Definitions

The following flags can be shown in the output for a domain (`ldm list`). If you use the long, parseable options (`-l -p`) for the command, the flags are spelled out for example, `flags=normal,control,vio-service`. If not, you see the letter abbreviation, for example `-n-cv-`. The list flag values are position dependent. The following values can appear in each of the six columns from left to right.

Column 1 – Starting or stopping domains

- `s` – Starting or stopping

Column 2 – Domain status

- `n` – Normal
- `t` – Transition
- `d` – Degraded domain that cannot be started due to missing resources

Column 3 – Reconfiguration status

- `d` – Delayed reconfiguration
- `r` – Memory dynamic reconfiguration

Column 4 – Control domain

- `c` – Control domain

Column 5 – Service domain

- `v` – Virtual I/O service domain

Column 6 – Migration status

- `s` – Source domain in a migration
- `t` – Target domain in a migration
- `e` – Error occurred during a migration

Utilization Statistic Definition

The per virtual CPU utilization statistic (`UTIL`) is shown through the long (`-l`) option of the `ldm list` command. The statistic is the percentage of time that the virtual CPU spent executing on behalf of the guest operating system. A virtual CPU is considered to be executing on behalf of the guest operating system except when it has been yielded to the hypervisor. If the guest operating system does not yield virtual CPUs to the hypervisor, the utilization of CPUs in the guest operating system will always show as `100%`.

The utilization statistic reported for a logical domain is the average of the virtual CPU utilizations for the virtual CPUs in the domain. The normalized utilization statistic (`NORM`) is the percentage of time the virtual CPU spends executing on behalf of the guest OS. This value takes into account such operations as cycle skip. Normalized virtualization is only available when your system runs at least version 8.2.0 of the system firmware.

When PM does not perform cycle skip operations, 100% utilization equals 100% normalized utilization. When PM adjusts the cycle skip to four eights, 100% utilization equals 50% utilization, which means that the CPU effectively has only half the possible number of cycles available. So, a fully utilized CPU has a 50% normalized utilization. Use the `ldm list` or `ldm list -l` command to show normalized utilization for both virtual CPUs and the guest OS.

Viewing Various Lists

- To view the current software versions installed:

  ```
  # ldm -V
  ```

- To generate a short list for all domains:

```
# ldm list
```

- To generate a long list for all domains:

```
# ldm list -l
```

- To generate an extended list of all domains:

```
# ldm list -e
```

- To generate a parseable, machine-readable list of all domains:

```
# ldm list -p
```

- You can generate output as a subset of resources by entering one or more of the following *format* options. If you specify more than one format, delimit the items by a comma with no spaces.

  `# ldm list -o` *resource*`[,`*resource*`...]` *ldom*

  - `console` – Output contains virtual console (`vcons`) and virtual console concentrator (`vcc`) service
  - `core` – Output contains information about domains that have whole cores allocated
  - `cpu` – Output contains information about the virtual CPU (`vcpu`), physical CPU (`pcpu`), and core ID
  - `crypto` – Cryptographic unit output contains Modular Arithmetic Unit (`mau`) and any other supported cryptographic unit, such as the Control Word Queue (CWQ)
  - `disk` – Output contains virtual disk (`vdisk`) and virtual disk server (`vds`)
  - `domain` – Output contains variables (`var`), host ID (`hostid`), domain state, flags, UUID, and software state
  - `memory` – Output contains `memory`
  - `network` – Output contains media access control (`mac`) address , virtual network switch (`vsw`), and virtual network (`vnet`) device
  - `physio` – Physical input/output contains peripheral component interconnect (`pci`) and network interface unit (`niu`)
  - `resmgmt` – Output contains dynamic resource management (DRM) policy information, indicates which policy is currently running, and lists constraints related to whole-core configuration
  - `serial` – Output contains virtual logical domain channel (`vldc`) service, virtual logical domain channel client (`vldcc`), virtual data plane channel client (`vdpcc`), and virtual data plane channel service (`vdpcs`)
  - `stats` – Output contains statistics that are related to resource management policies
  - `status` – Output contains status about a domain migration in progress

  The following examples show various subsets of output that you can specify.

  - To list CPU information for the control domain:

```
# ldm list -o cpu primary
```

- To list domain information for a guest domain:

  ```
  # ldm list -o domain ldm2
  ```

- To list memory and network information for a guest domain:

  ```
  # ldm list -o network,memory ldm1
  ```

- To list DRM policy information for a guest domain:

  ```
  # ldm list -o resmgmt,stats ldm1
  ```

- To show a variable and its value for a domain:

  ```
  # ldm list-variable variable-name ldom
  ```

  For example, the following command shows the value for the `boot-device` variable on the `ldg1` domain:

  ```
  # ldm list-variable boot-device ldg1
  boot-device=/virtual-devices@100/channel-devices@200/disk@0:a
  ```

- To list the resources that are bound to a domain:

  ```
  # ldm list-bindings ldom
  ```

- To list logical domain configurations that have been stored on the SP:

  The `ldm list-config` command lists the logical domain configurations that are stored on the service processor. When used with the `-r` option, this command lists those configurations for which autosave files exist on the control domain.

  For more information about configurations, see "Managing Domain Configurations" on page 285. For more examples, see the `ldm`(1M) man page.

  ```
  # ldm list-config
  factory-default
  3guests
  foo [next poweron]
  primary
  reconfig-primary
  ```

  The labels to the right of the configuration name mean the following:

  - `[current]` – Last booted configuration, only as long as it matches the currently running configuration; that is, until you initiate a reconfiguration. After the reconfiguration, the annotation changes to `[next poweron]`.
  - `[next poweron]` – Configuration to be used at the next power cycle.
  - `[degraded]` – Configuration is a degraded version of the previously booted configuration.

- To list all server resources, bound and unbound:

  ```
  # ldm list-devices -a
  ```

- To list the amount of memory available to be allocated:

  ```
  # ldm list-devices mem
  MEMORY
  ```

```
    PA                  SIZE
    0x14e000000         2848M
```

- To list the services that are available:

```
# ldm list-services
```

Listing Constraints

To the Logical Domains Manager, constraints are one or more resources you want to have assigned to a particular domain. You either receive all the resources you ask to be added to a domain or you get none of them, depending upon the available resources. The `list-constraints` subcommand lists those resources you requested assigned to the domain.

- To list constraints for one domain:

```
# ldm list-constraints ldom
```

- To list constraints in XML format for a particular domain:

```
# ldm list-constraints -x ldom
```

- To list constraints for all domains in a parseable format:

```
# ldm list-constraints -p
```

◆ ◆ ◆ CHAPTER 11

Managing Domain Configurations

This chapter contains information about managing domain configurations.

This chapter covers the following topics:

Managing Domain Configurations

A domain *configuration* is a complete description of all the domains and their resource allocations within a single system. You can save and store configurations on the service processor (SP) for later use.

Saving a configuration on the SP makes it persist across system power cycles. You can save several configurations and specify which configuration to boot on the next power-on attempt.

When you power up a system, the SP boots the selected configuration. The system runs the same set of domains and uses the same virtualization and partitioning resource allocations that are specified in the configuration. The default configuration is the one that is most recently saved. You can also explicitly request another configuration by using the `ldm set-spconfig` command or the appropriate ILOM command.

Caution – Always save your stable configuration to the SP and save it as XML. Saving the configuration in these ways enable you to recover your system configuration after a power failure and save it for later use. See "Saving Domain Configurations" on page 289.

A local copy of the SP configuration and the Logical Domains constraint database is saved on the control domain whenever you save a configuration to the SP. This local copy is called a *bootset*. The bootset is used to load the corresponding Logical Domains constraints database when the system undergoes a power cycle.

On SPARC T5 and SPARC M5 systems, the bootsets on the control domain are the master copies of the configurations. On startup, the Logical Domains Manager automatically synchronizes all configurations with the SP, which ensures that the configurations on the SP are always identical to the bootsets that are stored on the control domain.

Note – Because the bootsets contain critical system data, ensure that the control domain's file system uses technology such as disk mirroring or RAID to reduce the impact of disk failures.

A physical domain is the scope of resources that are managed by a single Oracle VM Server for SPARC instance. A physical domain might be a complete physical system as is the case of supported SPARC T-Series platforms. Or, it might be either the entire system or a subset of the system as is the case of supported SPARC M-Series platforms.

Available Configuration Recovery Methods

Oracle VM Server for SPARC supports the following configuration recovery methods:

- The autosave method, used when the configuration is not available on the SP.

  This situation might occur in one of the following circumstances:

  - The hardware that holds the saved configurations has been replaced
  - The configuration is not up to date because you neglected to save the latest configuration changes to the SP or an unexpected power cycle occurred
- The `ldm add-domain` method, used if a subset of the domains need to have their configurations restored
- The `ldm init-system` method, which should be used only as a last resort. Use this method only when both the configuration on the SP and the autosave information from the control domain are lost.

Restoring Configurations By Using Autosave

A copy of the current configuration is automatically saved on the control domain whenever the domain configuration is changed. This autosave operation does not explicitly save the configuration to the SP.

The autosave operation occurs immediately, even in the following situations:

- When the new configuration is not explicitly saved on the SP
- When the configuration change is not made until after the affected domain reboots

This autosave operation enables you to recover a configuration when the configurations that are saved on the SP are lost. This operation also enables you to recover a configuration when the

current configuration was not explicitly saved to the SP after a system power cycle. In these circumstances, the Logical Domains Manager can restore that configuration on restart if it is newer than the configuration marked for the next boot.

Note – Power management, FMA, and ASR events do not cause an update to the autosave files.

You can automatically or manually restore autosave files to new or existing configurations. By default, when an autosave configuration is newer than the corresponding running configuration, a message is written to the Logical Domains log. Thus, you must use the `ldm add-spconfig -r` command to manually update an existing configuration or create a new one based on the autosave data.

Note – When a delayed reconfiguration is pending, the configuration changes are immediately autosaved. As a result, if you run the `ldm list-config -r` command, the autosave configuration is shown as being newer than the current configuration.

For information about how to use the `ldm *-spconfig` commands to manage configurations and to manually recover autosave files, see the `ldm`(1M) man page.

For information about how to select a configuration to boot, see "Using Oracle VM Server for SPARC With the Service Processor" on page 306. You can also use the `ldm set-spconfig` command, which is described on the `ldm`(1M) man page.

Autorecovery Policy

The autorecovery policy specifies how to handle the recovery of a configuration when one configuration that is automatically saved on the control domain is newer than the corresponding running configuration. The autorecovery policy is specified by setting the `autorecovery_policy` property of the `ldmd` SMF service. This property can have the following values:

- `autorecovery_policy=1` – Logs warning messages when an autosave configuration is newer than the corresponding running configuration. These messages are logged in the `ldmd` SMF log file. You must manually perform any configuration recovery. This is the default policy.
- `autorecovery_policy=2` – Displays a notification message if an autosave configuration is newer than the corresponding running configuration. This notification message is printed in the output of any `ldm` command the first time an `ldm` command is issued after each restart of the Logical Domains Manager. You must manually perform any configuration recovery.

- `autorecovery_policy=3` – Automatically updates the configuration if an autosave configuration is newer than the corresponding running configuration. This action overwrites the SP configuration that will be used during the next power cycle. This configuration is updated with the newer configuration that is saved on the control domain. This action does not affect the currently running configuration. It affects only the configuration that will be used during the next power cycle. A message is also logged that states that a newer configuration has been saved on the SP and that it will be booted at the next system power cycle. These messages are logged in the `ldmd` SMF log file.

▼ How to Modify the Autorecovery Policy

1. **Log in to the control domain.**
2. **Become an administrator.**
   - **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in** *System Administration Guide: Security Services***.**
   - **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in** *Oracle Solaris 11.1 Administration: Security Services***.**
3. **View the `autorecovery_policy` property value.**

   ```
   # svccfg -s ldmd listprop ldmd/autorecovery_policy
   ```
4. **Stop the `ldmd` service.**

   ```
   # svcadm disable ldmd
   ```
5. **Change the `autorecovery_policy` property value.**

   ```
   # svccfg -s ldmd setprop ldmd/autorecovery_policy=value
   ```

   For example, to set the policy to perform autorecovery, set the property value to 3:

   ```
   # svccfg -s ldmd setprop ldmd/autorecovery_policy=3
   ```
6. **Refresh and restart the `ldmd` service.**

   ```
   # svcadm refresh ldmd
   # svcadm enable ldmd
   ```

Example 11–1 Modifying the Autorecovery Policy From Log to Autorecovery

The following example shows how to view the current value of the `autorecovery_policy` property and change it to a new value. The original value of this property is 1, which means that autosave changes are logged. The `svcadm` command is used to stop and restart the `ldmd` service, and the `svccfg` command is used to view and set the property value.

```
# svccfg -s ldmd listprop ldmd/autorecovery_policy
ldmd/autorecovery_policy integer 1
# svcadm disable ldmd
# svccfg -s ldmd setprop ldmd/autorecovery_policy=3
# svcadm refresh ldmd
# svcadm enable ldmd
```

Saving Domain Configurations

You can save a domain configuration for a single domain or for all the domains on a system.

With the exception of the named physical resources, the following method does not preserve actual bindings. However, the method does preserve the constraints used to create those bindings. After saving and restoring the configuration, the domains have the same virtual resources but are not necessarily bound to the same physical resources. Named physical resources are bound as specified by the administrator.

- To save the configuration for a single domain, create an XML file containing the domain's constraints.

  # ldm list-constraints -x *ldom* **>***ldom***.xml**

  The following example shows how to create an XML file, `ldg1.xml`, which contains the `ldg1` domain's constraints:

  ```
  # ldm list-constraints -x ldg1 >ldg1.xml
  ```

- To save the configurations for all the domains on a system, create an XML file containing the constraints for all domains.

  # ldm list-constraints -x >*file***.xml**

  The following example shows how to create an XML file, `config.xml`, which contains the constraints for all the domains on a system:

  ```
  # ldm list-constraints -x >config.xml
  ```

Restoring Domain Configurations

This section describes how to restore a domain configuration from an XML file for guest domains and for the control (`primary`) domain.

- To restore a domain configuration for guest domains, you use the `ldm add-domain -i` command, as described in "How to Restore a Domain Configuration From an XML File (`ldm add-domain`)" on page 290. Although you can save the `primary` domain's constraints to an XML file, you cannot use the file as input to this command.
- To restore a domain configuration for the `primary` domain, you use the `ldm init-system` command and the resource constraints from the XML file to reconfigure your `primary` domain. You can also use the `ldm init-system` command to reconfigure other domains that are described in the XML file, but those domains might be left inactive when the configuration is complete. See "How to Restore a Domain Configuration From an XML File (`ldm init-system`)" on page 291.

▼ How to Restore a Domain Configuration From an XML File (`ldm add-domain`)

This procedure works for guest domains but not for the control (`primary`) domain. If you want to restore the configuration for the `primary` domain, or for other domains that are described in the XML file, see "How to Restore a Domain Configuration From an XML File (`ldm init-system`)" on page 291.

1 Create the domain by using the XML file that you created as input.

```
# ldm add-domain -i ldom.xml
```

2 Bind the domain.

```
# ldm bind-domain [-fq] ldom
```

The `-f` option forces the binding of the domain even if invalid back-end devices are detected. The `-q` option disables the validation of back-end devices so that the command runs more quickly.

3 Start the domain.

```
# ldm start-domain ldom
```

Example 11–2 Restoring a Single Domain From an XML File

The following example shows how to restore a single domain. First, you restore the `ldg1` domain from the XML file. Then, you bind and restart the `ldg1` domain that you restored.

```
# ldm add-domain -i ldg1.xml
# ldm bind ldg1
# ldm start ldg1
```

How to Restore a Domain Configuration From an XML File (`ldm init-system`)

This procedure explains how to use the `ldm init-system` command with an XML file to re-create a previously saved configuration.

Caution – The `ldm init-system` command might not correctly restore a configuration in which physical I/O commands have been used. Such commands are `ldm add-io`, `ldm set-io`, `ldm remove-io`, `ldm create-vf`, and `ldm destroy-vf`. For more information, see "ldm init-system Command Might Not Correctly Restore a Domain Configuration on Which Physical I/O Changes Have Been Made" in *Oracle VM Server for SPARC 3.1.1.1, 3.1.1, and 3.1 Release Notes*.

Before You Begin You should have created an XML configuration file by running the `ldm list-constraints -x` command. The file should describe one or more domain configurations.

1. **Log in to the `primary` domain.**

2. **Verify that the system is in the `factory-default` configuration.**

   ```
   primary# ldm list-config | grep "factory-default"
   factory-default [current]
   ```

   If the system is not in the `factory-default` configuration, see "How to Restore the Factory Default Configuration" on page 40.

3. **Become an administrator.**

   - **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in *System Administration Guide: Security Services*.**
   - **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in *Oracle Solaris 11.1 Administration: Security Services*.**

4. **Restore the domain configuration or configurations from the XML file.**

   ```
   # ldm init-system [-frs] -i filename.xml
   ```

   The `primary` domain must be rebooted for the configuration to take effect. The `-r` option reboots the `primary` domain after the configuration. If you do not specify the `-r` option, you must perform the reboot manually.

   The `-s` option restores only the virtual services configuration (`vds`, `vcc`, and `vsw`) and might be able to be performed without having to reboot.

   The `-f` option skips the factory-default configuration check and continues regardless of what was already configured on the system. Use the `-f` option with caution. The `ldm init-system` command assumes that the system is in the factory-default configuration and so directly applies the changes that are specified by the XML file. Using `-f` when the system is in a configuration

other than the factory default will likely result in a system that is not configured as specified by the XML file. One or more changes might fail to be applied to the system, depending on the combination of changes in the XML file and the initial configuration.

The `primary` domain is reconfigured as specified in the file. Any non-`primary` domains that have configurations in the XML file are reconfigured but left inactive.

Example 11–3 Restoring Domains From XML Configuration Files

The following examples show how to use the `ldm init-system` command to restore the `primary` domain and all the domains on a system from the `factory-default` configuration.

- **Restore the `primary` domain.** The `-r` option is used to reboot the `primary` domain after the configuration completes. The `primary.xml` file contains the XML domain configuration that you saved at an earlier time.

  ```
  primary# ldm init-system -r -i primary.xml
  ```

- **Restore all the domains on a system.** Restore the domains on the system to the configurations in the `config.xml` XML file. The `config.xml` file contains the XML domain configurations that you saved at an earlier time. The `primary` domain is restarted automatically by the `ldm init-system` command. Any other domains are restored but not bound and restarted.

  ```
  # ldm init-system -r -i config.xml
  ```

  After the system reboots, the following commands bind and restart the `ldg1` and `ldg2` domains:

  ```
  # ldm bind ldg1
  # ldm start ldg1
  # ldm bind ldg2
  # ldm start ldg2
  ```

◆ ◆ ◆ CHAPTER 12

Handling Hardware Errors

This chapter contains information about how Oracle VM Server for SPARC handles hardware errors.

This chapter covers the following topics:

Hardware Error-Handling Overview

The Oracle VM Server for SPARC software adds the following RAS capabilities for the SPARC enterprise-class platforms starting with SPARC T5 and SPARC M5:

- **Fault Management Architecture (FMA) blacklisting.** When FMA detects faulty CPU or memory resources, Oracle VM Server for SPARC places them on a blacklist. A faulty resource that is on the blacklist cannot be reassigned to any domains until FMA marks it as being repaired.
- **Recovery mode.** Automatically recover domain configurations that cannot be booted because of faulty or missing resources.

Though the Fujitsu M10 system does not support this blacklisting of faulty resources, the Fujitsu M10 system auto-replacement feature provides similar functionality.

Using FMA to Blacklist or Unconfigure Faulty Resources

FMA contacts the Logical Domains Manager when it detects a faulty resource. Then, the Logical Domains Manager attempts to stop using that resource in all running domains. To ensure that a faulty resource cannot be assigned to a domain in the future, FMA adds the resource to a blacklist.

The Logical Domains Manager supports blacklisting only for CPU and memory resources, not for I/O resources.

If a faulty resource is not in use, the Logical Domains Manager removes it from the available resource list, which you can see in the `ldm list-devices` output. At this time, this resource is internally marked as "blacklisted" so that it cannot be re-assigned to a domain in the future.

If the faulty resource is in use, the Logical Domains Manager attempts to evacuate the resource. To avoid a service interruption on the running domains, the Logical Domains Manager first attempts to use CPU or memory dynamic reconfiguration to evacuate the faulty resource. The Logical Domains Manager remaps a faulted core if a core is free to use as a target. If this "live evacuation" succeeds, the faulty resource is internally marked as blacklisted and is not shown in the `ldm list-devices` output so that it will not be assigned to a domain in the future.

If the live evacuation fails, the Logical Domains Manager internally marks the faulty resource as "evacuation pending." The resource is shown as normal in the `ldm list-devices` output because the resource is still in use on the running domains until the affected guest domains are rebooted or stopped.

When the affected guest domain is stopped or rebooted, the Logical Domains Manager attempts to evacuate the faulty resources and internally mark them as blacklisted so that the resource cannot be assigned in the future. Such a device is not shown in the `ldm` output. After the pending evacuation completes, the Logical Domains Manager attempts to start the guest domain. However, if the guest domain cannot be started because sufficient resources are not available, the guest domain is marked as "degraded" and the following warning message is logged for the user intervention to perform the manual recovery.

```
primary# ldm ls
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  NORM  UPTIME
primary          active     -n-cv-  UART    368   2079488M 0.1%  0.0%  16h 57m
gd0              bound      -d----  5000    8

warning: Could not restart domain gd0 after completing pending evacuation.
The domain has been marked degraded and should be examined to see
if manual recovery is possible.
```

When the system is power-cycled, FMA repeats the evacuation requests for resources that are still faulty and the Logical Domains Manager handles those requests by evacuating the faulty resources and internally marking them as blacklisted.

Prior to support for FMA blacklisting, a guest domain that panicked because of a faulty resource might result in a never-ending panic-reboot loop. By using resource evacuation and blacklisting when the guest domain is rebooted, you can avoid this panic-reboot loop and prevent future attempts to use a faulty resource.

Recovering Domains After Detecting Faulty or Missing Resources

If a SPARC T5 or SPARC M5 system detects a faulty or missing resource at power on, the Logical Domains Manager attempts to recover the configured domains by using the remaining available resources. While the recovery takes place, the system (or physical domain on SPARC M5) is said to be in *recovery mode*. A recovery is attempted only if recovery mode is enabled. See "Enabling Recovery Mode" on page 298.

At power on, the system firmware reverts to the factory-default configuration if the last selected power-on configuration cannot be booted in any of the following circumstances:

- The I/O topology within each PCIe switch in the configuration does not match the I/O topology of the last selected power-on configuration
- CPU resources or memory resources of the last selected power-on configuration are no longer present in the system

If recovery mode is enabled, the Logical Domains Manager recovers all active and bound domains from the last selected power-on configuration. The resulting running configuration is called the *degraded configuration*. The degraded configuration is saved to the SP and remains the active configuration until either a new SP configuration is saved or the physical domain is power-cycled.

Note – The physical domain does not require a power cycle to activate the degraded configuration after recovery as it is already the running configuration.

If the physical domain is power-cycled, the system firmware first attempts to boot the last original power-on configuration. That way, if the missing or faulty hardware was replaced in the meantime, the system can boot the original normal configuration. If the last selected power-on configuration is not bootable, the firmware next attempts to boot the associated degraded configuration if it exists. If the degraded configuration is not bootable or does not exist, the factory-default configuration is booted and recovery mode is invoked.

The recovery operation works in the following order:

- **Control domain.** The Logical Domains Manager recovers the control domain by restoring its CPU, memory, and I/O configuration as well as its virtual I/O services.

  If the amount of CPU or memory required for all recoverable domains is larger than the remaining available amounts, the number of CPUs or cores or memory is reduced in proportion to the size of the other domains. For example, in a four-domain system where each domain has 25% of the CPUs and memory assigned, the resulting degraded configuration still assigns 25% of the CPUs and memory to each domain. If the `primary` domain originally had up to two cores (16 virtual CPUs) and eight Gbytes of memory, the control domain size is not reduced.

  Root complexes and PCIe devices that are assigned to other domains are removed from the control domain. The virtual functions on root complexes that are owned by the control domain are re-created. Any missing root complex, PCIe device, physical function, or virtual function that is assigned to the control domain is marked as evacuated. The Logical Domains Manager then reboots the control domain to make the changes active.
- **Root domains.** After the control domain has been rebooted, the Logical Domains Manager recovers the root domains. The amount of CPU and memory is reduced in proportion to the other recoverable domains, if needed. If a root complex is no longer physically present in the system, it is marked as evacuated. This root complex is not configured into the domain during the recovery operation. A root domain is recovered as long as at least one of the root complexes that is assigned to the root domain is available. If none of its root complexes are available, the root domain is not recovered. The Logical Domains Manager boots the root domain and re-creates the virtual functions on the physical functions that are owned by the root domain. Any missing PCIe slots, physical functions, and virtual functions are marked as evacuated. Any virtual I/O services that are provided by the domain are re-created, if possible.

  Note – Configurations in which a non-`primary` root domain loans out PCIe slots cannot be recovered at this time. So, you must manually move those slots to an I/O domain after the recovery completes.

- **I/O domains.** Logical Domains Manager recovers any I/O domains. Any PCIe slots and virtual functions that are missing from the system are marked as evacuated. If none of the required I/O devices are present, the domain is not recovered and its CPU and memory resources are available for use by other domains. Any virtual I/O services that are provided by the domain are re-created, if possible.
- **Guest domains.** A guest domain is recovered *only* if at least one of the service domains that serves the domain has been recovered. If the guest domain cannot be recovered, its CPU and memory resources are available for use by other guest domains.

When possible, the same number of CPUs and amount of memory are allocated to a domain as specified by the original configuration. If that number of CPUs or amount of memory are not available, these resources are reduced proportionally to consume the remaining available resources.

Note – When a system is in recovery mode, you can only perform `ldm list-*` commands. All other `ldm` commands are disabled until the recovery operation completes.

The Logical Domains Manager only attempts to recover bound and active domains. The existing resource configuration of any unbound domain is copied to the new configuration as-is.

During a recovery operation, fewer resources might be available than in the previously booted configuration. As a result, the Logical Domains Manager might only be able to recover some of the previously configured domains. Also, a recovered domain might not include all of the resources from its original configuration. For example, a recovered bound domain might have fewer I/O resources than it had in its previous configuration. A domain might not be recovered if its I/O devices are no longer present or if its parent service domain could not be recovered.

Recovery mode records its steps to the Logical Domains Manager SMF log, `/var/svc/log/ldoms-ldmd:default.log`. A message is written to the system console when Logical Domains Manager starts a recovery, reboots the control domain, and when the recovery completes.

Caution – A recovered domain is not guaranteed to be completely operable. The domain might not include a resource that is essential to run the OS instance or an application. For example, a recovered domain might only have a network resource and no disk resource. Or, a recovered domain might be missing a file system that is required to run an application. Using multipathed I/O for a domain reduces the impact of missing I/O resources.

Degraded Configuration

Each physical domain can have only one degraded configuration saved to the SP. If a degraded configuration already exists, it is replaced by the newly created degraded configuration.

You cannot interact directly with degraded configurations. The system firmware transparently boots the degraded version of the next power-on configuration, if necessary. This transparency enables the system to boot the original configuration after a power cycle when the missing resources reappear. When the active configuration is a degraded configuration, it is marked as `[degraded]` in the `ldm list-spconfig` output.

The autosave functionality is disabled while the active configuration is a degraded configuration. If you save a new configuration to the SP while a degraded configuration is active, the new configuration is a normal non-degraded configuration.

Note – A previously missing resource that reappears on a subsequent power cycle has no effect on the contents of a normal configuration. However, if you subsequently select the configuration that triggered recovery mode, the SP boots the original, non-degraded configuration now that all its hardware is available.

Enabling Recovery Mode

The `ldmd/recovery_mode` SMF property controls recovery mode behavior.

To configure the Logical Domains Manager to automatically begin the recovery process when the system enters recovery mode, you must first enable recovery mode. To enable recovery mode, set the `ldmd/recovery_mode` property value to `auto` and refresh the `ldmd` SMF service.

```
primary# svccfg -s ldmd setprop ldmd/recovery_mode = astring: auto
primary# svcadm refresh ldmd
```

By default, the `ldmd/recovery_mode` property is not present. When this property is not present or is set to `never`, the Logical Domains Manager exits recovery mode without taking any action and the physical domain runs the factory-default configuration.

Note – If the system firmware requests recovery mode while it is not enabled, issue the following commands to enable recovery mode after the request is made:

```
primary# svccfg -s ldmd setprop ldmd/recovery_mode = astring: auto
primary# svcadm refresh ldmd
primary# svcadm restart ldmd
```

Recovery mode is initiated immediately in this scenario only if no changes were made to the system, that is, if it is still in the factory-default configuration.

Marking Domains as Degraded

A domain is marked as degraded if the FMA blacklisting of a resource leaves a domain with insufficient resources to start. The domain then remains in the bound state, which prevents the remaining resources that are assigned to the domain from being reallocated to other domains.

Marking I/O Resources as Evacuated

An I/O resource that is detected as missing by recovery mode is marked as evacuated by showing an asterisk (*) in `ldm` list output.

◆ ◆ ◆ CHAPTER 13

Performing Other Administration Tasks

This chapter contains information about using the Oracle VM Server for SPARC software and tasks that are not described in the preceding chapters.

This chapter covers the following topics:

Entering Names in the CLI

The following sections describe the restrictions on entering names in the Logical Domains Manager CLI.

- File names (*file*) and variable names (*var-name*)
  - First character must be a letter, a number, or a forward slash (/).
  - Subsequent letters must be letters, numbers, or punctuation.
- Virtual disk server *backend* and virtual switch device names

  The names must contain letters, numbers, or punctuation.
- Configuration Name (*config-name*)

  The logical domain configuration name (*config-name*) that you assign to a configuration stored on the service processor (SP) must have no more than 64 characters.

- All other names

  The remainder of the names, such as the logical domain name (*ldom*), service names (*vswitch-name*, *service-name*, *vdpcs-service-name*, and *vcc-name*), virtual network name (*if-name*), and virtual disk name (*disk-name*), must be in the following format:

  - First character must be a letter or number.
  - Subsequent characters must be letters, numbers, or any of the following characters `-_+#.:;~()`.

Connecting to a Guest Console Over the Network

You can connect to a guest console over a network if the `listen_addr` property is set to the IP address of the control domain in the `vntsd`(1M) SMF manifest. For example:

```
$ telnet hostname 5001
```

Note – Enabling network access to a console has security implications. Any user can connect to a console and for this reason it is disabled by default.

A Service Management Facility manifest is an XML file that describes a service. For more information about creating an SMF manifest, refer to the Oracle Solaris 10 System Administrator Documentation (`http://download.oracle.com/docs/cd/E18752_01/index.html`).

Note – To access a non-English OS in a guest domain through the console, the terminal for the console must be in the locale required by the OS.

Using Console Groups

The virtual network terminal server daemon, `vntsd`, enables you to provide access for multiple domain consoles using a single TCP port. At the time of domain creation, the Logical Domains Manager assigns a unique TCP port to each console by creating a new default group for that domain's console. The TCP port is then assigned to the console group as opposed to the console itself. The console can be bound to an existing group using the `set-vcons` subcommand.

▼ How to Combine Multiple Consoles Into One Group

1 Bind the consoles for the domains into one group.

The following example shows binding the console for three different domains (`ldg1`, `ldg2`, and `ldg3`) to the same console group (`group1`).

```
primary# ldm set-vcons group=group1 service=primary-vcc0 ldg1
primary# ldm set-vcons group=group1 service=primary-vcc0 ldg2
primary# ldm set-vcons group=group1 service=primary-vcc0 ldg3
```

2 Connect to the associated TCP port (`localhost` at port `5000` in this example).

```
# telnet localhost 5000
primary-vnts-group1: h, l, c{id}, n{name}, q:
```

You are prompted to select one of the domain consoles.

3 List the domains within the group by selecting `l` (list).

```
primary-vnts-group1: h, l, c{id}, n{name}, q: l
DOMAIN ID           DOMAIN NAME                   DOMAIN STATE
0                   ldg1                          online
1                   ldg2                          online
2                   ldg3                          online
```

Note – To reassign the console to a different group or `vcc` instance, the domain must be unbound; that is, it has to be in the inactive state. Refer to the Oracle Solaris 10 OS `vntsd`(1M) man page for more information about configuring and using SMF to manage `vntsd` and using console groups.

Stopping a Heavily Loaded Domain Can Time Out

An `ldm stop-domain` command can time out before the domain completes shutting down. When this happens, an error similar to the following is returned by the Logical Domains Manager.

```
LDom ldg8 stop notification failed
```

However, the domain could still be processing the shutdown request. Use the `ldm list-domain` command to verify the status of the domain. For example:

```
# ldm list-domain ldg8
NAME         STATE   FLAGS  CONS   VCPU MEMORY  UTIL UPTIME
ldg8         active  s----  5000   22   3328M   0.3% 1d 14h 31m
```

The preceding list shows the domain as active, but the `s` flag indicates that the domain is in the process of stopping. This should be a transitory state.

The following example shows the domain has now stopped.

```
# ldm list-domain ldg8
NAME         STATE   FLAGS  CONS   VCPU MEMORY  UTIL UPTIME
ldg8         bound   -----  5000   22   3328M
```

The `ldm stop` command uses the `shutdown` command to stop a domain. The execution of the shutdown sequence usually takes much longer than a quick stop, which can be performed by running the `ldm stop -q` command. See the `ldm(1M)` man page.

A long shutdown sequence might generate the following timeout message:

domain-name `stop timed out. The domain might still be in the process of shutting down. Either let it continue, or specify -f to force it to stop.`

While this shutdown sequence runs, the `s` flag is also shown for the domain.

Operating the Oracle Solaris OS With Oracle VM Server for SPARC

This section describes the changes in behavior in using the Oracle Solaris OS that occur once a configuration created by the Logical Domains Manager is instantiated.

OpenBoot Firmware Not Available After the Oracle Solaris OS Has Started

The OpenBoot firmware is not available after the Oracle Solaris OS has started because it is removed from memory.

To reach the `ok` prompt from the Oracle Solaris OS, you must halt the domain by using the Oracle Solaris OS `halt` command.

Performing a Power Cycle of a Server

Whenever performing any maintenance on a system running Oracle VM Server for SPARC software that requires you to perform a power cycle of the server, you must save your current logical domain configurations to the SP first.

To save your current domain configurations to the SP, use the following command:

`# ldm add-config` *config-name*

Result of Oracle Solaris OS Breaks

You can initiate Oracle Solaris OS breaks as follows:

1. Press the L1-A key sequence when the input device is set to `keyboard`.
2. Enter the `send break` command when the virtual console is at the `telnet` prompt.

When you initiate such a break, the Oracle Solaris OS issues the following prompt:

```
c)ontinue, s)ync, r)eset, h)alt?
```

Type the letter that represents what you want the system to do after these types of breaks.

Results From Halting or Rebooting the Control Domain

The following table shows the expected behavior of halting or rebooting the control (`primary`) domain.

TABLE 13–1 Expected Behavior of Halting or Rebooting the Control Domain

Command	Other Domain Configured?	Behavior
`halt`	Not configured	Host powered off and stays off until powered on at the SP.
	Configured	Soft resets and boots up if the variable `auto-boot?=true`. Soft resets and halts at ok prompt if the variable `auto-boot?=false`.
`reboot`	Not configured	Reboots the host, no power off.
	Configured	Reboots the host, no power off.
`shutdown -i 5`	Not configured	Host powered off, stays off until powered on at the SP.
	Configured	Soft resets and reboots.

For information about the consequences of rebooting a domain that has the root domain role, see "Rebooting the Root Domain" on page 87.

Using Oracle VM Server for SPARC With the Service Processor

The section describes information related to using the Integrated Lights Out Manager (ILOM) service processor (SP) with the Logical Domains Manager. For more information about using the ILOM software, see the documents for your specific platform at `http://www.oracle.com/technetwork/documentation/sparc-tseries-servers-252697.html`.

An additional `config` option is available to the existing ILOM command:

```
-> set /HOST/bootmode config=config-name
```

This option enables you to set the configuration on the next power on to another configuration, including the `factory-default` shipping configuration.

You can invoke the command regardless of whether the host is powered on or off. It takes effect on the next host reset or power on.

To reset the logical domain configuration, you set the option to `factory-default`.

```
-> set /HOST/bootmode config=factory-default
```

You also can select other configurations that have been created with the Logical Domains Manager using the `ldm add-config` command and stored on the service processor (SP). The name you specify in the Logical Domains Manager `ldm add-config` command can be used to select that configuration with the ILOM `bootmode` command. For example, assume you stored the configuration with the name `ldm-config1`.

```
-> set /HOST/bootmode config=ldm-config1
```

Now, you must perform a power cycle of the system to load the new configuration.

See the `ldm(1M)` man page for more information about the `ldm add-config` command.

Configuring Domain Dependencies

You can use the Logical Domains Manager to establish dependency relationships between domains. A domain that has one or more domains that depend on it is called a *master domain*. A domain that depends on another domain is called a *slave domain*.

Each slave domain can specify up to four master domains by setting the `master` property. For example, the `pine` slave domain specifies its four master domains in the following comma-separated list:

```
# ldm add-domain master=apple,lemon,orange,peach pine
```

Each master domain can specify what happens to its slave domains in the event that the master domain fails. For instance, if a master domain fails, it might require its slave domains to panic. If a slave domain has more than one master domain, the first master domain to fail triggers its defined failure policy on all of its slave domains.

Note – If more than one master domain fails simultaneously, only one of the specified failure policies will be enforced on all the affected slave domains. For example, if the failed master domains have failure policies of `stop` and `panic`, all slave domains will be either stopped or panicked.

The master domain's failure policy is controlled by setting one of the following values to the `failure-policy` property:

- `ignore` ignores any slave domains
- `panic` panics any slave domains
- `reset` resets any slave domains
- `stop` stops any slave domains

In this example, the master domains specify their failure policy as follows:

```
# ldm set-domain failure-policy=ignore apple
# ldm set-domain failure-policy=panic lemon
# ldm set-domain failure-policy=reset orange
# ldm set-domain failure-policy=stop peach
```

You can use this mechanism to create explicit dependencies between domains. For example, a guest domain implicitly depends on the service domain to provide its virtual devices. A guest domain's I/O is blocked when the service domain on which it depends is not up and running. By defining a guest domain as a slave of its service domain, you can specify the behavior of the guest domain when its service domain goes down. When no such dependency is established, a guest domain just waits for its service domain to return to service.

Note – The Logical Domains Manager does not permit you to create domain relationships that create a dependency cycle. For more information, see "Dependency Cycles" on page 309.

For domain dependency XML examples, see Example 19–6.

Domain Dependency Examples

The following examples show how to configure domain dependencies.

EXAMPLE 13–1 Configuring a Failure Policy by Using Domain Dependencies

The first command creates a master domain called `twizzle`. This command uses `failure-policy=reset` to specify that slave domains reset if the `twizzle` domain fails. The second command modifies a master domain called `primary`. This command uses `failure-policy=panic` to specify that slave domains panic if the `primary` domain fails. The third command creates a slave domain called `chocktaw` that depends on two master domains, `twizzle` and `primary`. The slave domain uses `master=twizzle,primary` to specify its master domains. In the event either the `twizzle` or `primary` domain fails, the `chocktaw` domain will reset or panic. The first master domain to fail is the one responsible for determining the behavior of the slave domains.

```
# ldm add-domain failure-policy=reset twizzle
# ldm set-domain failure-policy=panic primary
# ldm add-domain master=twizzle,primary chocktaw
```

EXAMPLE 13–2 Modifying a Domain to Assign a Master Domain

This example shows how to use the `ldm set-domain` command to modify the `orange` domain to assign `primary` as the master domain. The second command uses the `ldm set-domain` command to assign `orange` and `primary` as master domains for the `tangerine` domain. The third command lists information about all of these domains.

```
# ldm set-domain master=primary orange
# ldm set-domain master=orange,primary tangerine
# ldm list -o domain
NAME             STATE      FLAGS   UTIL
primary          active     -n-cv-  0.2%

SOFTSTATE
Solaris running

HOSTID
    0x83d8b31c

CONTROL
    failure-policy=ignore

DEPENDENCY
    master=

------------------------------------------------------------------------------
NAME             STATE      FLAGS   UTIL
orange           bound      ------

HOSTID
    0x84fb28ef

CONTROL
    failure-policy=stop

DEPENDENCY
    master=primary
```

EXAMPLE 13–2 Modifying a Domain to Assign a Master Domain *(Continued)*

```
------------------------------------------------------------------------------
NAME             STATE      FLAGS   UTIL
tangerine        bound      ------

HOSTID
    0x84f948e9

CONTROL
    failure-policy=ignore

DEPENDENCY
    master=orange,primary
```

EXAMPLE 13–3 Showing a Parseable Domain Listing

The following shows an example listing with parseable output:

```
# ldm list -o domain -p
```

Dependency Cycles

The Logical Domains Manager does not permit you to create domain relationships that create a dependency cycle. A *dependency cycle* is a relationship between two or more domains that lead to a situation where a slave domain depends on itself or a master domain depends on one of its slave domains.

The Logical Domains Manager determines whether a dependency cycle exists before adding a dependency. The Logical Domains Manager starts at the slave domain and searches along all paths that are specified by the master array until the end of the path is reached. Any dependency cycles found along the way are reported as errors.

The following example shows how a dependency cycle might be created. The first command creates a slave domain called `mohawk` that specifies its master domain as `primary`. So, `mohawk` depends on `primary` in the dependency chain shown in the following diagram.

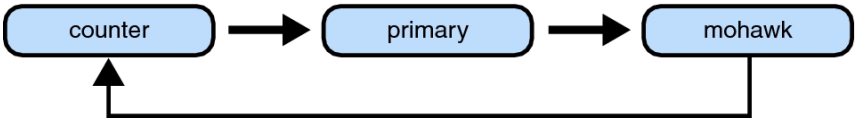
FIGURE 13–1 Single Domain Dependency

The second command creates a slave domain called `primary` that specifies its master domain as `counter`. So, `mohawk` depends on `primary`, which depends on `counter` in the dependency chain shown in the following diagram.

FIGURE 13–2 Multiple Domain Dependency

The third command attempts to create a dependency between the `counter` and `mohawk` domains, which would produce the dependency cycle shown in the following diagram.

FIGURE 13–3 Domain Dependency Cycle



The `ldm set-domain` command will fail with the following error message:

```
# ldm add-domain master=primary mohawk
# ldm set-domain master=counter primary
# ldm set-domain master=mohawk counter
Dependency cycle detected: LDom "counter" indicates "primary" as its master
```

Determining Where Errors Occur by Mapping CPU and Memory Addresses

This section describes how you can correlate the information that is reported by the Oracle Solaris Fault Management Architecture (FMA) with the logical domain resources that are marked as being faulty.

FMA reports CPU errors in terms of physical CPU numbers and memory errors in terms of physical memory addresses.

If you want to determine within which logical domain an error occurred and the corresponding virtual CPU number or real memory address within the domain, then you must perform a mapping.

CPU Mapping

You can find the domain and the virtual CPU number within the domain that correspond to a given physical CPU number.

First, generate a long parseable list for all domains by using the following command:

```
primary# ldm list -l -p
```

Look for the entry in the list's `VCPU` sections that has a `pid` field equal to the physical CPU number.

- If you find such an entry, the CPU is in the domain the entry is listed under, and the virtual CPU number within the domain is given by the entry's `vid` field.
- If you do not find such an entry, the CPU is not in any domain.

Memory Mapping

You can find the domain and the real memory address within the domain that correspond to a given physical memory address (PA).

First, generate a long parseable list for all domains.

```
primary# ldm list -l -p
```

Look for the line in the list's `MEMORY` sections where the PA falls within the inclusive range *pa* to (*pa* + *size* - 1); that is, *pa* ≤ PA ≤ (*pa* + *size* - 1). *pa* and *size* refer to the values in the corresponding fields of the line.

- If you find such an entry, the PA is in the domain the entry is listed under and the corresponding real address within the domain is given by *ra* + (PA - *pa*).
- If you do not find such an entry, the PA is not in any domain.

Example of CPU and Memory Mapping

EXAMPLE 13–4 Determining the Configuration of Domains

The following command produces a long parseable list of logical domains configurations.

```
primary# ldm list -l -p
VERSION 1.6
DOMAIN|name=primary|state=active|flags=normal,control,vio-service|
cons=SP|ncpu=4|mem=1073741824|util=0.6|uptime=64801|
softstate=Solaris running
VCPU
|vid=0|pid=0|util=0.9|strand=100
|vid=1|pid=1|util=0.5|strand=100
|vid=2|pid=2|util=0.6|strand=100
|vid=3|pid=3|util=0.6|strand=100
MEMORY
|ra=0x8000000|pa=0x8000000|size=1073741824
IO
|dev=pci@780|alias=bus_a
|dev=pci@7c0|alias=bus_b
...
DOMAIN|name=ldg1|state=active|flags=normal|cons=5000|
ncpu=2|mem=805306368|util=29|uptime=903|
```

EXAMPLE 13–4 Determining the Configuration of Domains *(Continued)*

```
softstate=Solaris running
VCPU
|vid=0|pid=4|util=29|strand=100
|vid=1|pid=5|util=29|strand=100
MEMORY
|ra=0x8000000|pa=0x48000000|size=805306368
...
DOMAIN|name=ldg2|state=active|flags=normal|cons=5001|
ncpu=3|mem=1073741824|util=35|uptime=775|
softstate=Solaris running
VCPU
|vid=0|pid=6|util=35|strand=100
|vid=1|pid=7|util=34|strand=100
|vid=2|pid=8|util=35|strand=100
MEMORY
|ra=0x8000000|pa=0x78000000|size=1073741824
...
```

EXAMPLE 13–5 Determining the Virtual CPU That Corresponds to a Physical CPU Number

The logical domain configuration is shown in Example 13–4. This example describes how to determine the domain and the virtual CPU corresponding to physical CPU number `5`, and the domain and the real address corresponding to physical address `0x7e816000`.

Looking through the `VCPU` entries in the list for the one with the `pid` field equal to `5`, you can find the following entry under logical domain `ldg1`.

```
|vid=1|pid=5|util=29|strand=100
```

Hence, the physical CPU number `5` is in domain `ldg1` and within the domain it has virtual CPU number `1`.

Looking through the `MEMORY` entries in the list, you can find the following entry under domain `ldg2`.

```
ra=0x8000000|pa=0x78000000|size=1073741824
```

Where 0x78000000 <= 0x7e816000 <= (0x78000000 + 1073741824 - 1); that is, *pa* <= PA <= (*pa* + *size* - 1). Hence, the PA is in domain `ldg2` and the corresponding real address is 0x8000000 + (0x7e816000 - 0x78000000) = 0xe816000.

Using Universally Unique Identifiers

Each domain is assigned a universally unique identifier (UUID). The UUID is assigned when a domain is created. For legacy domains, the UUID is assigned when the `ldmd` daemon initializes.

Note – The UUID is lost if you use the `ldm migrate-domain -f` command to migrate a domain to a target machine that runs an older version of the Logical Domains Manager. When you migrate a domain from a source machine that runs an older version of the Logical Domains Manager, the domain is assigned a new UUID as part of the migration. Otherwise, the UUID is migrated.

You can obtain the UUID for a domain by running the `ldm list -l`, `ldm list-bindings`, or `ldm list -o domain` command. The following examples show the UUID for the `ldg1` domain:

```
primary# ldm create ldg1
primary# ldm ls -l ldg1
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
ldg1             inactive   ------

UUID
    6c908858-12ef-e520-9eb3-f1cd3dbc3a59

primary# ldm ls -l -p ldg1
VERSION 1.6
DOMAIN|name=ldg1|state=inactive|flags=|cons=|ncpu=|mem=|util=|uptime=
UUID|uuid=6c908858-12ef-e520-9eb3-f1cd3dbc3a59
```

Virtual Domain Information Command and API

The `virtinfo` command enables you to gather information about a running virtual domain. You can also use the Virtual Domain Information API to create programs to gather information related to virtual domains.

The following list shows some of the information that you can gather about a virtual domain by using the command or API:

- Domain type (implementation, control, guest, I/O, service, root)
- Domain name determined by the Virtual Domain Manager
- Universally unique identifier (UUID) of the domain
- Network node name of the domain's control domain
- Chassis serial number on which the domain is running

For information about the `virtinfo` command, see the `virtinfo`(1M) man page. For information about the API, see the `libv12n`(3LIB) and `v12n`(3EXT) man pages.

Using Logical Domain Channels

Oracle VM Server for SPARC uses logical domain channels (LDCs) to implement all communications such as console, virtual I/O, and control traffic. An LDC is the method used to enable communications between two endpoints. Although typically each endpoint is in a different domain, the endpoints can be in the same domain to enable loopback communications.

The Oracle VM Server for SPARC 3.1.1.1 software and system firmware provide a large pool of LDC endpoints that you can use for the control domain and guest domains. This LDC endpoint pool is only available for the SPARC T4, SPARC T5, SPARC M5, and SPARC M6 platforms. The number of LDCs in the pool is based on the platform type as follows:

- **SPARC T4, SPARC T5 –** 1984 LDC endpoints per guest domain, 98304 LDC endpoints total
- **SPARC M5, SPARC M6 –** 1984 LDC endpoints per guest domain, 98304 LDC endpoints per physical domain

The required system firmware to support the LDC endpoint pool is 8.5.1.b for SPARC T4 and 9.2.1.b for SPARC T5, SPARC M5, and SPARC M6.

The following LDC endpoint limits per guest domain still apply if you run an older version of the system firmware on a supported platform or on an UltraSPARC T2, UltraSPARC T2 Plus, SPARC T3, or Fujitsu M10 system:

- **UltraSPARC T2 system –** 512 LDC endpoints per guest domain
- **UltraSPARC T2 Plus, SPARC T3, SPARC T4, SPARC T5, SPARC M5, SPARC M6, and Fujitsu M10 systems –** 768 LDC endpoints per guest domain

This limitation might be an issue on the control domain because of the potentially large number of LDC endpoints that are used for both virtual I/O data communications and the Logical Domains Manager control of the other domains.

If you attempt to add a service or bind a domain so that the number of LDC endpoints exceeds the limit on any single domain, the operation fails with an error message similar to the following:

```
13 additional LDCs are required on guest primary to meet this request,
but only 9 LDCs are available
```

The following guidelines enable you to plan properly for using LDC endpoints and explain why you might experience an overflow of the LDC capabilities of the control domain:

- The control domain uses approximately 15 LDC endpoints for various communication purposes with the hypervisor, Fault Management Architecture (FMA), and the system processor (SP), independent of the number of other domains configured. The number of LDC endpoints used by the control domain depends on the platform and on the version of the software that is used.
- The Logical Domains Manager allocates an LDC endpoint to the control domain for every domain, including itself, for control traffic.
- Each virtual I/O service on the control domain uses one LDC endpoint for every connected client of that service. Each domain needs at least a virtual network, a virtual disk, and a virtual console.

The following equation incorporates these guidelines to determine the number of LDC endpoints that are required by the control domain:

15 + *number-of-domains* + (*number-of-domains* x *number-of-virtual-services*) = *total-LDC-endpoints*

number-of-domains is the total number of domains including the control domain and *number-of-virtual-services* is the total number of virtual I/O devices that are serviced by this domain.

The following example shows how to use the equation to determine the number of LDC endpoints when there is a control domain and eight additional domains:

15 + 9 + (8 x 3) = 48 LDC endpoints

The following example has 45 guest domains and each domain includes five virtual disks, two virtual networks, and a virtual console. The calculation yields the following result:

15 + 46 + 45 x 8 = 421 LDC endpoints

Depending upon the number of supported LDC endpoints of your platform, the Logical Domains Manager will either accept or reject the configuration.

If you run out of LDC endpoints on the control domain, consider creating service domains or I/O domains to provide virtual I/O services to the guest domains. This action enables the LDC endpoints to be created on the I/O domains and the service domains instead of on the control domain.

A guest domain can also run out of LDC endpoints. This situation might be caused by the `inter-vnet-link` property being set to `on`, which assigns additional LDC endpoints to guest domains to connect directly to each other.

The following equation determines the number of LDC endpoints that are required by a guest domain when `inter-vnet-link=off`:

2 + *number-of-vnets* + *number-of-vdisks* = *total-LDC-endpoints*

2 represents the virtual console and control traffic, *number-of-vnets* is the total number of virtual network devices assigned to the guest domain, and *number-of-vdisks* is the total number of virtual disks assigned to the guest domain.

The following example shows how to use the equation to determine the number of LDC endpoints per guest domain when `inter-vnet-link=off` and you have two virtual disks and two virtual networks:

2 + 2 + 2 = 6 LDC endpoints

The following equation determines the number of LDC endpoints that are required by a guest domain when `inter-vnet-link=on`:

2 + [[(*number-of-vnets-from-vswX* x *number-of-vnets-in-vswX*)] ...] + *number-of-vdisks* = *total-LDC-endpoints*

2 represents the virtual console and control traffic, *number-of-vnets-from-vswX* is the total number of virtual network devices assigned to the guest domain from the *vswX* virtual switch, *number-of-vnets-in-vswX* is the total number of virtual network devices on the *vswX* virtual switch, and *number-of-virtual-disks* is the total number of virtual disks assigned to the guest domain.

The following example shows how to use the equation to determine the number of LDC endpoints per guest domain when `inter-vnet-link=on` and you have two virtual disks and two virtual switches. The first virtual switch has eight virtual networks and assigns four of them to the domain. The second virtual switch assigns all eight of its virtual networks to the domain.

2 + (4 x 8) + (8 x 8) + 2 = 100 LDC endpoints

To resolve the issue of running out of LDC endpoints on a guest domain, consider using the `ldm add-vsw` or `ldm set-vsw` command to set the `inter-vnet-link` property to `off`. This action reduces the number of LDC endpoints in the domains that have the virtual network devices. However, the `off` property value does not affect the service domain that has the virtual switch because the service domain still requires an LDC connection to each virtual network device. When this property is set to `off`, LDC channels are not used for inter-vnet communications. Instead, an LDC channel is assigned only for communication between virtual network devices and virtual switch devices. See the `ldm`(1M) man page.

Note – Although disabling the assignment of inter-vnet links reduces the number of LDC endpoints, it might negatively affect guest-to-guest network performance. This degredation would occur because all guest-to-guest communications traffic goes through the virtual switch rather than directly from one guest domain to another guest domain.

PART II

Optional Oracle VM Server for SPARC Software

This part introduces optional software and features that you can use with the Oracle VM Server for SPARC 3.1 software.

◆ ◆ ◆ CHAPTER 14

Oracle VM Server for SPARC Physical-to-Virtual Conversion Tool

This chapter covers the following topics:

Oracle VM Server for SPARC P2V Tool Overview

The Oracle VM Server for SPARC Physical-to-Virtual (P2V) Conversion tool automatically converts an existing physical system to a virtual system that runs the Oracle Solaris 10 OS in a logical domain on a chip multithreading (CMT) system. You can run the `ldmp2v` command from a control domain that runs the Oracle Solaris 10 OS or the Oracle Solaris 11 OS to convert one of the following source systems to a logical domain:

- Any `sun4u` SPARC based system that runs at least the Solaris 8, Solaris 9, or Oracle Solaris 10 OS
- Any `sun4v` system that runs the Oracle Solaris 10 OS but does not run in a logical domain

Note – The `ldmp2v` command does not support any SPARC based system that runs the Oracle Solaris 10 OS with a ZFS root or the Oracle Solaris 11 OS.

The conversion from a physical system to a virtual system is performed in the following phases:

- **Collection phase.** Runs on the physical source system. In the `collect` phase, a file system image of the source system is created based on the configuration information that it collects about the source system.
- **Preparation phase.** Runs on the control domain of the target system. In the `prepare` phase, a logical domain is created on the target system based on the configuration information collected in the `collect` phase. The file system image is restored to one or more virtual disks. You can use the P2V tool to create virtual disks on plain files or ZFS volumes. You can also create virtual disks on physical disks or LUNs, or on volume manager volumes that you created. The image is modified to enable it to run as a logical domain.
- **Conversion phase.** Runs on the control domain of the target system. In the `convert` phase, the created logical domain is converted into a logical domain that runs the Oracle Solaris 10 OS by using the standard Oracle Solaris upgrade process.

For information about the P2V tool, see the `ldmp2v(1M)` man page.

The following sections describe how the conversion from a physical system to a virtual system is performed.

Collection Phase

The Collection phase runs on the system to be converted. To create a consistent file system image, ensure that the system is as quiet as possible and that all applications are stopped. The `ldmp2v` command creates a backup of all mounted UFS file systems, so ensure that any file systems to be moved to a logical domain are mounted. You can exclude mounted file systems that you do not want to move, such as file systems on SAN storage or file systems that will be moved by other means. Use the `-x` option to exclude such file systems. File systems that are excluded by the `-x` option are not re-created on the guest domain. You can use the `-O` option to exclude files and directories.

No changes are required on the source system. The only requirement is the `ldmp2v` script that was installed on the control domain. Ensure that the `flarcreate` utility is present on the source system.

Preparation Phase

The preparation phase uses the data collected during the collection phase to create a logical domain that is comparable to the source system.

You can use the `ldmp2v prepare` command in one of the following ways:

- **Automatic mode.** This mode automatically creates virtual disks and restores file system data.
  - Creates the logical domain and the required virtual disks of the same size as on the source system.
  - Partitions the disks and restores the file systems.

    If the combined size of the `/`, `/usr`, and `/var` file systems is less than 10 Gbytes, the sizes of these file systems are automatically adjusted to allow for the larger disk space requirements of the Oracle Solaris 10 OS. Automatic resize can be disabled by using the `-x no-auto-adjust-fs` option or by using the `-m` option to manually resize a file system.
  - Modifies the OS image of the logical domain to replace all references to physical hardware with versions that are appropriate for a logical domain. You can then upgrade the system to the Oracle Solaris 10 OS by using the normal Oracle Solaris upgrade process. Modifications include updating the `/etc/vfstab` file to account for new disk names. Any Oracle Solaris Volume Manager or Veritas Volume Manager (VxVM) encapsulated boot disks are automatically unencapsulated during this process. When a disk is unencapsulated, it is converted into plain disk slices. If VxVM is installed on the source system, the P2V process disables VxVM on the created guest domain.
- **Non-automatic mode.** You must create the virtual disks and restore the file system data manually. This mode enables you to change the size and number of disks, the partitioning, and the file system layout. The preparation phase in this mode runs only the logical domain creation and the OS image modification steps on the file system.
- **Cleanup mode.** Removes a logical domain and all of the underlying back-end devices that are created by `ldmp2v`.

Conversion Phase

In the conversion phase, the logical domain uses the Oracle Solaris upgrade process to upgrade to the Oracle Solaris 10 OS. The upgrade operation removes all existing packages and installs the Oracle Solaris 10 `sun4v` packages, which automatically performs a `sun4u-to-sun4v` conversion. The `convert` phase can use an Oracle Solaris DVD ISO image or a network installation image. On Oracle Solaris 10 systems, you can also use the Oracle Solaris JumpStart feature to perform a fully automated upgrade operation.

Back-End Devices

You can create virtual disks for a guest domain on a number of back-end types: files (`file`), ZFS volumes (`zvol`), physical disks or LUNs (`disk`), or volume manager volumes (`disk`). The `ldmp2v` command automatically creates files or ZFS volumes of the appropriate size if you specify `file` or `zvol` as the back-end type in one of the following ways:

- By using the `-b` option
- By specifying the value of the `BACKEND_TYPE` parameter in the `/etc/ldmp2v.conf` file

The `disk` back-end type enables you to use a physical disk, LUN, or volume manager volume (Oracle Solaris Volume Manager and Veritas Volume Manager (VxVM)) as a back-end device for virtual disks. You must create the disk or volume with an appropriate size prior to beginning the `prepare` phase. For a physical disk or LUN, specify the back-end device as slice 2 of the block or character device of the disk, such as `/dev/dsk/c0t3d0s2`. For a volume manager volume, specify the block or character device for the volume, such as `/dev/md/dsk/d100` for Oracle Solaris Volume Manager or `/dev/vx/dsk/ldomdg/vol1` for VxVM.

Unless you specify the volume and virtual disk names with the `-B` *backend*`:`*volume*`:`*vdisk* option, the volumes and virtual disks that you create for the guest are given default names.

- *backend* specifies the name of the back end to use. You must specify *backend* for the `disk` back-end type. *backend* is optional for the `file` and `zvol` back-end types, and can be used to set a non-default name for the file or ZFS volume that `ldmp2v` creates. The default name is `$BACKEND_PREFIX/`*guest-name*`/disk`*N*.
- *volume* is optional for all back-end types and specifies the name of the virtual disk server volume to create for the guest domain. If not specified, *volume* is *guest-name*`-vol`*N*.
- *vdisk* is optional for all back-end types and specifies the name of the volume in the guest domain. If not specified, *vdisk* is `disk`*N*.

Note – During the conversion process, the virtual disk is temporarily named *guest-name*`-disk`*N* to ensure that the name in the control domain is unique.

To specify a blank value for *backend*, *volume*, or *vdisk*, include only the colon separator. For example, specifying `-B ::vdisk001` sets the name of the virtual disk to `vdisk001` and uses the default names for the back end and volume. If you do not specify *vdisk*, you can omit the trailing colon separator. For example, `-B /ldoms/ldom1/vol001:vol001` specifies the name of the back-end file as `/ldoms/ldom1/vol001` and the volume name as `vol001`. The default virtual disk name is `disk0`.

Installing the Oracle VM Server for SPARC P2V Tool

The Oracle VM Server for SPARC P2V Tool package must be installed and configured *only* on the control domain of the target system. You do not need to install the package on the source system. Instead, you can simply copy the `/usr/sbin/ldmp2v` script from the target system to the source system.

Note – The `ldmp2v` is installed on an Oracle Solaris 10 system from the `SUNWldmp2v` package, while the `ldmp2v` is installed by default on an Oracle Solaris 11 system from the `ldomsmanager` package.

Prerequisites for using the SPARC P2V Tool

Before you can run the Oracle VM Server for SPARC P2V tool, ensure that the following conditions are met:

- The following Flash Archive patches are installed on the source system:
  - **For the Solaris 8 OS:** At least patch ID 109318-34
  - **For the Solaris 9 OS:** At least patch ID 113434-06
- The target system runs at least Logical Domains 1.1 on the following:
  - Oracle Solaris 10 10/08 OS
  - Oracle Solaris 10 5/08 OS with the appropriate Logical Domains 1.1 patches
- Guest domains run at least the Oracle Solaris 10 5/08 OS
- The source system runs at least the Solaris 8 OS

In addition to these prerequisites, configure an NFS file system to be shared by both the source and target systems. This file system should be writable by `root`. However, if a shared file system is not available, use a local file system that is large enough to hold a file system dump of the source system on both the source and target systems.

Limitations of Using the SPARC P2V Tool

The Oracle VM Server for SPARC P2V tool has the following limitations:

- Only UFS file systems are supported.
- Only plain disks (`/dev/dsk/c0t0d0s0`), Oracle Solaris Volume Manager metadevices (`/dev/md/dsk/d`*NNN*), and VxVM encapsulated boot disks are supported on the source system.
- During the P2V process, each guest domain can have only a single virtual switch and virtual disk server. You can add more virtual switches and virtual disk servers to the domain after the P2V conversion.

- Support for VxVM volumes is limited to the following volumes on an encapsulated boot disk: `rootvol`, `swapvol`, `usr`, `var`, `opt`, and `home`. The original slices for these volumes must still be present on the boot disk. The P2V tool supports Veritas Volume Manager 5.x on the Oracle Solaris 10 OS. However, you can also use the P2V tool to convert Solaris 8 and Solaris 9 operating systems that use VxVM.
- Oracle Solaris 10 systems that have zones can be converted if the zones are detached by using the `zoneadm detach` command prior to running the `ldmp2v collect` operation. After the P2V conversion completes, use the `zoneadm attach` command to reattach the zones that have been created on the guest domain. For information about performing these steps on a guest domain, see "Migrating a Non-Global Zone to a Different Machine" in *Oracle Solaris Administration: Oracle Solaris Zones, Oracle Solaris 10 Zones, and Resource Management*.

Note – The P2V tool does not update any zone configuration, such as the zone path or network interface, nor does the tool move or configure the storage for the zone path. You must manually update the zone configuration and move the zone path on the guest domain. See "Migrating a Non-Global Zone to a Different Machine" in *Oracle Solaris Administration: Oracle Solaris Zones, Oracle Solaris 10 Zones, and Resource Management*.

▼ How to Install the Oracle VM Server for SPARC P2V Tool

This procedure describes how to install the `ldmp2v` command on an Oracle Solaris 10 system by using the `SUNWldmp2v` package.

On an Oracle Solaris 11 system, the `ldmp2v` command is installed by default when you install the `ldomsmanager` package.

1. **From the Oracle VM Server for SPARC download page at `http://www.oracle.com/virtualization/index.html`, download the P2V software package, `SUNWldmp2v`.**

   The `SUNWldmp2v` package is included in the Oracle VM Server for SPARC zip file.

2. **Become an administrator.**

   - **For Oracle Solaris 10, see "Configuring RBAC (Task Map)" in *System Administration Guide: Security Services*.**
   - **For Oracle Solaris 11.1, see Part III, "Roles, Rights Profiles, and Privileges," in *Oracle Solaris 11.1 Administration: Security Services*.**

3. **Use the `pkgadd` command to install the `SUNWldmp2v` package.**

   ```
   # pkgadd -d . SUNWldmp2v
   ```

4. **Create the `/etc/ldmp2v.conf` file and configure the following default properties:**

- VDS – Name of the virtual disk service, such as VDS="primary-vds0"
- VSW – Name of the virtual switch, such as VSW="primary-vsw0"
- VCC – Name of the virtual console concentrator, such as VCC="primary-vcc0"
- BACKEND_TYPE – Back-end type of zvol, file, or disk
- BACKEND_SPARSE – Determines whether to create back-end devices as sparse volumes or files (BACKEND_SPARSE="yes") or non-sparse volumes or files (BACKEND_SPARSE="no")
- BACKEND_PREFIX – Location to create virtual disk back-end devices

  When BACKEND_TYPE="zvol", specify the BACKEND_PREFIX value as a ZFS dataset name. When BACKEND_TYPE="files", the BACKEND_PREFIX value is interpreted as a path name of a directory that is relative to /.

  For example, BACKEND_PREFIX="tank/ldoms" would result in having ZVOLs created in the tank/ldoms/*domain-name* dataset, and files created in the /tank/ldoms/*domain-name* subdirectory.

  The BACKEND_PREFIX property is not applicable to the disk back end.
- BOOT_TIMEOUT – Timeout for Oracle Solaris OS boot in seconds

For more information, see the ldmp2v.conf.sample configuration file that is part of the downloadable bundle.

Using the ldmp2v Command

This section includes examples for the three phases of conversion.

EXAMPLE 14–1 Collection Phase Examples

The following examples show how you might use the ldmp2v collect command.

- **Sharing an NFS-mounted file system.** The following example shows the simplest way to perform the collect step where the source and target systems share an NFS-mounted file system.

  As superuser, ensure that all required UFS file systems are mounted.

```
volumia# df -k
Filesystem            kbytes    used   avail capacity  Mounted on
/dev/dsk/c1t1d0s0    16516485  463289 15888032     3%    /
/proc                       0       0       0     0%    /proc
fd                          0       0       0     0%    /dev/fd
mnttab                      0       0       0     0%    /etc/mnttab
/dev/dsk/c1t1d0s3    8258597    4304 8171708     1%    /var
swap                 4487448      16 4487432     1%    /var/run
swap                 4487448      16 4487432     1%    /tmp
/dev/dsk/c1t0d0s0    1016122       9  955146     1%    /u01
vandikhout:/u1/home/dana
                     6230996752 1051158977 5179837775    17%    /home/dana
```

EXAMPLE 14–1 Collection Phase Examples *(Continued)*

The following exammple shows how to run the collection tool when the source and target systems share an NFS-mounted file system:

```
volumia# ldmp2v collect -d home/dana/volumia
Collecting system configuration ...
Archiving file systems ...
Determining which filesystems will be included in the archive...
Creating the archive...
895080 blocks
Archive creation complete.
```

- **Not sharing an NFS-mounted file system.** When the source and target systems do not share an NFS-mounted file system, the file system image can be written to local storage and later copied to the control domain. The Flash Archive utility automatically excludes the archive that it creates.

```
volumia# ldmp2v collect -d /var/tmp/volumia
Collecting system configuration ...
Archiving file systems ...
Determining which filesystems will be included in the archive...
Creating the archive...
895080 blocks
Archive creation complete.
```

Copy the flash archive and the `manifest` file from the `/var/tmp/volumia` directory to the target system.

Tip – In some cases, `ldmp2v` might show `cpio` command errors. Most commonly, these errors generate messages such as `File size of etc/mnttab has increased by 435`. You can ignore messages that pertain to log files or to files that reflect the system state. Be sure to review all error messages thoroughly.

- **Skip file-system backup step.** If you already create backups of the system using a third-party backup tool such as NetBackup, you can skip the file system backup step by using the `none` archiving method. When you use this option, only the system configuration manifest is created.

```
volumia# ldmp2v collect -d /home/dana/p2v/volumia -a none
Collecting system configuration ...
The following file system(s) must be archived manually: / /u01 /var
```

Note that if the directory specified by `-d` is not shared by the source and target systems, you must copy the contents of that directory to the control domain. The directory contents must be copied to the control domain prior to the preparation phase.

EXAMPLE 14–2 Preparation Phase Examples

The following examples show how you might use the `ldmp2v prepare` command.

- The following example creates a logical domain called `volumia` by using the defaults configured in `/etc/ldmp2v.conf` while keeping the MAC addresses of the physical system:

```
# ldmp2v prepare -d /home/dana/p2v/volumia -o keep-mac volumia
Creating vdisks ...
Creating file systems ...
Populating file systems ...
Modifying guest domain OS image ...
Removing SVM configuration ...
Unmounting guest file systems ...
Creating domain volumia ...
Attaching vdisks to domain volumia ...
```

- The following command shows information about the `volumia` logical domain:

```
# ldm list -l volumia
NAME             STATE      FLAGS   CONS    VCPU  MEMORY   UTIL  UPTIME
volumia          inactive   ------          2     4G

NETWORK
    NAME    SERVICE                DEVICE     MAC               MODE   PVID VID
    vnet0   primary-vsw0                       00:03:ba:1d:7a:5a        1

DISK
    NAME    DEVICE  TOUT MPGROUP        VOLUME                      SERVER
    disk0                                       volumia-vol0@primary-vds0
    disk1                                       volumia-vol1@primary-vds0
```

- The following example shows how to completely remove a domain and its back-end devices by using the `-C` option.

```
# ldmp2v prepare -C volumia
Cleaning up domain volumia ...
Removing vdisk disk0 ...
Removing vdisk disk1 ...
Removing domain volumia ...
Removing volume volumia-vol0@primary-vds0 ...
Removing ZFS volume tank/ldoms/volumia/disk0 ...
Removing volume volumia-vol1@primary-vds0 ...
Removing ZFS volume tank/ldoms/volumia/disk1 ...
```

- The following example shows how to resize one or more file systems during P2V by specifying the mount point and the new size with the `-m` option.

```
# ldmp2v prepare -d /home/dana/p2v/volumia -m /:8g volumia
Resizing file systems ...
Creating vdisks ...
Creating file systems ...
Populating file systems ...
Modifying guest domain OS image ...
Removing SVM configuration ...
Modifying file systems on SVM devices ...
Unmounting guest file systems ...
Creating domain volumia ...
Attaching vdisks to domain volumia ...
```

EXAMPLE 14–3 Conversion Phase Examples

The following examples show how you might use the `ldmp2v convert` command.

- **Using a network installation server.** The `ldmp2v convert` command boots the domain over the network by using the specified virtual network interface. You must run the `setup_install_server` and `add_install_client` scripts on the installation server.

  On Oracle Solaris 10 systems, you can use the Oracle Solaris JumpStart feature to perform a fully automated conversion. This feature requires that you create and configure the appropriate `sysidcfg` and profile files for the client on the JumpStart server. The profile should consist of the following lines:

  ```
  install_type    upgrade
  root_device     c0d0s0
  ```

  The `sysidcfg` file is only used for the upgrade operation, so a configuration such as the following should be sufficient:

  ```
  name_service=NONE
  root_password=uQkoXlMLCsZhI
  system_locale=C
  timeserver=localhost
  timezone=Europe/Amsterdam
  terminal=vt100
  security_policy=NONE
  nfs4_domain=dynamic
  auto_reg=disable
  network_interface=PRIMARY {netmask=255.255.255.192
          default_route=none protocol_ipv6=no}
  ```

  For more information about using JumpStart, see *Oracle Solaris 10 8/11 Installation Guide: Custom JumpStart and Advanced Installations*.

Note – The example `sysidcfg` file includes the `auto_reg` keyword, which was introduced in the Oracle Solaris 10 9/10 release. This keyword is required only if you are running at least the Oracle Solaris 10 9/10 release.

```
# ldmp2v convert -j -n vnet0 -d /p2v/volumia volumia
LDom volumia started
Waiting for Solaris to come up ...
Using Custom JumpStart
Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.

Connecting to console "volumia" in group "volumia" ....
Press ~? for control options ..
SunOS Release 5.10 Version Generic_137137-09 64-bit
Copyright (c) 1983-2010, Oracle and/or its affiliates.  All rights reserved.
Configuring devices.
Using RPC Bootparams for network configuration information.
Attempting to configure interface vnet0...
Configured interface vnet0
```

EXAMPLE 14–3 Conversion Phase Examples *(Continued)*

```
Reading ZFS config: done.
Setting up Java. Please wait...
Serial console, reverting to text install
Beginning system identification...
Searching for configuration file(s)...
Using sysid configuration file
  129.159.206.54:/opt/SUNWjet/Clients/volumia/sysidcfg
Search complete.
Discovering additional network configuration...
Completing system identification...
Starting remote procedure call (RPC) services: done.
System identification complete.
Starting Solaris installation program...
Searching for JumpStart directory...
Using rules.ok from 129.159.206.54:/opt/SUNWjet.
Checking rules.ok file...
Using begin script: Clients/volumia/begin
Using profile: Clients/volumia/profile
Using finish script: Clients/volumia/finish
Executing JumpStart preinstall phase...
Executing begin script "Clients/volumia/begin"...
Begin script Clients/volumia/begin execution completed.
Searching for SolStart directory...
Checking rules.ok file...
Using begin script: install_begin
Using finish script: patch_finish
Executing SolStart preinstall phase...
Executing begin script "install_begin"...
Begin script install_begin execution completed.
WARNING: Backup media not specified.  A backup media (backup_media)
  keyword must be specified if an upgrade with disk space reallocation
  is required

Processing profile

Loading local environment and services

Generating upgrade actions
Checking file system space: 100% completed
Space check complete.

Building upgrade script

Preparing system for Solaris upgrade

Upgrading Solaris: 10% completed
[...]
```

- **Using an ISO image.** The `ldmp2v convert` command attaches the Oracle Solaris DVD ISO image to the logical domain and boots from it. To upgrade, answer all `sysid` prompts and select Upgrade.

EXAMPLE 14–3 Conversion Phase Examples *(Continued)*

Caution – A safety check is performed prior to converting the guest domain. This check ensures that none of the original system's IP addresses are active so as to prevent duplicate active IP addresses on the network. You can use the `-x skip-ping-test` option to skip this safety check. Skipping this check speeds up the conversion process. Use this option *only* if you are certain that no duplicate IP addresses exist, such as when the original host is not active.

The answers to the `sysid` questions are used only for the duration of the upgrade process. This data is not applied to the existing OS image on disk. The fastest and simplest way to run the conversion is to select Non-networked. The `root` password that you specify does not need to match the `root` password of the source system. The system's original identity is preserved by the upgrade and takes effect after the post-upgrade reboot. The time required to perform the upgrade depends on the Oracle Solaris Cluster that is installed on the original system.

```
# ldmp2v convert -i /tank/iso/s10s_u5.iso -d /home/dana/p2v/volumia volumia
Testing original system status ...
LDom volumia started
Waiting for Solaris to come up ...

        Select 'Upgrade' (F2) when prompted for the installation type.
        Disconnect from the console after the Upgrade has finished.

Trying 0.0.0.0...
Connected to 0.
Escape character is '^]'.

Connecting to console "volumia" in group "volumia" ....
Press ~? for control options ..
Configuring devices.
Using RPC Bootparams for network configuration information.
Attempting to configure interface vnet0...
Extracting windowing system. Please wait...
Beginning system identification...
Searching for configuration file(s)...
Search complete.
Discovering additional network configuration...
Configured interface vnet0
Setting up Java. Please wait...

Select a Language

   0. English
   1. French
   2. German
   3. Italian
   4. Japanese
   5. Korean
   6. Simplified Chinese
```

EXAMPLE 14–3 Conversion Phase Examples *(Continued)*

```
      7. Spanish
      8. Swedish
      9. Traditional Chinese

   Please make a choice (0 - 9), or press h or ? for help:
   [...]
   - Solaris Interactive Installation ----------------------------------------

     This system is upgradable, so there are two ways to install the Solaris
     software.

     The Upgrade option updates the Solaris software to the new release, saving
     as many modifications to the previous version of Solaris software as
     possible.  Back up the system before using the Upgrade option.

     The Initial option overwrites the system disks with the new version of
     Solaris software.  This option allows you to preserve any existing file
     systems.  Back up any modifications made to the previous version of Solaris
     software before starting the Initial option.

     After you select an option and complete the tasks that follow, a summary of
     your actions will be displayed.

   --------------------------------------------------------------------------------
        F2_Upgrade    F3_Go Back    F4_Initial    F5_Exit    F6_Help
```

◆ ◆ ◆ CHAPTER 15

Oracle VM Server for SPARC Configuration Assistant (Oracle Solaris 10)

The Oracle VM Server for SPARC Configuration Assistant (the `ldmconfig` command) leads you through the configuration of a logical domain by setting basic properties. It runs on chip multithreading (CMT)-based systems.

After gathering the configuration data, the Configuration Assistant creates a configuration that is suitable for booting as a logical domain. You can also use the default values selected by the Configuration Assistant to create a usable system configuration.

Note – The `ldmconfig` command is supported only on Oracle Solaris 10 systems.

In addition to this chapter, see the `ldmconfig(1M)` man page.

Using the Configuration Assistant (`ldmconfig`)

The `ldmconfig` command works through a series of operations that correspond to user interface screens. The end result is the creation of a configuration that you can deploy to a logical domain.

The following sections describe how to install the `ldmconfig` command and some features of the Configuration Assistant tool.

Installing the Configuration Assistant

The Configuration Assistant is delivered as part of the `SUNWldm` package.

After you install the `SUNWldm` package, you can find the `ldmconfig` command in the `/usr/sbin` directory. The command is also installed in the `/opt/SUNWldm/bin` directory for legacy purposes.

Prerequisites for Running the Configuration Assistant

Before you install and run the Configuration Assistant, ensure that the following conditions are met:

- The target system must be running at least the Logical Domains 1.2 software.
- Your terminal window must be at least 80 characters wide by 24 lines long.

Limitations and Known Issues of the Configuration Assistant

The Configuration Assistant has the following limitations:

- Resizing the terminal while using `ldmconfig` might cause garbled output
- Support for UFS disk files as virtual disks only
- Works only with systems where no existing logical domains configurations are present
- Virtual console concentrator ports are from `5000` to `5100`
- Default names that are used for guest domains, services, and devices cannot be changed

`ldmconfig` Features

The `ldmconfig` command works through a series of operations that correspond to user interface screens. You can navigate backward (previous) and forward (next) through these screens until you reach the final step. The final step produces the configuration. At any time you can quit the Configuration Assistant or reset the configuration to use the defaults. From the final screen, you can deploy the configuration to a logical domain.

First, the Configuration Assistant automatically inspects the system to determine the most suitable default property values based on best practices, and then shows those properties that are required to control a deployment. Note that this is not an exhaustive list. You can set other properties to further customize the configuration.

For information about the using the `ldmconfig` tool, see the `ldmconfig(1M)` man page.

You can adjust the following properties:

- **Number of guest domains.** Specify the number of guest domains for the application to create. The minimum is one guest domain. The maximum value is determined by the availability of VCPU resources. For example, you could create up to 60 guest domains with a single thread each on a 64-thread CMT system, and four threads reserved for the control domain. If best practices are selected, the minimum number of VCPU resources per guest domain is a single core. So, on an 8-core, 8-thread-per-core system with best practices selected, you could create up to seven guest domains with one core each. Also, one core is assigned to the control domain.

  The Configuration Assistant shows the maximum number of domains that can be configured for this system.

The Configuration Assistant performs the following tasks to create domains:

- For all domains:
  - Creates a virtual terminal service on ports from 5000 to 5100
  - Creates a virtual disk service
  - Creates a virtual network switch on the network adapter nominated
  - Enables the virtual terminal server daemon
- For each domain:
  - Creates the logical domain
  - Configures VCPUs assigned to the domain
  - Configures memory assigned to the domain
  - Creates a UFS disk file to use as a virtual disk
  - Creates a virtual disk server device (`vdsdev`) for the disk file
  - Assigns the disk file as virtual disk `vdisk0` for the domain
  - Adds a virtual network adapter attached to the virtual switch on the network adapter nominated
  - Sets the OBP property `auto-boot?=true`
  - Sets the OBP property `boot-device=vdisk0`
  - Binds the domain
  - Starts the domain

- **Default network.** Specify the network adapter that the new domains will use for virtual networking. The adapter must be present in the system. The Configuration Assistant highlights those adapters that are currently in use by the system as default adapters, and those that have active link status (cabled adapters).
- **Virtual disk size.** Create virtual disks for each of the new domains. These virtual disks are created based on the disk files that are located in the local file systems. This property controls the size of each virtual disk in Gbytes. The minimum size, 8 Gbytes, is based on the approximate size required to contain an Oracle Solaris 10 OS, and the maximum size is 100 Gbytes.

  If the Configuration Assistant cannot find file systems that have adequate space to contain the disk files for all domains, an error screen is shown. In this case, you might need to do the following before rerunning the application:

  - Reduce the size of the virtual disks
  - Reduce the number of domains
  - Add more higher-capacity file systems
- **Virtual disk directory.** Specify a file system that has sufficient capacity on which to store the files to be created as virtual disks for the new domains. The directory is based on the number of domains that are selected and the size of the virtual disks. The value must be recalculated and destination directories selected any time that these property values are changed. The

Configuration Assistant presents you with a list of file systems that have sufficient space. After you specify the file system name, the Configuration Assistant creates a directory in this file system called /ldoms/disks in which to create the disk images.

- **Best practice.** Specify whether to use best practice for property values.
  - When the value is yes, the Configuration Assistant uses best practice for several configuration property values. It forces the minimum of one core per domain, including the system domains. This setting limits the maximum number of guest domains to the total number of cores present in the system minus one core for the system domains. For example, in the case of a two-socket SPARC Enterprise T5140 with eight cores each, the maximum number of guest domains is 15 plus the system domain.
  - When the value is no, the Configuration Assistant permits the creation of domains that have a minimum of one thread, but maintain at least four threads for the system domain.

Next, the Configuration Assistant summarizes the deployment configuration to be created, which includes the following information:

- Number of domains
- CPU assigned to each guest domain
- Memory assigned to each guest domain
- Size and location of the virtual disks
- Network adapter to be used for virtual network services for guest domains
- Amount of CPU and memory to be used by the system for services
- If a valid Oracle Solaris OS DVD was identified, it will be used to create a shared virtual CD-ROM device to permit guest domains to install the Oracle Solaris OS

Finally, the Configuration Assistant configures the system to create the specified Oracle VM Server for SPARC deployment. It also describes the actions to be taken and shows the commands to be run to configure the system. This information can assist you in learning how to use the ldm commands that are needed to configure the system.

Caution – Do *not* interact with this configuration step and do *not* interrupt this process as doing so might result in a partially configured system.

After the commands have been completed successfully, reboot the system for the changes to take effect.

◆ ◆ ◆ CHAPTER 16

Using Power Management

This chapter contains information about using power management on Oracle VM Server for SPARC systems.

Using Power Management

To enable power management (PM), you first need to set the PM policy in the Oracle Integrated Lights Out Manager (ILOM) 3.0 firmware. This section summarizes the information that you need to be able to use PM with the Oracle VM Server for SPARC software.

For more information about ILOM, see the following:

- "Monitoring Power Consumption" in the *Oracle Integrated Lights Out Manager (ILOM) 3.0 CLI Procedures Guide*
- *Oracle Integrated Lights Out Manager (ILOM) 3.0 Feature Updates and Release Notes*

The power policy governs system power usage at any point in time. The following power policies are supported, assuming that the underlying platform has implemented PM features:

- **Disabled.** Permits the system to use all the power that is available.
- **Performance.** Enables one or more of the following PM features that have a negligible affect on performance:
  - CPU core auto-disabling
  - CPU clock cycle skip
  - CPU dynamic voltage and frequency scaling (DVFS)
  - Coherency link scaling
  - Oracle Solaris Power Aware Dispatcher (PAD)
- **Elastic.** Adapts the system power usage to the current utilization level by using the PM features described in the performance section. For example, the power state of resources is reduced as utilization decreases.

Power Management Features

The PM features are as follows:

- **CPU core auto-disabling.** When the elastic or performance policy is in effect, the Logical Domains Manager automatically disables a CPU core when all the hardware threads (strands) on that core are not bound to a domain. This feature is available only for the UltraSPARC T2, UltraSPARC T2 Plus, SPARC T3, and SPARC T4 platforms.
- **CPU clock cycle skip.**When the elastic policy is in effect, the Logical Domains Manager automatically adjusts the number of clock cycles that execute instructions on the following CPU resources that are bound to domains:
  - Processors (SPARC T3 or SPARC T4 on domains that run the Oracle Solaris 10 or Oracle Solaris 11 OS)
  - Cores (SPARC M5 only on domains that run the Oracle Solaris 10 OS)
  - Core-pairs (SPARC T5 or SPARC M6 only on domains that run the Oracle Solaris 10 OS)

  The Logical Domains Manager also applies cycle skipping if the processor, core, or core-pair has no bound strands.
- **CPU dynamic voltage and frequency scaling (DVFS).** When the elastic policy is in effect, the Logical Domains Manager automatically adjusts the clock frequency of processors that are bound to domains running the Oracle Solaris 10 OS. The Logical Domains Manager also reduces the clock frequency on processors that have no bound strands. This feature is available only on SPARC T5 and M5 systems.
- **Coherency link scaling.** When the elastic policy is in effect, the Logical Domains Manager causes the hypervisor to automatically adjust the number of coherency links that are in use. This feature is only available on SPARC T5-2 systems.
- **Power limit.** You can set a *power limit* on SPARC T3, SPARC T4, SPARC T5, and SPARC M5 platforms to restrict the power draw of a system. If the power draw is greater than the power limit, PM uses techniques to reduce power. You can use the ILOM service processor (SP) to set the power limit.

  See the following documents:
  - *Oracle Integrated Lights Out Manager (ILOM) 3.0 CLI Procedures Guide*
  - *Oracle Integrated Lights Out Manager (ILOM) 3.0 Feature Updates and Release Notes*

  You can use the ILOM interface to set a power limit, grace period, and violation action. If the power limit is exceeded for more than the grace period, the violation action is performed.

  If the current power draw exceeds the power limit, an attempt is made to reduce the power state of CPUs. If the power draw drops below the power limit, the power state of those

resources is permitted to increase. If the system has the elastic policy in effect, an increase in the power state of resources is driven by the utilization level.

- **Solaris Power Aware Dispatcher (PAD).** A guest domain that runs the Oracle Solaris 11.1 OS uses the power-aware dispatcher (PAD) on SPARC T5, SPARC M5, and SPARC M6 systems to minimize power consumption from idle or under-utilized resources. PAD, instead of the Logical Domains Manager, adjusts the CPU clock cycle skip level and DVFS level.

For instructions on configuring the power policy by using the ILOM 3.0 firmware CLI, see "Monitoring Power Consumption" in the *Oracle Integrated Lights Out Manager (ILOM) 3.0 CLI Procedures Guide*.

Viewing Power-Consumption Data

The Oracle VM Server for SPARC 3.1 software provides the Power Management (PM) Observability Module and the `ldmpower` command that enable you to view CPU thread power-consumption data for your domains.

The PM Observability Module is enabled by default as the `ldmd/pm_observability_enabled` Service Management Facility (SMF) property is set to `true`. See the `ldmd(1M)` man page.

The `ldmpower` command has the following options and operands with which you can customize the power-consumption reporting data:

```
ldmpower [-ehiprstvx | -o hours | -m minutes] | -c resource [-l ldom[,ldom[,...]]]
  [interval [count]]
```

For information about the options, see the `ldmpower(1M)` man page.

To run this command as a non-privileged user, you must be assigned the `LDoms Power Mgmt Observability` rights profile. If you already have been assigned the `LDoms Management` or `LDoms Review` rights profile, you automatically have permission to run the `ldmpower` command.

For information about how Oracle VM Server for SPARC uses rights, see "Logical Domains Manager Rights Profile Contents" on page 46.

These rights profiles can be assigned directly to users or to a role that is then assigned to users. When one of these profiles is assigned directly to a user, you must use the `pfexec` command or a profile shell, such as `pfbash` or `pfksh`, to successfully use the `ldmpower` command to view CPU thread power-consumption data. See "Delegating the Management of Logical Domains by Using Rights" on page 43.

The following examples show how to enable the PM Observability Module and show ways in which to gather power-consumption data for the CPUs that are assigned to your domains.

EXAMPLE 16–1 Enabling the Power Management Observability Module

The following command enables the PM Observability Module by setting the `ldmd/pm_observability_enabled` property to `true` if the property is currently set to `false`.

```
# svccfg -s ldmd setprop ldmd/pm_observability_enabled=true
# svcadm refresh ldmd
# svcadm restart ldmd
```

EXAMPLE 16–2 Using a Profile Shell to Obtain CPU Thread Power-Consumption Data by Using Roles and Rights Profiles

- The following example shows how to create the `ldmpower` role with the `LDoms Power Mgmt Observability` rights profile, which permits you to run the `ldmpower` command.

  ```
  primary# roleadd -P "LDoms Power Mgmt Observability" ldmpower
  primary# passwd ldmpower
  New Password:
  Re-enter new Password:
  passwd: password successfully changed for ldmpower
  ```

  This command assigns the `ldmpower` role to the `sam` user.

  ```
  primary# usermod -R ldmpower sam
  ```

  User `sam` assumes the `ldmpower` role and can use the `ldmpower` command. For example:

  ```
  $ id
  uid=700299(sam) gid=1(other)
  $ su ldmpower
  Password:
  $ pfexec ldmpower
  Processor Power Consumption in Watts
  DOMAIN  15_SEC_AVG  30_SEC_AVG  60_SEC_AVG
  primary 75          84          86
  gdom1   47          24          19
  gdom2   10          24          26
  ```

- The following examples show how to use rights profiles to run the `ldmpower` command.
  - **Oracle Solaris 10:** Assign the rights profile to *username*.

    ```
    primary# usermod -P "All,Basic Solaris User,LDoms Power Mgmt Observability" \
    username
    ```

    The following commands show how to verify that the user is `sam` and that the `All`, `Basic Solaris User`, and `LDoms Power Mgmt Observability` rights profiles are in effect.

    ```
    $ id
    uid=702048(sam) gid=1(other)
    $ profiles
    All
    Basic Solaris User
    LDoms Power Mgmt Observability
    $ pfexec ldmpower
    Processor Power Consumption in Watts
    DOMAIN  15_SEC_AVG  30_SEC_AVG  60_SEC_AVG
    primary 75          84          86
    ```

EXAMPLE 16–2 Using a Profile Shell to Obtain CPU Thread Power-Consumption Data by Using Roles and Rights Profiles *(Continued)*

```
gdom1   47          24          19
gdom2   10          24          26
```

- **Oracle Solaris 11:** Assign the rights profile to a user.

  ```
  primary# usermod -P +"LDoms Power Mgmt Observability" sam
  ```

  The following commands show how to verify that the user is `sam` and that the `All`, `Basic Solaris User`, and `LDoms Power Mgmt Observability` rights profiles are in effect.

  ```
  $ id
  uid=702048(sam) gid=1(other)
  $ profiles
  All
  Basic Solaris User
  LDoms Power Mgmt Observability
  $ pfexec ldmpower
  Processor Power Consumption in Watts
  DOMAIN  15_SEC_AVG  30_SEC_AVG  60_SEC_AVG
  primary 75          84          86
  gdom1   47          24          19
  gdom2   10          24          26
  ```

EXAMPLE 16–3 Viewing Processor Power-Consumption Data

The following examples show how to use the `ldmpower` to report processor power-consumption data for your domains.

- The following command shows the 15-second, 30-second, and 60-second rolling average processor power-consumption data for all domains:

  ```
  primary# ldmpower
  Processor Power Consumption in Watts
  DOMAIN  15_SEC_AVG  30_SEC_AVG  60_SEC_AVG
  primary 75          84          86
  gdom1   47          24          19
  gdom2   10          24          26
  ```

- The following command shows extrapolated power-consumption data for all the domains: `primary`, `gdom1`, and `gdom2`.

  ```
  primary# ldmpower -x
  System Power Consumption in Watts
  DOMAIN  15_SEC_AVG  30_SEC_AVG  60_SEC_AVG
  primary 585/57.47%  701/68.96%  712/70.22%
  gdom1   132/12.97%  94/9.31%    94/9.30%
  gdom2   298/29.27%  218/21.47%  205/20.22%
  ```

- The following command shows the instantaneous processor power-consumption data for the `gdom2` and `gdom5` domains. It reports the data every ten seconds for five times.

  ```
  primary# ldmpower -itl gdom2,gdom5 10 5
  Processor Power Consumption in Watts
  DOMAIN          TIMESTAMP               INSTANT
  gdom2           2013.05.17 11:14:45     13
  ```

EXAMPLE 16–3 Viewing Processor Power-Consumption Data *(Continued)*

```
gdom5           2013.05.17 11:14:45     24

gdom2           2013.05.17 11:14:55     18
gdom5           2013.05.17 11:14:55     26

gdom2           2013.05.17 11:15:05     9
gdom5           2013.05.17 11:15:05     16

gdom2           2013.05.17 11:15:15     15
gdom5           2013.05.17 11:15:15     19

gdom2           2013.05.17 11:15:25     12
gdom5           2013.05.17 11:15:25     18
```

- The following command shows the average power-consumption data for the last 12 hours for all domains. Data is shown at one-hour intervals starting from the last requested hourly calculation.

```
primary# ldmpower -eto 12
Per domain MINIMUM and MAXIMUM power consumption ever recorded:
primary         2013.05.17 08:53:06     3               Min Processors
primary         2013.05.17 08:40:44     273             Max Processors
gdom1           2013.05.17 09:56:35     2               Min Processors
gdom1           2013.05.17 08:53:06     134             Max Processors
gdom2           2013.05.17 10:31:55     2               Min Processors
gdom2           2013.05.17 08:56:35     139             Max Processors

primary         2013.05.17 08:53:06     99              Min Memory
primary         2013.05.17 08:40:44     182             Max Memory
gdom1           2013.05.17 09:56:35     13              Min Memory
gdom1           2013.05.17 08:53:06     20              Max Memory
gdom2           2013.05.17 10:31:55     65              Min Memory
gdom2           2013.05.17 08:56:35     66              Max Memory

Processor Power Consumption in Watts
12 hour's worth of data starting from 2013.05.16 23:17:02
DOMAIN          TIMESTAMP               1 HOUR AVG
primary         2013.05.17 09:37:35     112
gdom1           2013.05.17 09:37:35     15
gdom2           2013.05.17 09:37:35     26

primary         2013.05.17 10:37:35     96
gdom1           2013.05.17 10:37:35     12
gdom2           2013.05.17 10:37:35     21

primary         2013.05.17 11:37:35     85
gdom1           2013.05.17 11:37:35     11
gdom2           2013.05.17 11:37:35     23
...
```

◆ ◆ ◆ CHAPTER 17

Using the Oracle VM Server for SPARC Management Information Base Software

The Oracle VM Server for SPARC Management Information Base (MIB) enables third-party system management applications to perform remote monitoring of domains, and to start and stop logical domains (domains) by using the Simple Network Management Protocol (SNMP).

You can run only one instance of the Oracle VM Server for SPARC MIB software on the control domain. The control domain should run at least the Solaris 10 11/06 OS and at least the Oracle VM Server for SPARC 2.2 software.

This chapter covers the following topics:

Oracle VM Server for SPARC Management Information Base Overview

This section covers the following topics:

Related Products and Features

To successfully use the Oracle VM Server for SPARC MIB, you must understand how to use the following software products and features:

- Oracle Solaris OS
- Oracle VM Server for SPARC software
- Simple Network Management Protocol (SNMP)
- SNMP Management Information Base (MIB)
- Oracle Solaris SNMP Agent
- SNMP version 1 (SNMPv1), SNMP version 2 (SNMPv2c), and SNMP version 3 (SNMPv3) protocols
- Structure of Management Information (SMI) version 1 and version 2
- Management Information Base (MIB) structure
- Abstract Syntax Notation (ASN.1)

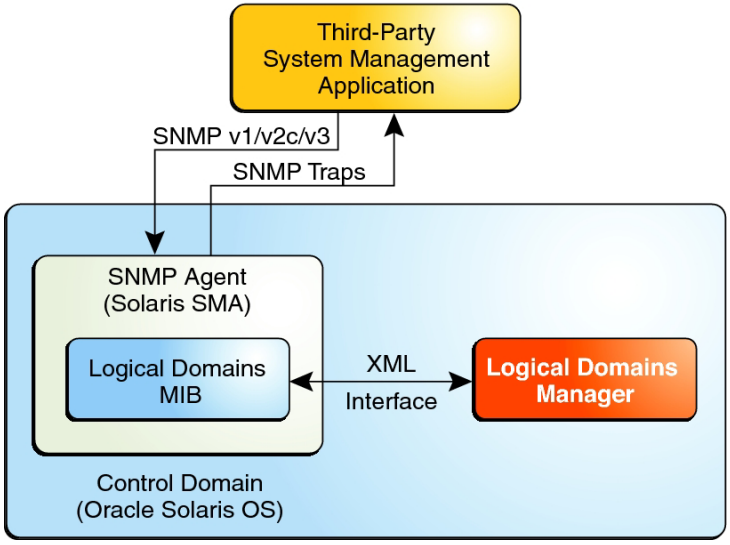
Software Components

The Oracle VM Server for SPARC MIB package, `SUNWldmib.v`, contains the following software components:

- `SUN-LDOM-MIB.mib` is an SNMP MIB in the form of a text file. This file defines the objects in the Oracle VM Server for SPARC MIB.
- `ldomMIB.so` is a System Management Agent extension module in the form of a shared library. This module enables the Oracle Solaris SNMP agent to respond to requests for information that are specified in the Oracle VM Server for SPARC MIB and to generate traps.

The following figure shows the interaction between the Oracle VM Server for SPARC MIB, the Oracle Solaris SNMP agent, the Logical Domains Manager, and a third-party system management application. The interaction shown in this figure is described in "System Management Agent" on page 345 and "Logical Domains Manager and the Oracle VM Server for SPARC MIB" on page 346.

FIGURE 17–1 Oracle VM Server for SPARC MIB Interaction With Oracle Solaris SNMP Agent, Logical Domains Manager, and a Third-Party System Management Application



System Management Agent

The Oracle Solaris SNMP agent performs the following functions:

- Listens for requests from a third-party system management application to get or set data offered by the Oracle VM Server for SPARC MIB. The agent listens on the standard SNMP port, `161`.
- Issues traps to the configured system management application by using the standard port for SNMP notifications, `162`.

The Oracle VM Server for SPARC MIB is exported by the Oracle Solaris OS default Oracle Solaris SNMP agent on the control domain.

The Oracle Solaris SNMP agent supports the get, set, and trap functions of SNMP versions v1, v2c, and v3. Most Oracle VM Server for SPARC MIB objects are read-only for monitoring purposes. However, to start or stop a domain, you must write a value to the `ldomAdminState` property of the `ldomTable` table. See Table 17–1.

Logical Domains Manager and the Oracle VM Server for SPARC MIB

A *domain* is a container that consists of a set of virtual resources for a guest operating system. The Logical Domains Manager provides the command-line interface (CLI) for creating, configuring, and managing the domains. The Logical Domains Manager and the Oracle VM Server for SPARC MIB support the following virtual resources:

- CPUs
- Memory
- Disk, network, and console I/O
- Cryptographic units

Parsing the XML-Based Control Interface

The Logical Domains Manager exports an XML-based control interface to the Oracle VM Server for SPARC MIB. The Oracle VM Server for SPARC MIB parses the XML interface and populates the MIB. The Oracle VM Server for SPARC MIB only provides support for the control domain.

Providing SNMP Traps

The Oracle VM Server for SPARC MIB polls the Logical Domains Manager periodically for updates or status changes, and then issues SNMP traps to the system management applications.

Providing Fault and Recovery Information

If the Oracle VM Server for SPARC MIB can no longer allocate a needed resource, the MIB returns a general error to the system management application through the SNMP agent. The SNMP trap-delivery mechanism does not confirm the error. No specific state or checkpointing is implemented in the Oracle VM Server for SPARC MIB. The Oracle Solaris SNMP agent with the Oracle VM Server for SPARC MIB is started and monitored by the `init` process and the Service Management Facility (SMF). If the Oracle Solaris SNMP agent fails and exits, SMF restarts the process automatically, and then the new process dynamically restarts the Oracle VM Server for SPARC MIB module.

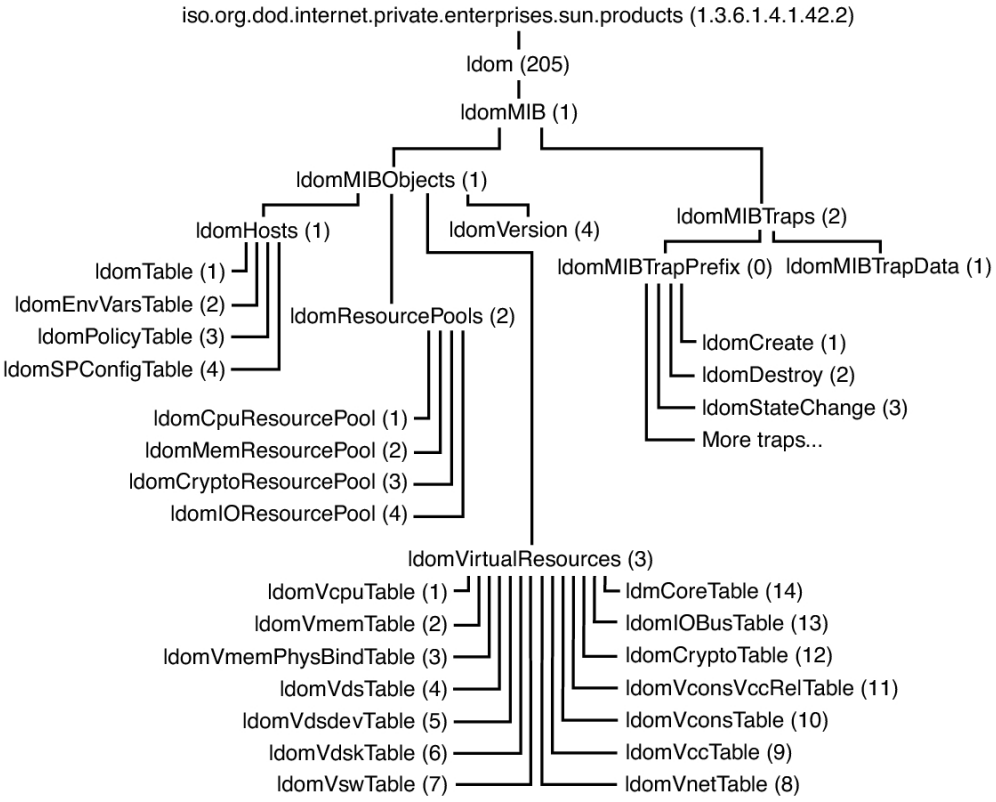
Oracle VM Server for SPARC MIB Object Tree

SNMP-managed objects are organized into a tree-like hierarchy. An object identifier (OID) consists of a series of integers based on the nodes in the tree, separated by dots. Each managed object has a numerical OID and an associated textual name. The Oracle VM Server for SPARC MIB is registered as the `ldom (205)` branch in this part of the object tree:

```
iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).sun(42).products(2)
```

The following figure shows the major subtrees under the Oracle VM Server for SPARC MIB.

FIGURE 17–2 Oracle VM Server for SPARC MIB Tree



Installing and Configuring the Oracle VM Server for SPARC MIB Software

This section covers the installation and configuration of the Oracle VM Server for SPARC MIB software on Oracle Solaris 10 and Oracle Solaris 11 systems. For information about administering SNMP, see the `snmpd.conf`(4) or `snmpd.conf`(5) man page.

Installing and Configuring the Oracle VM Server for SPARC MIB Software

The following table lists the tasks that you can use to install and configure the Oracle VM Server for SPARC MIB software.

Task	Description	For Instructions
Install the Oracle VM Server for SPARC MIB software package on the `primary` domain.	Use the `pkgadd` command to install the `SUNWldmib.v` package on an Oracle Solaris 10 system. Or, use the `pkg install` command to install the `system/ldoms/mib` package on an Oracle Solaris 11 system.	"How to Install the Oracle VM Server for SPARC MIB Software Package" on page 348
Load the Oracle VM Server for SPARC MIB module into the Oracle Solaris SNMP agent to query the Oracle VM Server for SPARC MIB.	Modify the SNMP configuration file to load the `ldomMIB.so` module.	"How to Load the Oracle VM Server for SPARC MIB Module Into the Oracle Solaris SNMP Agent" on page 349
Remove the Oracle VM Server for SPARC MIB software package from the `primary` domain.	Use the `pkgrm` command to remove the `SUNWldmib` package from an Oracle Solaris 10 system. Or, use the `pkg remove` command to remove the `system/ldoms/mib` package from an Oracle Solaris 11 system.	"How to Remove the Oracle VM Server for SPARC MIB Software Package" on page 350

▼ How to Install the Oracle VM Server for SPARC MIB Software Package

This procedure describes how to install the Oracle VM Server for SPARC MIB software package on Oracle Solaris 10 and Oracle Solaris 11 systems. The Oracle VM Server for SPARC MIB software package is included as part of the Oracle VM Server for SPARC 3.1 software.

The Oracle VM Server for SPARC MIB package includes the following files:

- `/opt/SUNWldmib/lib/mibs/SUN-LDOM-MIB.mib`
- `/opt/SUNWldmib/lib/ldomMIB.so`

Before You Begin Download and install the Oracle VM Server for SPARC 3.1 software. See Chapter 2, "Installing and Enabling Software."

1 Determine whether your system runs the Oracle Solaris 10 OS or the Oracle Solaris 11 OS.

```
# uname -r
```

2. **Install the Oracle VM Server for SPARC MIB software on the `primary` domain.**

   - **Oracle Solaris 10: Install the Oracle VM Server for SPARC MIB software package, `SUNWldmib`.**

     ```
     # pkgadd -d . SUNWldmib.v
     ```

   - **Oracle Solaris 11: Install the Oracle VM Server for SPARC MIB software package, `system/ldoms/mib`.**

     ```
     # pkg install -v -g IPS-package-directory/ldoms.repo mib
     ```

Next Steps After you install this package, you can configure your system to dynamically load the Oracle VM Server for SPARC MIB module. See "How to Load the Oracle VM Server for SPARC MIB Module Into the Oracle Solaris SNMP Agent" on page 349.

How to Load the Oracle VM Server for SPARC MIB Module Into the Oracle Solaris SNMP Agent

The Oracle VM Server for SPARC MIB module, `ldomMIB.so`, must be loaded into the Oracle Solaris SNMP agent to query the Oracle VM Server for SPARC MIB. The Oracle VM Server for SPARC MIB module is dynamically loaded so that the module is included within the SNMP agent without requiring you to recompile and relink the agent binary.

This procedure describes how to configure your system to dynamically load the Oracle VM Server for SPARC MIB module. Instructions for dynamically loading the module without restarting the Oracle Solaris SNMP agent are provided in *Solaris System Management Agent Developer's Guide*. For more information about the Oracle Solaris SNMP agent, see *Solaris System Management Administration Guide*.

1. **Determine whether your system runs the Oracle Solaris 10 OS or the Oracle Solaris 11 OS.**

   ```
   # uname -r
   ```

2. **Update the SNMP configuration file.**

   - **Oracle Solaris 10:**

     Append the following line to the `/etc/sma/snmp/snmpd.conf` configuration file:

     ```
     dlmod ldomMIB /opt/SUNWldmib/lib/ldomMIB.so
     ```

   - **Oracle Solaris 11:**

     Append the following line to the `/etc/net-snmp/snmp/snmpd.conf` configuration file:

     ```
     dlmod ldomMIB /opt/SUNWldmib/lib/ldomMIB.so
     ```

3. **Restart the SMF service.**

   - **Oracle Solaris 10:**

     ```
     # svcadm restart svc:/application/management/sma:default
     ```

- **Oracle Solaris 11:**

  ```
  # svcadm restart svc:/application/management/net-snmp:default
  ```

How to Remove the Oracle VM Server for SPARC MIB Software Package

This procedure describes how to remove the Oracle VM Server for SPARC MIB software package and unload the Oracle VM Server for SPARC MIB module from an Oracle Solaris 10 or Oracle Solaris 11 system.

1. **Stop the SMF service.**

   - **Oracle Solaris 10:**

     ```
     # svcadm disable svc:/application/management/sma:default
     ```

   - **Oracle Solaris 11:**

     ```
     # svcadm disable svc:/application/management/net-snmp:default
     ```

2. **Remove the Oracle VM Server for SPARC MIB software package from the `primary` domain.**

   - **Oracle Solaris 10:**

     ```
     # pkgrm SUNWldmib
     ```

   - **Oracle Solaris 11:**

     ```
     # pkg uninstall system/ldoms/mib
     ```

3. **Update the SNMP configuration file.**

   - **Oracle Solaris 10:**

     Remove the line that you added to the `/etc/sma/snmp/snmpd.conf` file during installation.

     ```
     dlmod ldomMIB /opt/SUNWldmib/lib/ldomMIB.so
     ```

   - **Oracle Solaris 11:**

     Remove the line that you added to the `/etc/net-snmp/snmp/snmpd.conf` file during installation.

     ```
     dlmod ldomMIB /opt/SUNWldmib/lib/ldomMIB.so
     ```

4. **Restart the SMF service.**

   - **Oracle Solaris 10:**

     ```
     # svcadm restart svc:/application/management/sma:default
     ```

   - **Oracle Solaris 11:**

     ```
     # svcadm restart svc:/application/management/net-snmp:default
     ```

Managing Security

This section describes how to create new Simple Network Management Protocol (SNMP) version 3 (v3) users to provide secure access to the Oracle Solaris SNMP agent. For SNMP version 1 (v1) and version 2 (v2c), the access control mechanism is the *community string*, which defines the relationship between an SNMP server and its clients. This string controls the client access to the server similar to a password controlling a user's access to a system. See *Solaris System Management Agent Administration Guide*.

Note – Creating `snmpv3` users enables you to use the Oracle Solaris SNMP agent in SNMP with the Oracle VM Server for SPARC MIB. This type of user does not interact with or conflict with users that you might have configured by using the rights feature of Oracle Solaris for the Logical Domains Manager.

▼ How to Create the Initial snmpv3 User

This procedure describes how to create the initial `snmpv3` user on an Oracle Solaris 10 or Oracle Solaris 11 system.

You can create additional users by cloning this initial user. Cloning enables subsequent users to inherit the initial user's authentication and security types. You can change these types later.

When you clone the initial user, you set secret key data for the new user. You must know the passwords for the initial user and for the subsequent users that you configure. You can only clone one user at a time from the initial user. See "To Create Additional SNMPv3 Users with Security" in *Solaris System Management Agent Administration Guide* for your version of the Oracle Solaris OS.

1 Stop the Oracle Solaris SNMP agent.

- **Oracle Solaris 10:**

  ```
  # svcadm disable -t svc:/application/management/sma:default
  ```

- **Oracle Solaris 11:**

  ```
  # svcadm disable svc:/application/management/net-snmp:default
  ```

2 Create the initial user.

This step creates user *initial-user* with a password that you choose, *my-password*, and adds an entry to the `/etc/sma/snmp/snmpd.conf` file. This entry gives the initial user read and write access to the agent.

Note – Passwords must contain at least eight characters.

- **Oracle Solaris 10:**

  ```
  # /usr/sfw/bin/net-snmp-config --create-snmpv3-user -a my-password initial-user
  ```

- **Oracle Solaris 11:**

  ```
  # /usr/bin/net-snmp-config --create-snmpv3-user -a my-password initial-user
  ```

3. **Start the Oracle Solaris SNMP agent.**

   - **Oracle Solaris 10:**

     ```
     # svcadm enable svc:/application/management/sma:default
     ```

   - **Oracle Solaris 11:**

     ```
     # svcadm enable svc:/application/management/net-snmp:default
     ```

4. **Verify that the initial user has been created.**

   ```
   # snmpget -v 3 -u initial-user -l authNoPriv -a MD5 -A my-password localhost sysUpTime.0
   ```

Monitoring Domains

This section describes how to monitor logical domains (domains) by querying the Oracle VM Server for SPARC MIB. This section also provides descriptions of the various types of MIB output.

This section covers the following topics:

Setting Environment Variables

Before you can query the Oracle VM Server for SPARC MIB, you must set the `PATH`, `MIBDIRS`, and `MIBS` environment variables for the shell that you use. The values are different for Oracle Solaris 10 and Oracle Solaris 11.

- Oracle Solaris 10:
  - **For C shell users:**

    ```
    % setenv PATH /usr/sfw/bin:$PATH
    % setenv MIBDIRS /opt/SUNWldmib/lib/mibs:/etc/sma/snmp/mibs
    % setenv MIBS +SUN-LDOM-MIB
    ```

- **For Bourne and Korn shell users:**

```
$ PATH=/usr/sfw/bin:$PATH; export PATH
$ MIBDIRS=/opt/SUNWldmib/lib/mibs:/etc/sma/snmp/mibs; export MIBDIRS
$ MIBS=+SUN-LDOM-MIB; export MIBS
```

- Oracle Solaris 11:
  - **For C shell users:**

```
% setenv PATH /usr/bin:$PATH
% setenv MIBDIRS /opt/SUNWldmib/lib/mibs:/etc/net-snmp/snmp/mibs
% setenv MIBS +SUN-LDOM-MIB
```

  - **For Bourne and Korn shell users:**

```
$ PATH=/usr/bin:$PATH; export PATH
$ MIBDIRS=/opt/SUNWldmib/lib/mibs:/etc/net-snmp/snmp/mibs; export MIBDIRS
$ MIBS=+SUN-LDOM-MIB; export MIBS
```

Querying the Oracle VM Server for SPARC MIB

When a system has large number of domains, the SNMP agent might time out before being able to respond to an SNMP request. To increase the timeout value, use the `-t` option to specify a longer timeout value. For example, the following `snmpwalk` command sets the timeout value to 20 seconds:

```
# snmpwalk -t 20 -v1 -c public localhost SUN-LDOM-MIB::ldomTable
```

You can also use the `-t` option to specify the timeout value for the `snmpget` and `snmptable` commands.

- To retrieve a single MIB object:

  `# snmpget -v` *version* `-c` *community-string host MIB-object*

- To retrieve an array of MIB objects:

  Use the `snmpwalk` or `snmptable` command.

  `# snmpwalk -v` *version* `-c` *community-string host MIB-object*
  `# snmptable -v` *version* `-c` *community-string host MIB-object*

EXAMPLE 17–1 Retrieving a Single Oracle VM Server for SPARC MIB Object (`snmpget`)

The following `snmpget` command queries the value of the `ldomVersionMajor` object. The command specifies `snmpv1` (`-v1`) and a community string (`-c public`) for the `localhost` host.

```
# snmpget -v1 -c public localhost SUN-LDOM-MIB::ldomVersionMajor.0
SUN-LDOM-MIB::ldomVersionMajor.0 = INTEGER: 1
```

EXAMPLE 17–2 Retrieving Object Values From ldomTable (`snmpwalk`)

The following examples show how to use the `snmpwalk` command to retrieve object values from `ldomTable`.

- The following `snmpwalk -v1` command returns the values for all objects in the `ldomTable` table.

```
# snmpwalk -v1 -c public localhost SUN-LDOM-MIB::ldomTable
SUN-LDOM-MIB::ldomName.1 = STRING: primary
SUN-LDOM-MIB::ldomName.2 = STRING: LdomMibTest_1
SUN-LDOM-MIB::ldomAdminState.1 = INTEGER: 0
SUN-LDOM-MIB::ldomAdminState.2 = INTEGER: 0
SUN-LDOM-MIB::ldomOperState.1 = INTEGER: active(1)
SUN-LDOM-MIB::ldomOperState.2 = INTEGER: bound(6)
SUN-LDOM-MIB::ldomNumVCpu.1 = INTEGER: 8
SUN-LDOM-MIB::ldomNumVCpu.2 = INTEGER: 4
SUN-LDOM-MIB::ldomMemSize.1 = INTEGER: 3360
SUN-LDOM-MIB::ldomMemSize.2 = INTEGER: 256
SUN-LDOM-MIB::ldomMemUnit.1 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomMemUnit.2 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomNumCrypto.1 = INTEGER: 1
SUN-LDOM-MIB::ldomNumCrypto.2 = INTEGER: 0
SUN-LDOM-MIB::ldomNumIOBus.1 = INTEGER: 2
SUN-LDOM-MIB::ldomNumIOBus.2 = INTEGER: 0
SUN-LDOM-MIB::ldomUUID.1 = STRING: 5f8817d4-5d2e-6f7d-c4af-91b5b34b5723
SUN-LDOM-MIB::ldomUUID.2 = STRING: 11284146-87ca-4877-8d80-cd0f60d5ec26
SUN-LDOM-MIB::ldomMacAddress.1 = STRING: 00:14:4f:46:47:d6
SUN-LDOM-MIB::ldomMacAddress.2 = STRING: 00:14:4f:f8:d5:6c
SUN-LDOM-MIB::ldomHostID.1 = STRING: 0x844647d6
SUN-LDOM-MIB::ldomHostID.2 = STRING: 0x84f8d56c
SUN-LDOM-MIB::ldomFailurePolicy.1 = STRING: ignore
SUN-LDOM-MIB::ldomFailurePolicy.2 = STRING: ignore
SUN-LDOM-MIB::ldomMaster.1 = STRING:
SUN-LDOM-MIB::ldomMaster.2 = STRING:
SUN-LDOM-MIB::ldomExtMapinSpace.1 = STRING: off
SUN-LDOM-MIB::ldomExtMapinSpace.2 = STRING: off
SUN-LDOM-MIB::ldomThreading.1 = STRING: max-throughput
SUN-LDOM-MIB::ldomThreading.2 = STRING: max-throughput
SUN-LDOM-MIB::ldomWholeCore.1 = INTEGER: 0
SUN-LDOM-MIB::ldomWholeCore.2 = INTEGER: 0
SUN-LDOM-MIB::ldomCpuArch.1 = STRING: native
SUN-LDOM-MIB::ldomCpuArch.2 = STRING: native
SUN-LDOM-MIB::ldomShutdownGroup.1 = INTEGER: 0
SUN-LDOM-MIB::ldomShutdownGroup.2 = INTEGER: 15
```

- The following `snmpwalk` commands use `snmpv2c` and `snmpv3` to retrieve the contents of `ldomTable`:

```
# snmpwalk -v2c -c public localhost SUN-LDOM-MIB::ldomTable
# snmpwalk -v 3 -u test -l authNoPriv -a MD5 -A testpassword localhost \
SUN-LDOMMIB::ldomTable
```

EXAMPLE 17–3 Retrieving Object Values From ldomTable in Tabular Form (`snmptable`)

The following examples show how to use the `snmptable` command to retrieve object values from `ldomTable` in tabular form.

- The following `snmptable -v1` command shows the contents of `ldomTable` in tabular form.

EXAMPLE 17–3 Retrieving Object Values From ldomTable in Tabular Form (`snmptable`) *(Continued)*

```
# snmptable -v1 -c public localhost SUN-LDOM-MIB::ldomTable
```

- The following `snmptable` command shows the contents of `ldomTable` in tabular form by using `snmpv2c`.

  Note that for the `v2c` or `v3` `snmptable` command, use the `-CB` option to specify only `GETNEXT`, not `GETBULK`, requests to retrieve data.

  ```
  # snmptable -v2c -CB -c public localhost SUN-LDOM-MIB::ldomTable
  ```

Retrieving Oracle VM Server for SPARC MIB Information

This section describes the information that you can retrieve from the Oracle VM Server for SPARC MIB in the form of tables or scalar objects.

Domain Table (ldomTable)

`ldomTable` is used to represent each domain in the system. Information includes resource constraints for virtual CPUs, memory, cryptographic units, and I/O buses. The table also includes other domain information, such as the universally unique identifier (UUID), MAC address, host ID, failure policy, and master domain.

TABLE 17–1 Domain Table (ldomTable)

Name	Data Type	Access	Description
`ldomIndex`	Integer	Not accessible	Integer that is used as an index of this table
`ldomName`	Display string	Read-only	Name of the domain
`ldomAdminState`	Integer	Read/Write	Starts or stops the domain for active management: ■ Value of 1 starts the domain ■ Value of 2 stops the domain
`ldomOperState`	Integer	Read-only	Current state of the domain, which can be one of the following values: ■ 1 is the Active state ■ 2 is the Stopping state ■ 3 is the Inactive state ■ 4 is the Binding state ■ 5 is the Unbinding state ■ 6 is the Bound state ■ 7 is the Starting state

TABLE 17–1 Domain Table (ldomTable) *(Continued)*

Name	Data Type	Access	Description
`ldomNumVCPU`	Integer	Read-only	Number of virtual CPUs used. If the domain is in an inactive state, this value is the requested number of virtual CPUs.
`ldomMemSize`	Integer	Read-only	Amount of virtual memory used. If the domain is in an inactive state, this value is the requested memory size.
`ldomMemUnit`	Integer	Read-only	One of the following memory units: ■ 1 is KB ■ 2 is MB ■ 3 is GB ■ 4 is bytes If not specified, the unit value is bytes.
`ldomNumCrypto`	Integer	Read-only	Number of cryptographic units used. If the domain is in an inactive state, this value is the requested number of cryptographic units.
`ldomNumIOBus`	Integer	Read-only	Number of physical I/O devices used
`ldomUUID`	Display string	Read-only	UUID of the domain
`ldomMacAddress`	Display string	Read-only	MAC address of the domain
`ldomHostID`	Display string	Read-only	Host ID of the domain
`ldomFailurePolicy`	Display string	Read-only	Master domain's failure policy, which can be one of `ignore`, `panic`, `reset`, or `stop`
`ldomMaster`	Display string	Read-only	Name of up to four master domains for a slave domain
`ldomExtMapinSpace`	Display string	Read-only	Extended mapin space for a domain. The extended mapin space refers to the additional LDC shared memory space. This memory space is required to support a large number of virtual I/O devices that use direct-mapped shared memory. This space is also used by virtual network devices to improve performance and scalability. The default value is `off`.

TABLE 17–1 Domain Table (ldomTable) *(Continued)*

Name	Data Type	Access	Description
`ldomThreading`	Display string	Read-only	Specifies the high instructions per cycle (IPC) threading control for a domain. The dynamic threading provides control over the number of hardware threads activated per core. Valid values are: ■ `max-throughput`, which means that all strands per core are active (default value) ■ `max-ipc`, which means that one strand per core is active
`ldomWholeCore`	Integer	Read-only	Constrains the domain to use whole-cores only. If the whole-core constraint is not enabled, the value is `0`. Otherwise, the value shows the number of max-cores.
`ldomCpuArch`	Display string	Read-only	CPU architecture for a domain. The CPU architecture specifies whether the domain can be migrated to another `sun4v` CPU architecture. Valid values are: ■ `native`, which means that the domain is permitted to be migrated only to platforms of the same `sun4v` CPU architecture (default value) ■ `generic`, which means that the domain is permitted to be migrated to all compatible `sun4v` CPU architectures
`ldomShutdownGroup`	Integer	Read-only	Shutdown-group number for a guest domain. On a SPARC64-X system, an SP-initiated ordered shutdown will shut down domains in descending order of their shutdown-group numbers, from `15` to `0`. The default value is `15`.

Environment Variables Table (ldomEnvVarsTable)

`ldomEnvVarsTable` describes the OpenBoot PROM environment variables that all domains use.

TABLE 17–2 Environment Variables Table (ldomEnvVarsTable)

Name	Data Type	Access	Description
`ldomEnvVarsLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the OpenBoot PROM environment variables
`ldomEnvVarsIndex`	Integer	Read-only	Integer that is used to index the OpenBoot PROM environment variables in this table
`ldomEnvVarsName`	Display string	Read-only	Name of the OpenBoot PROM variable
`ldomEnvVarsValue`	Display string	Read-only	Value of the OpenBoot PROM variable

Domain Policy Table (ldomPolicyTable)

`ldomPolicyTable` describes the dynamic resource management (DRM) policies that apply to all domains.

TABLE 17–3 Domain Policy Table (ldomPolicyTable)

Name	Data Type	Access	Description
`ldomPolicyLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the DRM policy
`ldomPolicyIndex`	Integer	Not accessible	Integer that is used to index the DRM policy in this table
`ldomPolicyName`	Display string	Read-only	Policy name
`ldomPolicyStatus`	Display string	Read-only	Policy status
`ldomPolicyPriority`	Integer	Read-only	Priority that is used to determine which DRM policy is selected when policies overlap
`ldomPolicyVcpuMin`	Integer	Read-only	Minimum number of virtual CPUs for a domain
`ldomPolicyVcpuMax`	Integer	Read-only	Maximum number of virtual CPUs for a domain. A value of `unlimited` uses the maximum integer value of 2147483647.
`ldomPolicyUtilLower`	Integer	Read-only	Lower utilization level at which policy analysis is triggered
`ldomPolicyUtilUpper`	Integer	Read-only	Upper utilization level at which policy analysis is triggered

TABLE 17–3 Domain Policy Table (ldomPolicyTable) *(Continued)*

Name	Data Type	Access	Description
`ldomPolicyTodBegin`	Display string	Read-only	Effective start time of a policy with a format of *hh*:*mm*:[*ss*]
`ldomPolicyTodEnd`	Display string	Read-only	Effective stop time of a policy with a format of *hh*:*mm*:[*ss*]
`ldomPolicySampleRate`	Integer	Read-only	Resource cycle time in seconds
`ldomPolicyElasticMargin`	Integer	Read-only	Amount of buffer between `util-lower` property (`ldomPolicyUtilLower`) and the number of free virtual CPUs to avoid oscillations at low virtual CPU counts
`ldomPolicyAttack`	Integer	Read-only	Maximum amount of a resource to be added during any one resource-control cycle. A value of `unlimited` uses the maximum integer value of 2147483647.
`ldomPolicyDecay`	Integer	Read-only	Maximum amount of a resource to be removed during any one resource-control cycle

Service Processor Configuration Table (ldomSPConfigTable)

`ldomSPConfigTable` describes the service processor (SP) configurations for all domains.

TABLE 17–4 Service Processor Configuration Table (ldomSPConfigTable)

Name	Data Type	Access	Description
`ldomSPConfigIndex`	Integer	Not accessible	Integer that is used to index an SP configuration in this table
`ldomSPConfigName`	Display string	Read-only	SP configuration name
`ldomSPConfigStatus`	Display string	Read-only	SP configuration status

Domain Resource Pool and Scalar Variables

The following resources can be assigned to domains:

- Virtual CPU (`vcpu`)
- Memory (`mem`)
- Cryptographic unit (`mau`)
- Virtual switch (`vsw`)
- Virtual network (`vnet`)
- Virtual disk server (`vds`)
- Virtual disk server device (`vdsdev`)
- Virtual disk (`vdisk`)

- Virtual console concentrator (`vcc`)
- Virtual console (`vcons`)
- Physical I/O device (`io`)

The following scalar MIB variables are used to represent resource pools and their properties.

TABLE 17–5 Scalar Variables for CPU Resource Pool

Name	Data Type	Access	Description
`ldomCpuRpCapacity`	Integer	Read-only	Maximum reservation allowed by the resource pool in `ldomCpuRpCapacityUnits`
`ldomCpuRpReserved`	Integer	Read-only	Accumulated processor clock speed of the CPU, in MHz, that is currently reserved from the resource pool
`ldomCpuRpCapacityUnit` and `ldomCpuRpReservedUnit`	Integer	Read-only	One of the following CPU allocation units: ■ 1 is MHz ■ 2 is GHz The default value is MHz.

TABLE 17–6 Scalar Variables for Memory Resource Pool

Name	Data Type	Access	Description
`ldomMemRpCapacity`	Integer	Read-only	Maximum reservation allowed by the resource pool in `MemRpCapacityUnits`
`ldomMemRpReserved`	Integer	Read-only	Amount of memory, in `MemRpReservedUnits`, that is currently reserved from the resource pool
`ldomMemRpCapacityUnit` and `ldomMemRpReservedUnit`	Integer	Read-only	One of the following memory allocation units: ■ 1 is KB ■ 2 is MB ■ 3 is GB ■ 4 is bytes If not specified, the unit value is bytes.

TABLE 17–7 Scalar Variables for Cryptographic Resource Pool

Name	Data Type	Access	Description
`ldomCryptoRpCapacity`	Integer	Read-only	Maximum reservation allowed by the resource pool

TABLE 17–7 Scalar Variables for Cryptographic Resource Pool *(Continued)*

Name	Data Type	Access	Description
`ldomCryptoRpReserved`	Integer	Read-only	Number of cryptographic units that is currently reserved from the resource pool

TABLE 17–8 Scalar Variables for I/O Bus Resource Pool

Name	Data Type	Access	Description
`ldomIOBusRpCapacity`	Integer	Read-only	Maximum reservation allowed by the pool
`ldomIOBusRpReserved`	Integer	Read-only	Number of I/O buses that is currently reserved from the resource pool

Virtual CPU Table (ldomVcpuTable)

`ldomVcpuTable` describes the virtual CPUs that all domains use.

TABLE 17–9 Virtual CPU Table (ldomVcpuTable)

Name	Data Type	Access	Description
`ldomVcpuLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual CPU
`ldomVcpuIndex`	Integer	Not accessible	Integer that is used to index the virtual CPU in this table
`ldomVcpuDeviceID`	Display string	Read-only	Identifier of the virtual CPU (VID)

TABLE 17–9 Virtual CPU Table (ldomVcpuTable) *(Continued)*

Name	Data Type	Access	Description
`ldomVcpuOperationalStatus`	Integer	Read-only	One of the following CPU statuses: 1=Unknown 2=Other 3=OK 4=Degraded 5=Stressed 6=Predictive failure 7=Error 8=Nonrecoverable error 9=Starting 10=Stopping 11=Stopped 12=In service 13=No contact 14=Lost communication 15=Aborted 16=Dormant 17=Supporting entity in error 18=Completed 19=Power mode The default value is 1 (Unknown) because the Logical Domains Manager does not provide the CPU state.
`ldomVcpuPhysBind`	Display string	Read-only	Physical binding (PID). Contains the identifier of a hardware thread (strand) that is assigned to this virtual CPU. This identifier uniquely identifies the core and the chip.

TABLE 17–9 Virtual CPU Table (ldomVcpuTable) *(Continued)*

Name	Data Type	Access	Description
`ldomVcpuPhysBindUsage`	Integer	Read-only	Indicates how much (in MHz) of the total capacity of the thread is used by this virtual CPU. For example, assume a thread can run at a maximum of one GHz. If only half of that capacity is allocated to this virtual CPU (50% of the thread), the property value is 500.
`ldomVcpuCoreID`	Display string	Read-only	Identifier of the core (core ID).
`ldomVcpuUtilPercent`	Display string	Read-only	Indicates the utilization percentage of the virtual CPU.

Virtual Memory Tables

A domain's memory space is referred to as *real memory*, that is, *virtual memory*. Host platform memory space that is detected by the hypervisor is referred to as *physical memory*. The hypervisor maps blocks of physical memory to form a block of real memory that is used by a domain.

The following example shows that the requested memory size can be split between two memory blocks instead of being assigned to a single large memory block. Assume that a domain requests 521 Mbytes of real memory. The memory can be assigned two 256-Mbyte blocks on the host system as physical memory by using the {*physical-address*, *real-address*, *size*} format.

```
{0x1000000, 0x1000000, 256}, {0x2000000, 0x2000000,256}
```

A domain can have up to 64 physical memory segments assigned to a guest domain. Therefore, an auxiliary table is used to hold each memory segment instead of a display string. A display string has a 255-character limit.

Virtual Memory Table (ldomVmemTable)

`ldomVmemTable` describes the properties of virtual memory that domains use.

TABLE 17–10 Virtual Memory Table (ldomVmemTable)

Name	Data Type	Access	Description
`ldomVmemLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual memory
`ldomVmemIndex`	Integer	Not accessible	Integer that is used to index the virtual memory in this table

TABLE 17–10 Virtual Memory Table (ldomVmemTable) *(Continued)*

Name	Data Type	Access	Description
`ldomVmemNumberofBlocks`	Integer	Read-only	Number of blocks of virtual memory

Virtual Memory Physical Binding Table (ldomVmemPhysBindTable)

`ldomVmemPhysBindTable` is an auxiliary table that contains physical memory segments for all domains.

TABLE 17–11 Virtual Memory Physical Binding Table (ldomVmemPhysBindTable)

Name	Data Type	Access	Description
`ldomVmemPhysBindLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the physical memory segments
`ldomVmemPhysBind`	Display string	Read-only	List of physical memory that is mapped to this virtual memory block in the following format: {*physical-address*, *real-address*, *size*}

Virtual Disk Tables

A virtual disk service (`vds`) and the physical device to which it maps (`vdsdev`) provide the virtual disk capability to the Oracle VM Server for SPARC technology. A virtual disk service exports a number of local volumes (physical disks or file systems). When a virtual disk service is specified, the following are included:

- Complete `/dev` path of the backing device (`vdsdev`)
- Unique name (volume name) for the device being added to the service

One or more disks, disk slices, and file systems can be bound to a single disk service. Each disk has a unique name and volume name. The volume name is used when the disk is bound to the service. The Logical Domains Manager creates virtual disk clients (`vdisk`) from the virtual disk service and its logical volumes.

Virtual Disk Service Table (ldomVdsTable)

`ldomVdsTable` describes the virtual disk services for all domains.

TABLE 17–12 Virtual Disk Service Table (ldomVdsTable)

Name	Data Type	Access	Description
`ldomVdsLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual disk service

TABLE 17–12 Virtual Disk Service Table (ldomVdsTable) *(Continued)*

Name	Data Type	Access	Description
`ldomVdsIndex`	Integer	Not accessible	Integer that is used to index the virtual disk service in this table
`ldomVdsServiceName`	Display string	Read-only	Service name for the virtual disk service. The property value is the *service-name* specified by the `ldm add-vds` command.
`ldomVdsNumofAvailVolume`	Integer	Read-only	Number of logical volumes exported by this virtual disk service
`ldomVdsNumofUsedVolume`	Integer	Read-only	Number of logical volumes used (bound) to this virtual disk service

Virtual Disk Service Device Table (ldomVdsdevTable)

`ldomVdsdevTable` describes the virtual disk service devices that all virtual disk services use.

TABLE 17–13 Virtual Disk Service Device Table (ldomVdsdevTable)

Name	Data Type	Access	Description
`ldomVdsdevVdsIndex`	Integer	Read-only	Integer that is used to index into `ldomVdsTable` that represents the virtual disk service that contains the virtual disk device
`ldomVdsdevIndex`	Integer	Not accessible	Integer that is used to index the virtual disk service device in this table
`ldomVdsdevVolumeName`	Display string	Read-only	Volume name for the virtual disk service device. This property specifies a unique name for the device that is being added to the virtual disk service. This name is exported by the virtual disk service to the clients for the purpose of adding this device. The property value is the *volume-name* specified by the `ldm add-vdsdev` command.
`ldomVdsdevDevPath`	Display string	Read-only	Path name of the physical disk device. The property value is the *backend* specified by the `ldm add-vdsdev` command.
`ldomVdsdevOptions`	Display string	Read-only	One or more of the options for the disk device, which are `ro`, `slice`, or `excl`
`ldomVdsdevMPGroup`	Display string	Read-only	Multipath group name for the disk device

Virtual Disk Table (ldomVdiskTable)

`ldomVdiskTable` describes the virtual disks for all domains.

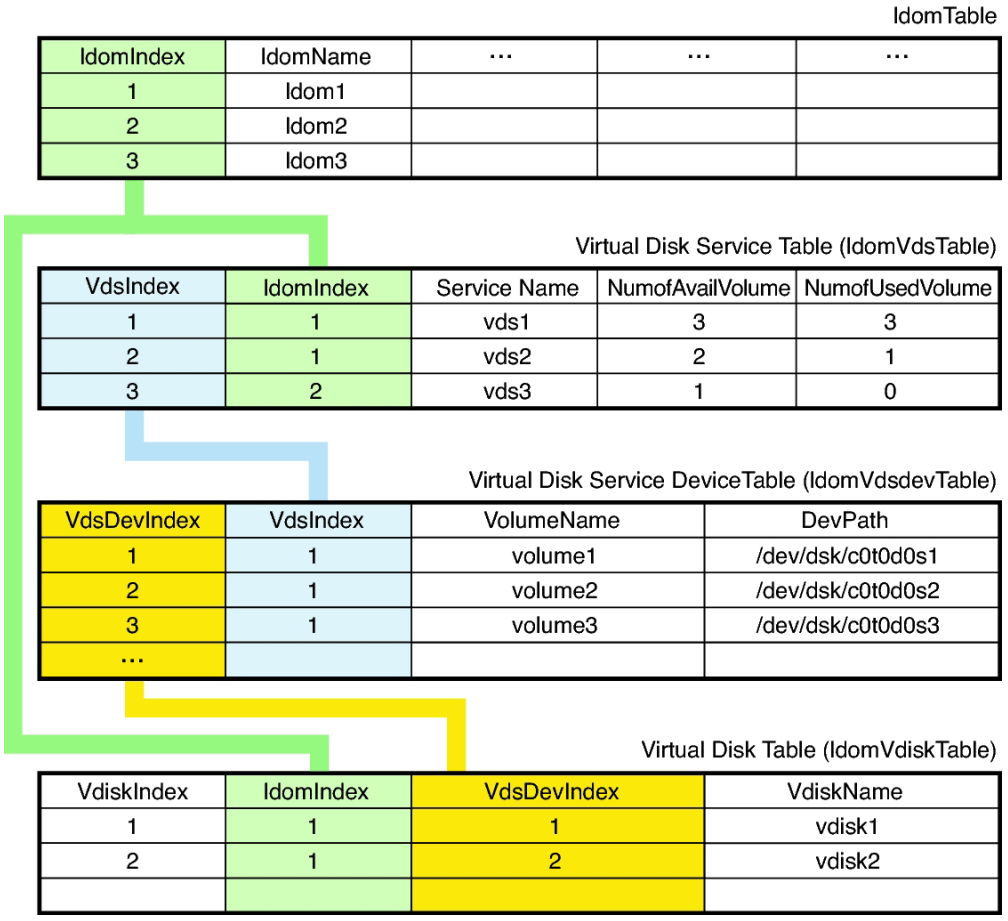
TABLE 17–14 Virtual Disk Table (ldomVdiskTable)

Name	Data Type	Access	Description
`ldomVdiskLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual disk device
`ldomVdiskVdsDevIndex`	Integer	Read-only	Integer that is used to index into `ldomVdsdevTable` that represents the virtual disk service device
`ldomVdiskIndex`	Integer	Not accessible	Integer that is used to index the virtual disk in this table
`ldomVdiskName`	Display string	Read-only	Name of the virtual disk. The property value is the *disk-name* specified by the `ldm add-vdisk` command.
`ldomVdiskTimeout`	Integer	Read-only	Timeout, in seconds, for establishing a connection between a virtual disk client and a virtual disk server
`ldomVdiskID`	Display string	Read-only	Identifier of the virtual disk

The following figure shows how indexes are used to define relationships among the virtual disk tables and the domain table. The indexes are used as follows:

- `ldomIndex` in `ldomVdsTable` and `ldomVdiskTable` points to `ldomTable`.
- `VdsIndex` in `ldomVdsdevTable` points to `ldomVdsTable`.
- `VdsDevIndex` in `ldomVdiskTable` points to `ldomVdsdevTable`.

FIGURE 17–3 Relationship Among Virtual Disk Tables and the Domain Table



Virtual Network Tables

Oracle VM Server for SPARC virtual network support enables guest domains to communicate with each other and with external hosts through a physical Ethernet device. The virtual network contains the following main components:

- Virtual switch (`vsw`)
- Virtual network device (`vnet`)

After you create a virtual switch on a service domain, you can bind a physical network device to the virtual switch. After that, you can create a virtual network device for a domain that uses the virtual switch service for communication. The virtual switch service communicates with other domains by connecting to the same virtual switch. The virtual switch service communicates with external hosts if a physical device is bound to the virtual switch.

Virtual Switch Service Table (ldomVswTable)

`ldomVswTable` describes the virtual switch services for all domains.

TABLE 17–15 Virtual Switch Service Table (ldomVswTable)

Name	Data Type	Access	Description
`ldomVswLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual switch service
`ldomVswIndex`	Integer	Not accessible	Integer that is used to index the virtual switch device in this table
`ldomVswServiceName`	Display string	Read-only	Virtual switch service name
`ldomVswMacAddress`	Display string	Read-only	MAC address used by the virtual switch
`ldomVswPhysDevPath`	Display string	Read-only	Physical device path for the virtual network switch. The property value is null when no physical device is bound to the virtual switch.
`ldomVswMode`	Display string	Read-only	Value is `mode=sc` for running cluster nodes
`ldomVswDefaultVlanID`	Display string	Read-only	Default VLAN ID for the virtual switch
`ldomVswPortVlanID`	Display string	Read-only	Port VLAN ID for the virtual switch
`ldomVswVlanID`	Display string	Read-only	VLAN ID for the virtual switch
`ldomVswLinkprop`	Display string	Read-only	Value is `linkprop=phys-state` to report the link status based on the physical network device
`ldomVswMtu`	Integer	Read-only	Maximum transmission unit (MTU) for a virtual switch device
`ldomVswID`	Display string	Read-only	Identifier of the virtual switch device
`ldomVswInterVnetLink`	Display string	Read-only	State of LDC channel assignment for inter-vnet communications. Value is either `on` or `off`.

Virtual Network Device Table (ldomVnetTable)

`ldomVnetTable` describes the virtual network devices for all domains.

TABLE 17–16 Virtual Network Device Table (ldomVnetTable)

Name	Data Type	Access	Description
`ldomVnetLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual network device
`ldomVnetVswIndex`	Integer	Read-only	Integer that is used to index into the virtual switch service table
`ldomVnetIndex`	Integer	Not accessible	Integer that is used to index the virtual network device in this table
`ldomVnetDevName`	Display string	Read-only	Virtual network device name. The property value is the `net-dev` property specified by the `ldm add-vnet` command.
`ldomVnetDevMacAddress`	Display string	Read-only	MAC address for this network device. The property value is the `mac-addr` property specified by the `ldm add-vnet` command.
`ldomVnetMode`	Display string	Read-only	Value is `mode=hybrid` to use NIU hybrid I/O on the virtual network device
`ldomVnetPortVlanID`	Display string	Read-only	Port VLAN ID for the virtual network device
`ldomVnetVlanID`	Display string	Read-only	VLAN ID for the virtual network device
`ldomVnetLinkprop`	Display string	Read-only	Value is `linkprop=phys-state` to report the link status based on the physical network device
`ldomVnetMtu`	Integer	Read-only	MTU for a virtual network device
`ldomVnetID`	Display string	Read-only	Identifier of the virtual network device

Virtual Console Tables

The Oracle VM Server for SPARC service domain provides a virtual network terminal service (`vNTS`). `vNTS` provides a virtual console service, called a virtual console concentrator (`vcc`), with a range of port numbers. Each virtual console concentrator has multiple console groups (`vcons`), and each group is assigned a port number. Each group can contain multiple domains.

Virtual Console Concentrator Table (ldomVccTable)

`ldomVccTable` describes the virtual console concentrators for all domains.

TABLE 17–17 Virtual Console Concentrator Table (ldomVccTable)

Name	Data Type	Access	Description
`ldomVccLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the virtual console service
`ldomVccIndex`	Integer	Not accessible	Integer that is used to index the virtual console concentrator in this table
`ldomVccName`	Display string	Read-only	Virtual console concentrator name. The property value is the *vcc-name* specified by the `ldm add-vcc` command.
`ldomVccPortRangeLow`	Integer	Read-only	Low number for the range of TCP ports to be used by the virtual console concentrator. The property value is the *x* part of the `port-range` specified by the `ldm add-vcc` command.
`ldomVccPortRangeHigh`	Integer	Read-only	High number for the range of TCP ports to be used by the virtual console concentrator. The property value is the *y* part of the `port-range` specified by the `ldm add-vcc` command.

Virtual Console Group Table (ldomVconsTable)

`ldomVconsTable` describes the virtual console groups for all virtual console services. This table also shows whether console logging is enabled or disabled on each domain.

TABLE 17–18 Virtual Console Group Table (ldomVconsTable)

Name	Data Type	Access	Description
`ldomVconsIndex`	Integer	Not accessible	Integer that is used to index a virtual group in this table
`ldomVconsGroupName`	Display string	Read-only	Group name to which to attach the virtual console. The property value is the `group` specified by the `ldm set-vcons` command.
`ldomVconsLog`	Display string	Read-only	Console logging status. The property value is the string `on` or `off` as specified by the `ldm set-vcons` command. When a group contains more than one domain, this property shows the console logging status of the domain that has most recently been modified by the `ldm set-vcons` command.

TABLE 17–18 Virtual Console Group Table (ldomVconsTable) *(Continued)*

Name	Data Type	Access	Description
`ldomVconsPortNumber`	Integer	Read-only	Port number assigned to this group. The property value is the `port` specified by the `ldm set-vcons` command.

Virtual Console Relationship Table (ldomVconsVccRelTable)

`ldomVconsVccRelTable` contains index values to show the inter-table relationships among a domain, a virtual console concentrator, and console groups.

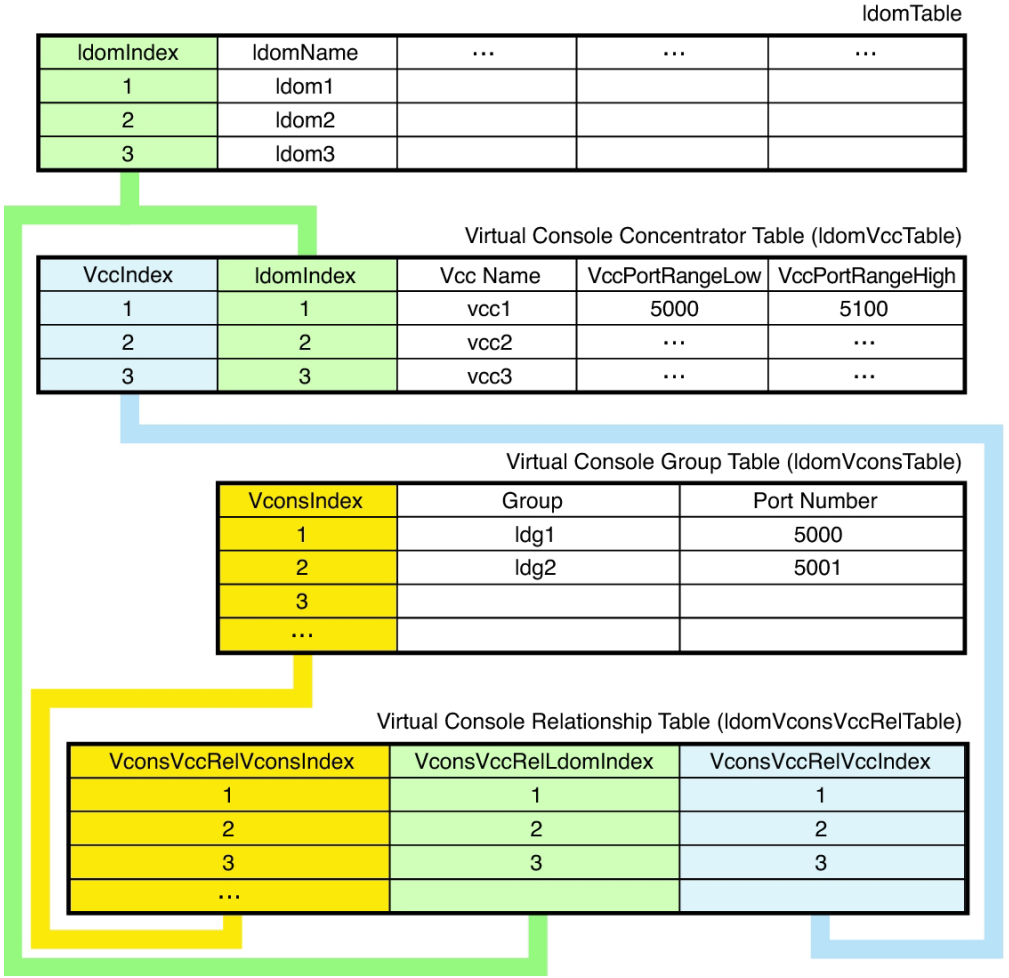
TABLE 17–19 Virtual Console Relationship Table (ldomVconsVccRelTable)

Name	Data Type	Access	Description
`ldomVconsVccRelVconsIndex`	Integer	Read-only	Value of `ldomVconsIndex` in `ldomVconsTable`
`ldomVconsVccRelLdomIndex`	Integer	Read-only	Value of `ldomIndex` in `ldomTable`
`ldomVconsVccRelVccIndex`	Integer	Read-only	Value of `ldomVccIndex` in `ldomVccTable`

The following figure shows how indexes are used to define relationships among the virtual console tables and the domain table. The indexes are used as follows:

- `ldomIndex` in `ldomVccTable` and `ldomVconsVccRelTable` points to `ldomTable`.
- `VccIndex` in `ldomVconsVccRelTable` points to `ldomVccTable`.
- `VconsIndex` in `ldomVconsVccRelTable` points to `ldomVconsTable`.

FIGURE 17–4 Relationship Among Virtual Console Tables and the Domain Table



Cryptographic Units Table (ldomCryptoTable)

`ldomCryptoTable` describes the cryptographic units that all domains use. A cryptographic unit is sometimes referred to as a modular arithmetic unit (MAU).

TABLE 17–20 Cryptographic Units Table (ldomCryptoTable)

Name	Data Type	Access	Description
`ldomCryptoLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the cryptographic unit

TABLE 17–20 Cryptographic Units Table (ldomCryptoTable) *(Continued)*

Name	Data Type	Access	Description
`ldomCryptoIndex`	Integer	Not accessible	Integer that is used to index the cryptographic unit in this table
`ldomCryptoCpuSet`	Display string	Read-only	List of CPUs that is mapped to `MAU-unit cpuset`. For example, `{0, 1, 2, 3}`.

I/O Bus Table (ldomIOBusTable)

`ldomIOBusTable` describes the physical I/O devices and PCI buses that all domains use.

TABLE 17–21 I/O Bus Table (ldomIOBusTable)

Name	Data Type	Access	Description
`ldomIOBusLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the I/O bus
`ldomIOBusIndex`	Integer	Not accessible	Integer that is used to index the I/O bus in this table
`ldomIOBusName`	Display string	Read-only	Physical l/O device name
`ldomIOBusPath`	Display string	Read-only	Physical I/O device path
`ldomIOBusOptions`	Display string	Read-only	Physical I/O device options

Core Table (ldomCoreTable)

`ldomCoreTable` describes the core information, such as `core-id` and `cpuset`, for all domains.

TABLE 17–22 Core Table (ldomCoreTable)

Name	Data Type	Access	Description
`ldomCoreLdomIndex`	Integer	Read-only	Integer that is used as an index into `ldomTable` that represents the domain that contains the core
`ldomCoreIndex`	Integer	Not accessible	Integer that is used to index a core in this table
`ldomCoreID`	Display string	Read-only	Identifier of a core (core ID)
`ldomCoreCpuSet`	Display string	Read-only	List of CPUs that is mapped to the core `cpuset`

Scalar Variables for Domain Version Information

The Logical Domains Manager protocol supports domain versions, which consists of a major number and a minor number. The Oracle VM Server for SPARC MIB has scalar variables to describe the domain version information.

TABLE 17–23 Scalar Variables for Domain Version Information

Name	Data Type	Access	Description
`ldomVersionMajor`	Integer	Read-only	Major version number
`ldomVersionMinor`	Integer	Read-only	Minor version number

The values for `ldomVersionMajor` and `ldomVersionMinor` are equivalent to the version shown by the `ldm list -p` command. For example:

```
$ ldm ls -p
VERSION 1.6
...

$ snmpget -v1 -c public localhost SUN-LDOM-MIB::ldomVersionMajor.0
SUN-LDOM-MIB::ldomVersionMajor.0 = INTEGER: 1

$ snmpget -v1 -c public localhost SUN-LDOM-MIB::ldomVersionMinor.0
SUN-LDOM-MIB::ldomVersionMinor.0 = INTEGER: 5
```

Using SNMP Traps

This section describes how to set up your system to send and receive traps. It also describes the traps that you can use to receive change notification for logical domains (domains), as well as other traps that you can use.

The Oracle VM Server for SPARC MIB provides the same SNMP traps for both Oracle Solaris 10 and Oracle Solaris 11. However, the `snmptrapd` daemon no longer automatically accepts all incoming traps for Oracle Solaris 11. Instead, the daemon must be configured with authorized SNMP v1 and v2c community strings, with SNMPv3 users, or both. Unauthorized traps or notifications are dropped. See the `snmptrapd.conf`(4) or `snmptrapd.conf`(5) man page.

Using Oracle VM Server for SPARC MIB Module Traps

The Oracle Solaris 11 MIB provides the same SNMP traps as are provided by the Oracle Solaris 10 MIB. However, the `net-snmp` versions are different and they must be configured in different ways. In Oracle Solaris 10 MIB, `snmptrapd` accepts all incoming notifications and automatically logs them. In Oracle Solaris 11 MIB, access control checks are applied to incoming notifications.

If `snmptrapd` runs without a suitable configuration file, or with equivalent access control settings, such traps are not processed. See the `snmptrapd.conf`(4) or `snmptrapd.conf`(5) man page.

How to Send Traps

1 Configure the trap.

- **Oracle Solaris 10:**

  Edit the `/etc/sma/snmp/snmpd.conf` file to add the directives to define the trap, inform version, and destination.

  ```
  trapcommunity string --> define community string to be used when sending traps
  trapsink host[community [port]] --> to send v1 traps
  trap2sink host[community [port]] --> to send v2c traps
  informsink host[community [port]] --> to send informs
  ```

  For more information, see the `snmpd.conf`(4) or `snmpd.conf`(5) man page.

- **Oracle Solaris 11:**

  Edit the `/etc/net-snmp/snmp/snmpd.conf` SNMP configuration file to add the directives to define the trap, inform version, and destination.

  ```
  trapcommunity string --> define community string to be used when sending traps
  trapsink host[community [port]] --> to send v1 traps
  trap2sink host[community [port]] --> to send v2c traps
  informsink host[community [port]] --> to send informs
  ```

  For more information, see the `snmpd.conf`(4) or `snmpd.conf`(5) man page.

  For example, the following directives use the `public` string as the community string when sending traps and indicate that the `v1` traps are sent to the `localhost` destination:

  ```
  trapcommunity public
  trapsink localhost
  ```

2 Configure access control settings by creating or editing the `/usr/etc/snmp/snmptrapd.conf` SNMP `trapd` configuration file.

The following example shows who is authorized to send traps (`public`) and how incoming traps should be processed (`log,execute,net`). See the `snmptrapd.conf`(4) or `snmptrapd.conf`(5) man page.

```
authCommunity log,execute,net public
```

3 To receive SNMP trap messages, start the SNMP trap daemon utility, `snmptrapd`.

Example 17–4 Sending SNMP v1 and v2c Traps

This example sends send both `v1` and `v2c` traps to the SNMP trap daemon that runs on the same host. Update the Oracle Solaris 10 `/etc/sma/snmp/snmpd.conf` file or the Oracle Solaris 11 `/etc/net-snmp/snmp/snmpd.conf` file with the following directives:

```
trapcommunity public
trapsink localhost
trap2sink localhost
```

▼ How to Receive Traps

- **Start the SNMP trap daemon utility.**

  - **Oracle Solaris 10:**

    For information about the output format options, see the `snmptrapd`(1M) man page.

    The `snmptrapd` utility is an SNMP application that receives and logs SNMP `TRAP` messages. For example, the following `snmptrapd` command shows that a new domain was created (`ldomTrapDesc = Ldom Created`) with a name of `ldg2` (`ldomName = ldg2`).

    ```
    # /usr/sfw/sbin/snmptrapd -P -F \
    "TRAP from %B on %m/%l/%y at %h:%j:%k Enterprise=%N Type=%w SubType=%q\n
    with Varbinds: %v\nSecurity info:%P\n\n" localhost:162
    TRAP from localhost on 5/18/2007 at 16:30:10 Enterprise=. Type=0 SubType=0
    with Varbinds: DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (47105)
    0:07:51.05 SNMPv2-MIB::snmpTrapOID.0 = OID: SUN-LDOM-MIB::ldomCreate
    SUN-LDOM-MIB::ldomIndexNotif = INTEGER: 3 SUN-LDOM-MIB::ldomName = STRING: ldg2
    SUN-LDOM-MIB::ldomTrapDesc = STRING: Ldom Created
    Security info:TRAP2, SNMP v2c, community public
    ```

    Note that the `-F` option argument string is broken on to two lines for readability purposes.

  - **Oracle Solaris 11:**

    For information about the output format options, see the `snmptrapd`(1M) man page.

    The `snmptrapd` utility is an SNMP application that receives and logs SNMP `TRAP` messages. For example, the following `snmptrapd` command shows that a new domain was created (`ldomTrapDesc = Ldom Created`) with a name of `ldg2` (`ldomName = ldg2`).

    ```
    # /usr/sbin/snmptrapd -f -Le -F \
    "TRAP from %B on %m/%l/%y at %h:%j:%k Enterprise=%N Type=%w SubType=%q\n
    with Varbinds: %v\nSecurity info:%P\n\n" localhost:162
    NET-SNMP version 5.4.1
    TRAP from localhost on 6/27/2012 at 12:13:48
    Enterprise=SUN-LDOM-MIB::ldomMIBTraps Type=6 SubType=SUN-LDOM-MIB::ldomCreate
    with Varbinds: SUN-LDOM-MIB::ldomIndexNotif = INTEGER: 3
    SUN-LDOM-MIB::ldomName = STRING: ldg2   SUN-LDOM-MIB::ldomTrapDesc = STRING:
    Ldom Created
    Security info:TRAP, SNMP v1, community public
    ```

    Note that the `-F` option argument string is broken on to two lines for readability purposes.

Oracle VM Server for SPARC MIB Trap Descriptions

This section describes the Oracle VM Server for SPARC MIB traps that you can use.

Domain Creation (ldomCreate)

This trap notifies you when any domains are created.

TABLE 17–24 Domain Creation Trap (ldomCreate)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain
`ldomTrapDesc`	Display string	Description of the trap

Domain Destroy (ldomDestroy)

This trap notifies you when any domains are destroyed.

TABLE 17–25 Domain Destroy Trap (ldomDestroy)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain
`ldomTrapDesc`	Display string	Description of the trap

Domain State Change (ldomStateChange)

This trap notifies you of any domain operating state changes.

TABLE 17–26 Domain State Change Trap (ldomStateChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain
`ldomOperState`	Integer	New state of the domain
`ldomStatePrev`	Integer	Previous state of the domain
`ldomTrapDesc`	Display string	Description of the trap

Virtual CPU Change (ldomVCpuChange)

This trap notifies you when the number of virtual CPUs in a domain changes.

TABLE 17–27 Domain Virtual CPU Change Trap (ldomVCpuChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual CPU
`ldomNumVCPU`	Integer	New number of virtual CPUs for the domain
`ldomNumVCPUPrev`	Integer	Previous number of virtual CPUs for the domain
`ldomTrapDesc`	Display string	Description of the trap

Virtual Memory Change (ldomVMemChange)

This trap notifies you when the amount of virtual memory in a domain changes.

TABLE 17–28 Domain Virtual Memory Change Trap (ldomVMemChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual memory
`ldomMemSize`	Integer	Amount of virtual memory for the domain
`ldomMemSizePrev`	Integer	Previous amount of virtual memory for the domain
`ldomMemUnit`	Integer	Memory unit for virtual memory, which is one of the following: ■ 1 is KB ■ 2 is MB ■ 3 is GB ■ 4 is bytes If not specified, the unit value is bytes.

TABLE 17–28 Domain Virtual Memory Change Trap (ldomVMemChange) *(Continued)*

Name	Data Type	Description
`ldomMemUnitPrev`	Integer	Memory unit for previous virtual memory, which is one of the following: ■ 1 is KB ■ 2 is MB ■ 3 is GB ■ 4 is bytes If not specified, the unit value is bytes.
`ldomTrapDesc`	Display string	Description of the trap

Virtual Disk Service Change (ldomVdsChange)

This trap notifies you when a domain's virtual disk service changes.

TABLE 17–29 Domain Virtual Disk Service Change Trap (ldomVdsChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual disk service
`ldomVdsServiceName`	Display string	Name of the virtual disk service that has changed
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual disk service: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Virtual Disk Change (ldomVdiskChange)

This trap notifies you when a domain's virtual disk changes.

TABLE 17–30 Virtual Disk Change Trap (ldomVdiskChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual disk device

TABLE 17–30 Virtual Disk Change Trap (ldomVdiskChange) *(Continued)*

Name	Data Type	Description
`ldomVdiskName`	Display string	Name of the virtual disk device that has changed
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual disk service: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Virtual Switch Change (ldomVswChange)

This trap notifies you when a domain's virtual switch changes.

TABLE 17–31 Virtual Switch Change Trap (ldomVswChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual switch service
`ldomVswServiceName`	Display string	Name of the virtual switch service that has changed
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual switch service: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Virtual Network Change (ldomVnetChange)

This trap notifies you when a domain's virtual network changes.

TABLE 17–32 Virtual Network Change Trap (ldomVnetChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual network device

TABLE 17–32 Virtual Network Change Trap (ldomVnetChange) *(Continued)*

Name	Data Type	Description
`ldomVnetDevName`	Display string	Name of the virtual network device for the domain
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual disk service: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Virtual Console Concentrator Change (ldomVccChange)

This trap notifies you when a domain's virtual console concentrator changes.

TABLE 17–33 Virtual Console Concentrator Change Trap (ldomVccChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual console concentrator
`ldomVccName`	Display string	Name of the virtual console concentrator service that has changed
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual console concentrator: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Virtual Console Group Change (ldomVconsChange)

This trap notifies you when a domain's virtual console group changes.

TABLE 17–34 Virtual Console Group Change Trap (ldomVconsChange)

Name	Data Type	Description
`ldomIndexNotif`	Integer	Index into `ldomTable`
`ldomName`	Display string	Name of the domain that contains the virtual console group

TABLE 17–34 Virtual Console Group Change Trap (ldomVconsChange) *(Continued)*

Name	Data Type	Description
`ldomVconsGroupName`	Display string	Name of the virtual console group that has changed
`ldomChangeFlag`	Integer	Indicates one of the following changes that occurred to the virtual console group: ■ 1 is Added ■ 2 is Modified ■ 3 is Removed
`ldomTrapDesc`	Display string	Description of the trap

Starting and Stopping Domains

This section describes the active management operations that you use to stop and start domains. You can control these active management operations by setting a value for the `ldomAdminState` property of the Domain Table, `ldomTable`. See Table 17–1.

▼ How to Start a Domain

This procedure describes how to start an existing bound domain. If a domain with the specified domain name does not exist or is not already bound, this operation fails.

1 Verify that the *domain-name* domain exists and is bound.

```
# ldm list domain-name
```

2 Identify *domain-name* in `ldomTable`.

```
# snmpwalk -v1 -c public localhost SUN-LDOM-MIB::ldomTable
SUN-LDOM-MIB::ldomName.1 = STRING: primary
SUN-LDOM-MIB::ldomName.2 = STRING: LdomMibTest_1
SUN-LDOM-MIB::ldomAdminState.1 = INTEGER: 0
SUN-LDOM-MIB::ldomAdminState.2 = INTEGER: 0
SUN-LDOM-MIB::ldomOperState.1 = INTEGER: active(1)
SUN-LDOM-MIB::ldomOperState.2 = INTEGER: bound(6)
SUN-LDOM-MIB::ldomNumVCpu.1 = INTEGER: 8
SUN-LDOM-MIB::ldomNumVCpu.2 = INTEGER: 4
SUN-LDOM-MIB::ldomMemSize.1 = INTEGER: 3360
SUN-LDOM-MIB::ldomMemSize.2 = INTEGER: 256
SUN-LDOM-MIB::ldomMemUnit.1 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomMemUnit.2 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomNumCrypto.1 = INTEGER: 1
SUN-LDOM-MIB::ldomNumCrypto.2 = INTEGER: 0
SUN-LDOM-MIB::ldomNumIOBus.1 = INTEGER: 2
SUN-LDOM-MIB::ldomNumIOBus.2 = INTEGER: 0
SUN-LDOM-MIB::ldomUUID.1 = STRING: 5f8817d4-5d2e-6f7d-c4af-91b5b34b5723
SUN-LDOM-MIB::ldomUUID.2 = STRING: 11284146-87ca-4877-8d80-cd0f60d5ec26
```

```
SUN-LDOM-MIB::ldomMacAddress.1 = STRING: 00:14:4f:46:47:d6
SUN-LDOM-MIB::ldomMacAddress.2 = STRING: 00:14:4f:f8:d5:6c
SUN-LDOM-MIB::ldomHostID.1 = STRING: 0x844647d6
SUN-LDOM-MIB::ldomHostID.2 = STRING: 0x84f8d56c
SUN-LDOM-MIB::ldomFailurePolicy.1 = STRING: ignore
SUN-LDOM-MIB::ldomFailurePolicy.2 = STRING: ignore
SUN-LDOM-MIB::ldomMaster.1 = STRING:
SUN-LDOM-MIB::ldomMaster.2 = STRING:
SUN-LDOM-MIB::ldomExtMapinSpace.1 = STRING: off
SUN-LDOM-MIB::ldomExtMapinSpace.2 = STRING: off
SUN-LDOM-MIB::ldomThreading.1 = STRING: max-throughput
SUN-LDOM-MIB::ldomThreading.2 = STRING: max-throughput
SUN-LDOM-MIB::ldomWholeCore.1 = INTEGER: 0
SUN-LDOM-MIB::ldomWholeCore.2 = INTEGER: 0
SUN-LDOM-MIB::ldomCpuArch.1 = STRING: native
SUN-LDOM-MIB::ldomCpuArch.2 = STRING: native
SUN-LDOM-MIB::ldomShutdownGroup.1 = INTEGER: 0
SUN-LDOM-MIB::ldomShutdownGroup.2 = INTEGER: 15
```

3 **Start the *domain-name* domain.**

Use the `snmpset` command to start the domain by setting a value of `1` to the `ldomAdminState` property. *n* specifies the domain to start.

```
# snmpset -v version -c community-string hostname \
SUN-LDOM-MIB::ldomTable.1.ldomAdminState.n = 1
```

4 **Verify that the *domain-name* domain is active by using one of the following commands:**

- ```
  # ldm list domain-name
  ```
- ```
  # snmpget -v version -c community-string hostname SUN-LDOM-MIB::ldomOperState.n
  ```

Example 17–5 Starting a Guest Domain

This example verifies that the `LdomMibTest_1` domain exists and is bound before setting the `ldomAdminState` property to `1`. Finally, the `ldm list LdomMibTest_1` command verifies that the `LdomMibTest_1` domain is active.

```
# ldm list LdomMibTest_1
# snmpset -v1 -c private localhost SUN-LDOM-MIB::ldomTable.1.ldomAdminState.2 = 1
# ldm list LdomMibTest_1
```

You can also use the `snmpget` command to retrieve the `LdomMibTest_1` domain's state instead of using the `ldm list` command.

```
# snmpget -v1 -c public localhost SUN-LDOM-MIB::ldomOperState.2
```

Note that if the domain is inactive when you use `snmpset` to start the domain, the domain is first bound and then started.

How to Stop a Domain

This procedure describes how to stop a started domain. Any operating system instances that are hosted by the domain are stopped.

1. **Identify *domain-name* in `ldomTable`.**

```
# snmpwalk -v1 -c public localhost SUN-LDOM-MIB::ldomTable
SUN-LDOM-MIB::ldomName.1 = STRING: primary
SUN-LDOM-MIB::ldomName.2 = STRING: LdomMibTest_1
SUN-LDOM-MIB::ldomAdminState.1 = INTEGER: 0
SUN-LDOM-MIB::ldomAdminState.2 = INTEGER: 0
SUN-LDOM-MIB::ldomOperState.1 = INTEGER: active(1)
SUN-LDOM-MIB::ldomOperState.2 = INTEGER: bound(6)
SUN-LDOM-MIB::ldomNumVCpu.1 = INTEGER: 8
SUN-LDOM-MIB::ldomNumVCpu.2 = INTEGER: 4
SUN-LDOM-MIB::ldomMemSize.1 = INTEGER: 3360
SUN-LDOM-MIB::ldomMemSize.2 = INTEGER: 256
SUN-LDOM-MIB::ldomMemUnit.1 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomMemUnit.2 = INTEGER: megabytes(2)
SUN-LDOM-MIB::ldomNumCrypto.1 = INTEGER: 1
SUN-LDOM-MIB::ldomNumCrypto.2 = INTEGER: 0
SUN-LDOM-MIB::ldomNumIOBus.1 = INTEGER: 2
SUN-LDOM-MIB::ldomNumIOBus.2 = INTEGER: 0
SUN-LDOM-MIB::ldomUUID.1 = STRING: 5f8817d4-5d2e-6f7d-c4af-91b5b34b5723
SUN-LDOM-MIB::ldomUUID.2 = STRING: 11284146-87ca-4877-8d80-cd0f60d5ec26
SUN-LDOM-MIB::ldomMacAddress.1 = STRING: 00:14:4f:46:47:d6
SUN-LDOM-MIB::ldomMacAddress.2 = STRING: 00:14:4f:f8:d5:6c
SUN-LDOM-MIB::ldomHostID.1 = STRING: 0x844647d6
SUN-LDOM-MIB::ldomHostID.2 = STRING: 0x84f8d56c
SUN-LDOM-MIB::ldomFailurePolicy.1 = STRING: ignore
SUN-LDOM-MIB::ldomFailurePolicy.2 = STRING: ignore
SUN-LDOM-MIB::ldomMaster.1 = STRING:
SUN-LDOM-MIB::ldomMaster.2 = STRING:
SUN-LDOM-MIB::ldomExtMapinSpace.1 = STRING: off
SUN-LDOM-MIB::ldomExtMapinSpace.2 = STRING: off
SUN-LDOM-MIB::ldomThreading.1 = STRING: max-throughput
SUN-LDOM-MIB::ldomThreading.2 = STRING: max-throughput
SUN-LDOM-MIB::ldomWholeCore.1 = INTEGER: 0
SUN-LDOM-MIB::ldomWholeCore.2 = INTEGER: 0
SUN-LDOM-MIB::ldomCpuArch.1 = STRING: native
SUN-LDOM-MIB::ldomCpuArch.2 = STRING: native
SUN-LDOM-MIB::ldomShutdownGroup.1 = INTEGER: 0
SUN-LDOM-MIB::ldomShutdownGroup.2 = INTEGER: 15
```

2. **Stop the *domain-name* domain.**

   Use the `snmpset` command to stop the domain by setting a value of `2` to the `ldomAdminState` property. *n* specifies the domain to stop.

```
# snmpset -v version -c community-string hostname \
SUN-LDOM-MIB::ldomTable.1.ldomAdminState.n = 2
```

3. **Verify that the *domain-name* domain is bound by using one of the following commands:**

   -

```
# ldm list domain-name
```

-
  ```
  # snmpget -v version -c community-string hostname SUN-LDOM-MIB::ldomOperState.n
  ```

Example 17–6 Stopping a Guest Domain

This example sets the `ldomAdminState` property to `2` to stop the guest domain and then uses the `ldm list LdomMibTest_1` command to verify that the `LdomMibTest_1` domain is bound.

```
# snmpset -v1 -c private localhost SUN-LDOM-MIB::ldomTable.1.ldomAdminState.2 = 2
# ldm list LdomMibTest_1
```

◆ ◆ ◆ CHAPTER 18

Logical Domains Manager Discovery

This chapter provides information about discovering the Logical Domains Manager running on systems on a subnet.

Discovering Systems Running the Logical Domains Manager

Logical Domains Managers can be discovered on a subnet by using multicast messages. The `ldmd` daemon is able to listen on a network for a specific multicast packet. If that multicast message is of a certain type, `ldmd` replies to the caller. This enables `ldmd` to be discovered on systems that are running Oracle VM Server for SPARC.

Multicast Communication

This discovery mechanism uses the same multicast network that is used by the `ldmd` daemon to detect collisions when automatically assigning MAC addresses. To configure the multicast socket, you must supply the following information:

```
#define    MAC_MULTI_PORT        64535
#define    MAC_MULTI_GROUP        "239.129.9.27"
```

By default, *only* multicast packets can be sent on the subnet to which the machine is attached. You can change the behavior by setting the `ldmd/hops` SMF property for the `ldmd` daemon.

Message Format

The discovery messages must be clearly marked so as not to be confused with other messages. The following multicast message format ensures that discovery messages can be distinguished by the discovery listening process:

```
#include <netdb.h> /* Used for MAXHOSTNAMELEN definition */
#define    MAC_MULTI_MAGIC_NO    92792004
#define    MAC_MULTI_VERSION    1

enum {
    SEND_MSG = 0,
    RESPONSE_MSG,
    LDMD_DISC_SEND,
    LDMD_DISC_RESP,
};

typedef struct {
    uint32_t    version_no;
    uint32_t    magic_no;
    uint32_t    msg_type;
    uint32_t    resv;
    union {
        mac_lookup_t        Mac_lookup;
        ldmd_discovery_t    Ldmd_discovery;
    } payload;
#define    lookup        payload.Mac_lookup
#define    discovery    payload.Ldmd_discovery
} multicast_msg_t;

#define    LDMD_VERSION_LEN    32

typedef struct {
    uint64_t mac_addr;
    char        source_ip[INET_ADDRSTRLEN];
} mac_lookup_t;

typedef struct {
    char        ldmd_version[LDMD_VERSION_LEN];
    char        hostname[MAXHOSTNAMELEN];
    struct in_addr    ip_address;
    int        port_no;
} ldmd_discovery_t;
```

How to Discover Logical Domains Managers Running on Your Subnet

1. **Open a multicast socket.**

   Ensure that you use the port and group information specified in "Multicast Communication" on page 387.

2. **Send a `multicast_msg_t` message over the socket.**

   The message should include the following:

   - Valid value for `version_no`, which is `1` as defined by `MAC_MULTI_VERSION`
   - Valid value for `magic_no`, which is `92792004` as defined by `MAC_MULTI_MAGIC_NO`
   - `msg_type` of `LDMD_DISC_SEND`

3 Listen on the multicast socket for responses from Logical Domains Managers.

The responses must be a `multicast_msg_t` message with the following information:

- Valid value for `version_no`
- Valid value for `magic_no`
- `msg_type` set to `LDMD_DISC_RESP`
- Payload consisting of a `ldmd_discovery_t` structure, which contains the following information:
  - `ldmd_version` – Version of the Logical Domains Manager running on the system
  - `hostname` – Host name of the system
  - `ip_address` – IP address of the system
  - `port_no` – Port number being used by the Logical Domains Manager for communications, which should be XMPP port `6482`

When listening for a response from Logical Domains Managers, ensure that any auto-allocation MAC collision-detection packets are discarded.

◆ ◆ ◆ CHAPTER 19

Using the XML Interface With the Logical Domains Manager

This chapter explains the Extensible Markup Language (XML) communication mechanism through which external user programs can interface with Oracle VM Server for SPARC software. These basic topics are covered:

XML Transport

External programs can use the Extensible Messaging and Presence Protocol (XMPP – RFC 3920) to communicate with the Logical Domains Manager. XMPP is supported for both local and remote connections and is on by default. To disable a remote connection, set the `ldmd/xmpp_enabled` SMF property to `false` and restart the Logical Domains Manager.

```
# svccfg -s ldom/ldmd setprop ldmd/xmpp_enabled=false
# svcadm refresh ldmd
# svcadm restart ldmd
```

Note – Disabling the XMPP server also prevents domain migration and the dynamic reconfiguration of memory.

XMPP Server

The Logical Domains Manager implements an XMPP server which can communicate with numerous available XMPP client applications and libraries. The Logical Domains Manager uses the following security mechanisms:

- Transport Layer Security (TLS) to secure the communication channel between the client and itself.
- Simple Authentication and Security Layer (SASL) for authentication. `PLAIN` is the only SASL mechanism supported. You must send in a user name and password to the server so it can authorize you before allowing monitoring or management operations.

Local Connections

The Logical Domains Manager detects whether user clients are running on the same domain as itself and, if so, does a minimal XMPP handshake with that client. Specifically, the SASL authentication step after the setup of a secure channel through TLS is skipped. Authentication and authorization are done based on the credentials of the process implementing the client interface.

Clients can choose to implement a full XMPP client or to simply run a streaming XML parser, such as the `libxml2` Simple API for XML (SAX) parser. Either way, the client has to handle an XMPP handshake to the point of TLS negotiation. Refer to the XMPP specification for the sequence needed.

XML Protocol

After communication initialization is complete, Oracle VM Server for SPARC-defined XML messages are sent next. The two general types of XML messages are:

- Request and response messages, which use the `<LDM_interface>` tag. This type of XML message is used for communicating commands and getting results back from the Logical Domains Manager, analogous to executing commands using the command-line interface (CLI). This tag is also used for event registration and unregistration.
- Event messages, which use the `<LDM_event>` tag. This type of XML message is used to asynchronously report events posted by the Logical Domains Manager.

Request and Response Messages

The XML interface into Oracle VM Server for SPARC has two different formats:

- A format for sending commands into the Logical Domains Manager
- A format for Logical Domains Manager to respond on the status of the incoming message and the actions requested within that message.

The two formats share many common XML structures, but they are separated in this discussion for a better understanding of the differences between them.

Request Messages

An incoming XML request to the Logical Domains Manager at its most basic level includes a description of a single command operating on a single object. More complicated requests can handle multiple commands and multiple objects per command. The following example shows the structure of a basic XML command.

EXAMPLE 19–1 Format of a Single Command Operating on a Single Object

```
<LDM_interface version="1.3">
  <cmd>
    <action>Place command here</action>
    <options>Place options for certain commands here</options>
    <arguments>Place arguments for certain commands here</arguments>
    <data version="3.0">
      <Envelope>
        <References/>
        <!-- Note a <Section> section can be here instead of <Content> -->
        <Content xsi:type="ovf:VirtualSystem_Type" id="Domain name">
          <Section xsi:type="ovf:ResourceAllocationSection_type">
            <Item>
              <rasd:OtherResourceType>LDom Resource Type</rasd:OtherResourceType>
              <gprop:GenericProperty
              key="Property name">Property Value</gprop:GenericProperty>
            </Item>
          </Section>
          <!-- Note: More Sections sections can be placed here -->
        </Content>
      </Envelope>
    </data>
    <!-- Note: More Data sections can be placed here -->
  </cmd>
  <!-- Note: More Commands sections can be placed here -->
</LDM_interface>
```

<LDM_interface> Tag

All commands sent to the Logical Domains Manager must start with the `<LDM_interface>` tag. Any document sent into the Logical Domains Manager must have only one `<LDM_interface>` tag contained within it. The `<LDM_interface>` tag must include a version attribute as shown in Example 19–1.

The <cmd> Tag

Within the <LDM_interface> tag, the document must include at least one <cmd> tag. Each <cmd> section must have only one <action> tag. Use the <action> tag to describe the command to run. Each <cmd> tag must include at least one <data> tag to describe the objects on which the command is to operate.

The <cmd> tag can also have an <options> tag, which is used for options and flags that are associated with some commands. The following commands use options:

- The `ldm remove-domain` command can use the `-a` option.
- The `ldm bind-domain` command can use the `-f` option.
- The `ldm add-vdsdev` command can use the `-f` option.
- The `ldm cancel-operation` command can use the `migration` or `reconf` option.
- The `ldm add-spconfig` command can use the `-r` *autosave-name* option.
- The `ldm remove-spconfig` command can use the `-r` option.
- The `ldm list-spconfig` command can use the `-r` [*autosave-name*] option.
- The `ldm stop-domain` command can use the following tags to set the command arguments:
  - <force> represents the `-f` option.
  - <halt> represents the `-h` option.
  - <message> represents the `-m` option.
  - <quick> represents the `-q` option.
  - <reboot> represents the `-r` option.
  - <timeout> represents the `-t` option.

  Note that the tags must not have any content value. However, the `-t` and `-m` options must have a non-null value, for example, <timeout>10</timeout> or <message>Shutting down now</message>.

The following XML example fragment shows how to pass a reboot request with a reboot message to the `ldm stop-domain` command:

```
<action>stop-domain</action>
<arguments>
    <reboot/>
    <message>my reboot message</message>
</arguments>
```

The <data> Tag

Each <data> section contains a description of an object pertinent to the command specified. The format of the <data> section is based on the XML schema portion of the Open Virtualization Format (OVF) draft specification. That schema defines an <Envelope> section which contains a <References> tag (unused by Oracle VM Server for SPARC) and <Content> and <Section> sections.

For Oracle VM Server for SPARC, the <Content> section is used to identify and describe a particular domain. The domain name in the id= attribute of the <Content> node identifies the domain. Within the <Content> section are one or more <Section> sections describing resources of the domain as needed by the particular command.

If you need to identify only a domain name, then you do not need to use any <Section> tags. Conversely, if no domain identifier is needed for the command, then you need to provide a <Section> section describing the resources needed for the command, placed outside a <Content> section but still within the <Envelope> section.

A <data> section does not need to contain an <Envelope> tag in cases where the object information can be inferred. This situation mainly applies to requests for monitoring all objects applicable to an action, and event registration and unregistration requests.

Two additional OVF types enable the use of the OVF specification's schema to properly define all types of objects:

- <gprop:GenericProperty> tag
- <Binding> tag

The <gprop:GenericProperty> tag handles any object's property for which the OVF specification does not have a definition. The property name is defined in the key= attribute of the node and the value of the property is the contents of the node. The <binding> tag is used in the `ldm list-bindings` command output to define resources that are bound to other resources.

Response Messages

An outgoing XML response closely matches the structure of the incoming request in terms of the commands and objects included, with the addition of a <Response> section for each object and command specified, as well as an overall <Response> section for the request. The <Response> sections provide status and message information. The following example shows the structure of a response to a basic XML request.

EXAMPLE 19–2 Format of a Response to a Single Command Operating on a Single Object

```
<LDM_interface version="1.3">
  <cmd>
    <action>Place command here</action>
    <data version="3.0">
      <Envelope>
        <References/>
        <!-- Note a <Section> section can be here instead of <Content> -->
        <Content xsi:type="ovf:VirtualSystem_Type" id="Domain name">
          <Section xsi:type="ovf:ResourceAllocationSection_type">
            <Item>
              <rasd:OtherResourceType>
                LDom Resource Type
              </rasd:OtherResourceType>
              <gprop:GenericProperty
              key="Property name">
```

EXAMPLE 19–2 Format of a Response to a Single Command Operating on a Single Object *(Continued)*

```
                Property Value
              </gprop:GenericProperty>
              </Item>
            </Section>
            <!-- Note: More <Section> sections can be placed here -->
          </Content>
        </Envelope>
        <response>
          <status>success or failure</status>
          <resp_msg>Reason for failure</resp_msg>
        </response>
      </data>
      <!-- Note: More Data sections can be placed here -->
      <response>
        <status>success or failure</status>
        <resp_msg>Reason for failure</resp_msg>
      </response>
    </cmd>
    <!-- Note: More Command sections can be placed here -->
    <response>
      <status>success or failure</status>
      <resp_msg>Reason for failure</resp_msg>
    </response>
</LDM_interface>
```

Overall Response

This <response> section, which is the direct child of the <LDM_interface> section, indicates overall success or failure of the entire request. Unless the incoming XML document is malformed, the <response> section includes only a <status> tag. If this response status indicates success, all commands on all objects have succeeded. If this response status is a failure and there is no <resp_msg> tag, then one of the commands included in the original request failed. The <resp_msg> tag is used only to describe some problem with the XML document itself.

Command Response

The <response> section under the <cmd> section alerts the user to success or failure of that particular command. The <status> tag shows whether that command succeeds or fails. As with the overall response, if the command fails, the <response> section includes only a <resp_msg> tag if the contents of the <cmd> section of the request is malformed. Otherwise, the failed status means one of the objects that the command ran against caused a failure.

Object Response

Finally, each <data> section in a <cmd> section also has a <response> section. This section shows whether the command being run on this particular object passes or fails. If the status of the response is SUCCESS, there is no <resp_msg> tag in the <response> section. If the status is

FAILURE, there are one or more <resp_msg> tags in the <response> field depending on the errors encountered when running the command against that object. Object errors can result from problems found when running the command, or a malformed or unknown object.

In addition to the <response> section, the <data> section can contain other information. This information is in the same format as an incoming <data> field, describing the object that caused a failure. See "The <data> Tag" on page 394. This additional information is especially useful in the following cases:

- When a command fails against a particular <data> section but passes for any additional <data> sections
- When an empty <data> section is passed into a command and fails for some domains but passes for others

Event Messages

In lieu of polling, you can subscribe to receive event notifications of certain state changes that occur. There are three types of events to which you can subscribe individually or collectively. See "Event Types" on page 398 for complete details.

Registration and Unregistration

Use an <LDM_interface> message to register for events. See "<LDM_interface> Tag" on page 393. The <action> tag details the type of event for which to register or unregister and the <data> section is left empty.

EXAMPLE 19–3 Example Event Registration Request Message

```
<LDM_interface version="1.3">
  <cmd>
    <action>reg-domain-events</action>
    <data version="3.0"/>
  </cmd>
</LDM_interface>
```

The Logical Domains Manager responds with an <LDM_interface> response message stating whether the registration or unregistration was successful.

EXAMPLE 19–4 Example Event Registration Response Message

```
<LDM_interface version="1.3">
  <cmd>
    <action>reg-domain-events</action>
    <data version="3.0"/>
      <response>
        <status>success</status>
```

EXAMPLE 19–4 Example Event Registration Response Message *(Continued)*

```
      </response>
    </data>
    <response>
      <status>success</status>
    </response>
  </cmd>
  <response>
    <status>success</status>
  </response>
</LDM_interface>
```

The action string for each type of event is listed in the events subsection.

<LDM_event> Messages

Event messages have the same format as an incoming <LDM_interface> message with the exception that the start tag for the message is <LDM_event>. The <action> tag of the message is the action that was performed to trigger the event. The <data> section of the message describes the object associated with the event; the details depend on the type of event that occurred.

EXAMPLE 19–5 Example <LDM_event> Notification

```
<LDM_event version='1.1'>
  <cmd>
    <action>Event command here</action>
    <data version='3.0'>
      <Envelope
        <References/>
        <Content xsi:type='ovf:VirtualSystem_Type' ovf:id='ldg1'/>
          <Section xsi:type="ovf:ResourceAllocationSection_type">
            <Item>
              <rasd:OtherResourceType>LDom Resource Type</rasd:OtherResourceType>
              <gprop:GenericProperty
              key="Property name">Property Value</gprop:GenericProperty>
            </Item>
          </Section>
      </Envelope>
    </data>
  </cmd>
</LDM_event>
```

Event Types

You can subscribe to the following event types:

- Domain events
- Hardware events
- Progress events

- Resource events

All the events correspond to `ldm` subcommands.

Domain Events

Domain events describe which actions can be performed directly to a domain. The following domain events can be specified in the `<action>` tag in the `<LDM_event>` message:

- `add-domain`
- `bind-domain`
- `domain-reset`
- `migrate-domain`
- `panic-domain`
- `remove-domain`
- `start-domain`
- `stop-domain`
- `unbind-domain`

These events always contain *only* a `<Content>` tag in the OVF `<data>` section that describes the domain to which the event happened. To register for the domain events, send an `<LDM_interface>` message with the `<action>` tag set to `reg-domain-events`. To unregister for these events, send an `<LDM_interface>` message with the `<action>` tag set to `unreg-domain-events`.

Hardware Events

Hardware events pertain to changing the physical system hardware. In the case of Oracle VM Server for SPARC software, the only hardware changes are those to the service processor (SP) when you add, remove, or set an SP configuration. Currently, the only three events of this type are:

- `add-spconfig`
- `set-spconfig`
- `remove-spconfig`

The hardware events always contain *only* a `<Section>` tag in the OVF `<data>` section which describes which SP configuration to which the event is happening. To register for these events, send an `<LDM_interface>` message with the `<action>` tag set to `reg-hardware-events`. To unregister for these events, send an `<LDM_interface>` message with the `<action>` tag set to `unreg-hardware-events`.

Progress Events

Progress events are issued for long-running commands, such as a domain migration. These events report the amount of progress that has been made during the life of the command. At this time, only the `migration-process` event is reported.

Progress events always contain only a <Section> tag in the OVF <data> section that describes the SP configuration affected by the event. To register for these events, send an <LDM_interface> message with the <action> tag set to reg-hardware-events. To unregister for these events, send an <LDM_interface> message with the <action> tag set to unreg-hardware-events.

The <data> section of a progress event consists of a <content> section that describes the affected domain. This <content> section uses an ldom_info <Section> tag to update progress. The following generic properties are shown in the ldom_info section:

- --progress – Percentage of the progress made by the command
- --status – Command status, which can be one of ongoing, failed, or done
- --source – Machine that is reporting the progress

Resource Events

Resource events occur when resources are added, removed, or changed in any domain. The <data> section for some of these events contains the <Content> tag with a <Section> tag providing a service name in the OVF <data> section.

The following events can be specified in the <action> tag in the <LDM_event> message:

- add-vdiskserverdevice
- remove-vdiskserverdevice
- set-vdiskserverdevice
- remove-vdiskserver
- set-vconscon
- remove-vconscon
- set-vswitch
- remove-vswitch
- remove-vdpcs

The following resource events always contain *only* the <Content> tag in the OVF <data> section that describes the domain to which the event happened:

- add-vcpu
- add-crypto
- add-memory
- add-io
- add-variable
- add-vconscon
- add-vdisk
- add-vdiskserver
- add-vnet
- add-vswitch
- add-vdpcs
- add-vdpcc

- set-vcpu
- set-crypto
- set-memory
- set-variable
- set-vnet
- set-vconsole
- set-vdisk
- remove-vcpu
- remove-crypto
- remove-memory
- remove-io
- remove-variable
- remove-vdisk
- remove-vnet
- remove-vdpcc

To register for the resource events, send an <LDM_interface> message with the <action> tag set to reg-resource-events. Unregistering for these events requires an <LDM_interface> message with the <action> tag set to unreg-resource-events.

All Events

You can also register to listen for all three type of events without having to register for each one individually. To register for all three types of events simultaneously, send an <LDM_interface> message with the <action> tag set to reg-all-events. Unregistering for these events require an <LDM_interface> message with the <action> tag set to unreg-all-events.

Logical Domains Manager Actions

The commands specified in the <action> tag, with the exception of *-*-events commands, correspond to those of the ldm command-line interface. For details about ldm subcommands, see the ldm(1M) man page.

Note – The XML interface does not support the verb or command aliases supported by the Logical Domains Manager CLI.

The supported strings in the <action> tag are as follows:

- add-domain
- add-io
- add-mau
- add-memory
- add-spconfig

- add-variable
- add-vconscon
- add-vcpu
- add-vdisk
- add-vdiskserver
- add-vdiskserverdevice
- add-vdpcc
- add-vdpcs
- add-vnet
- add-vswitch
- bind-domain
- cancel-operation
- list-bindings
- list-constraints
- list-devices
- list-domain
- list-services
- list-spconfig
- list-variable
- migrate-domain
- reg-all-events
- reg-domain-events
- reg-hardware-events
- reg-resource-events
- remove-domain
- remove-io
- remove-mau
- remove-memory
- remove-reconf
- remove-spconfig
- remove-variable
- remove-vconscon
- remove-vcpu
- remove-vdisk
- remove-vdiskserver
- remove-vdiskserverdevice
- remove-vdpcc
- remove-vdpcs
- remove-vnet
- remove-vswitch
- set-domain
- set-mau
- set-memory
- set-spconfig

- set-variable
- set-vconscon
- set-vconsole
- set-vcpu
- set-vnet
- set-vswitch
- start-domain
- stop-domain
- unbind-domain
- unreg-all-events
- unreg-domain-events
- unreg-hardware-events
- unreg-resource-events

Logical Domains Manager Resources and Properties

This section provides examples of the Logical Domains Manager resources and the properties that can be defined for each of those resources. The resources and properties are shown in **bold** type in the XML examples. These examples show resources, not binding output. The constraint output can be used to create input for the Logical Domains Manager actions except domain migration output. See "Domain Migration" on page 418. Each resource is defined in a `<Section>` OVF section and is specified by a `<rasd:OtherResourceType>` tag.

Domain Information (ldom_info) Resource

The following example shows the optional properties of the `ldom_info` resource:

EXAMPLE 19–6 Example ldom_info XML Output

The following example shows values specified for several `ldom_info` properties such as `uuid`, `hostid`, and `Address`.

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="primary">
    <Section xsi:type="ovf:ResourceAllocationSection_type">
      <Item>
        <rasd:OtherResourceType>ldom_info</rasd:OtherResourceType>
        <uuid>c2c3d93b-a3f9-60f6-a45e-f35d55c05fb6</uuid>
        <rasd:Address>00:03:ba:d8:ba:f6</rasd:Address>
        <gprop:GenericProperty key="hostid">83d8baf6</gprop:GenericProperty>
        <gprop:GenericProperty key="master">plum</gprop:GenericProperty>
        <gprop:GenericProperty key="failure-policy">reset</gprop:GenericProperty>
        <gprop:GenericProperty key="extended-mapin-space">on</gprop:GenericProperty>
        <gprop:GenericProperty key="progress">45%</gprop:GenericProperty>
        <gprop:GenericProperty key="status">ongoing</gprop:GenericProperty>
```

EXAMPLE 19–6 Example ldom_info XML Output *(Continued)*

```
        <gprop:GenericProperty key="source">dt90-319</gprop:GenericProperty>
        <gprop:GenericProperty key="rc-add-policy"></gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

The `ldom_info` resource is always contained within a `<Content>` section. The following properties within the `ldom_info` resource are optional properties:

- `<uuid>` tag, which specifies the UUID of the domain.
- `<rasd:Address>` tag, which specifies the MAC address to be assigned to a domain.
- `<gprop:GenericProperty key="extended-mapin-space">` tag, which specifies whether extended mapin space is enabled (`on`) or disabled (`off`) for the domain. The default value is `off`.
- `<gprop:GenericProperty key="failure-policy">` tag, which specifies how slave domains should behave should the master domain fail. The default value is `ignore`. Following are the valid property values:
  - `ignore` ignores failures of the master domain (slave domains are unaffected).
  - `panic` panics any slave domains when the master domain fails.
  - `reset` resets any slave domains when the master domain fails.
  - `stop` stops any slave domains when the master domain fails.
- `<gprop:GenericProperty key="hostid">` tag, which specifies the host ID to be assigned to the domain.
- `<gprop:GenericProperty key="master">` tag, which specifies up to four comma-separated master domain names.
- `<gprop:GenericProperty key="progress">` tag, which specifies the percentage of progress made by the command.
- `<gprop:GenericProperty key="source">` tag, which specifies the machine reporting on the progress of the command.
- `<gprop:GenericProperty key="status">` tag, which specifies the status of the command (`done`, `failed`, or `ongoing`).
- `<gprop:GenericProperty key="rc-add-policy">` tag, which specifies whether to enable or disable the direct I/O and SR-IOV I/O virtualization operations on any root complex that might be added to the specified domain. Valid values are `iov` and no value (`rc-add-policy=`).

CPU (cpu) Resource

The equivalent of the `add-vcpu`, `set-vcpu`, and `remove-vcpu` XML request actions is to set the value of the `<gpropGenericProperty key="wcore">` tag as follows:

- If the `-c` option is used, set the `wcore` property to the number of whole cores specified.
- If the `-c` option is *not* used, set the `wcore` property to `0`.

Note that the allocation units property, `<rasd:AllocationUnits>`, for the `cpu` resource always specifies the number of virtual CPUs and not the number of cores.

A `cpu` resource is always contained within a `<Content>` section.

EXAMPLE 19–7 Example cpu XML

The following example shows the XML request equivalent for the `ldm add-vcpu -c 1 ldg1` command.

```
<?xml version="1.0"?>
<LDM_interface version="1.3"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="./schemas/combined-v3.xsd"
xmlns:ovf="./schemas/envelope"
xmlns:rasd="./schemas/CIM_ResourceAllocationSettingData"
xmlns:vssd="./schemas/CIM_VirtualSystemSettingData"
xmlns:gprop="./schemas/GenericProperty"
xmlns:bind="./schemas/Binding">
  <cmd>
    <action>add-vcpu</action>
    <data version="3.0">
      <Envelope>
        <References/>
        <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="ldg1">
          <Section xsi:type="ovf:VirtualHardwareSection_Type">
            <Item>
              <rasd:OtherResourceType>cpu</rasd:OtherResourceType>
              <rasd:AllocationUnits>8</rasd:AllocationUnits>
              <gprop:GenericProperty key="wcore">1</gprop:GenericProperty>
            </Item>
          </Section>
        </Content>
      </Envelope>
    </data>
  </cmd>
</LDM_interface>
```

EXAMPLE 19–8 cpu XML Section Output from the `ldm list-bindings` Command

The following example shows the XML output for the `<cpu>` section by using the `ldm list-bindings` command.

```
<?xml version="1.0"?>
<LDM_interface
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
```

EXAMPLE 19–8 cpu XML Section Output from the `ldm list-bindings` Command *(Continued)*

```
xmlns:ovf="./schemas/envelope"
xmlns:rasd="./schemas/CIM_ResourceAllocationSettingData"
xmlns:vssd="./schemas/CIM_VirtualSystemSettingData"
xmlns:gprop="./schemas/GenericProperty"
xmlns:bind="./schemas/Binding"
version="1.3"
xsi:noNamespaceSchemaLocation="./schemas/combined-v3.xsd">
  <cmd>
    <action>list-bindings</action>
    <data version="3.0">
      <Envelope>
        <References/>
        <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="primary">
          <Section xsi:type="ovf:ResourceAllocationSection_Type">
            <Item>
              <rasd:OtherResourceType>ldom_info</rasd:OtherResourceType>
              <uuid>1e04cdbd-472a-e8b9-ba4c-d3eee86e7725</uuid>
              <rasd:Address>00:21:28:f5:11:6a</rasd:Address>
              <gprop:GenericProperty key="hostid">0x8486632a</gprop:GenericProperty>
              <failure-policy>fff</failure-policy>
              <wcore>0</wcore>
              <extended-mapin-space>0</extended-mapin-space>
              <threading>8</threading>
              <cpu-arch>native</cpu-arch>
              <rc-add-policy/>
              <gprop:GenericProperty key="state">active</gprop:GenericProperty>
            </Item>
          </Section>
          <Section xsi:type="ovf:VirtualHardwareSection_Type">
            <Item>
              <rasd:OtherResourceType>cpu</rasd:OtherResourceType>
              <rasd:AllocationUnits>8</rasd:AllocationUnits>
              <bind:Binding>
                <Item>
                  <rasd:OtherResourceType>cpu</rasd:OtherResourceType>
                  <gprop:GenericProperty key="vid">0</gprop:GenericProperty>
                  <gprop:GenericProperty key="pid">0</gprop:GenericProperty>
                  <gprop:GenericProperty key="cid">0</gprop:GenericProperty>
                  <gprop:GenericProperty key="strand_percent">100</gprop:GenericProperty>
                  <gprop:GenericProperty key="util_percent">1.1%</gprop:GenericProperty>
                  <gprop:GenericProperty key="normalized_utilization">0.1%</gprop:GenericProperty>
                </Item>
          </Section>
        </Content>
      </Envelope>
    </data>
  </cmd>
</LDM_interface>
```

EXAMPLE 19–9 cpu XML Section Output from the `ldm list-domain` Command

The following example shows the XML output for the <cpu> section by using the `ldm list-domain` command.

```
<?xml version="1.0"?>
<LDM_interface
```

EXAMPLE 19–9 cpu XML Section Output from the `ldm list-domain` Command *(Continued)*

```
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ovf="./schemas/envelope"
xmlns:rasd="./schemas/CIM_ResourceAllocationSettingData"
xmlns:vssd="./schemas/CIM_VirtualSystemSettingData"
xmlns:gprop="./schemas/GenericProperty"
xmlns:bind="./schemas/Binding"
version="1.3"
xsi:noNamespaceSchemaLocation="./schemas/combined-v3.xsd">
  <cmd>
    <action>list-domain</action>
    <data version="3.0">
      <Envelope>
        <References/>
        <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="primary">
          <Section xsi:type="ovf:ResourceAllocationSection_Type">
            <Item>
              <rasd:OtherResourceType>ldom_info</rasd:OtherResourceType>
              <gprop:GenericProperty key="state">active</gprop:GenericProperty>
              <gprop:GenericProperty key="flags">-n-cv-</gprop:GenericProperty>
              <gprop:GenericProperty key="utilization">0.7%</gprop:GenericProperty>
              <gprop:GenericProperty key="uptime">3h</gprop:GenericProperty>
              <gprop:GenericProperty key="normalized_utilization">0.1%</gprop:GenericProperty>
            </Item>
          </Section>
        </Content>
      </Envelope>
    </data>
  </cmd>
</LDM_interface>
```

MAU (mau) Resource

A `mau` resource is always contained within a `<Content>` section. The only property is the `<rasd:AllocationUnits>` tag, which signifies the number of MAUs or other cryptographic units.

Note – The `mau` resource is any supported cryptographic unit on a supported server. Currently, the two cryptographic units supported are the Modular Arithmetic Unit (MAU) and the Control Word Queue (CWQ).

EXAMPLE 19–10 Example mau XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>mau</rasd:OtherResourceType>
        <rasd:AllocationUnits>1</rasd:AllocationUnits>
      </Item>
```

EXAMPLE 19–10 Example mau XML *(Continued)*

```
    </Section>
  </Content>
</Envelope>
```

Memory (memory) Resource

A memory resource is always contained within a `<Content>` section. The only property is the `<rasd:AllocationUnits>` tag, which signifies the amount of memory.

EXAMPLE 19–11 Example memory XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>memory</rasd:OtherResourceType>
        <rasd:AllocationUnits>4G</rasd:AllocationUnits>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Virtual Disk Server (vds) Resource

A virtual disk server (`vds`) resource can be in a `<Content>` section as part of a domain description, or it can appear on its own in an `<Envelope>` section. The only property is the `<gprop:GenericProperty>` tag with a key of `service_name`, which contains the name of the `vds` resource being described.

EXAMPLE 19–12 Example vds XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vds</rasd:OtherResourceType>
        <gprop:GenericProperty
          key="service_name">vdstmp</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Virtual Disk Server Volume (vds_volume) Resource

A `vds_volume` resource can be in a `<Content>` section as part of a domain description, or it can appear on its own in an `<Envelope>` section. It must have `<gprop:GenericProperty>` tags with the following keys:

- `vol_name` – Name of the volume
- `service_name` – Name of the virtual disk server to which this volume is to be bound
- `block_dev` – File or device name to be associated with this volume

Optionally, a `vds_volume` resource can also have the following properties:

- `vol_opts` – One or more of the following, comma-separated, within one string: {`ro,slice,excl`}
- `mpgroup` – Name of the multipath (failover) group

EXAMPLE 19–13 Example vds_volume XML

```
<Envelope>
  <References/>
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vds_volume</rasd:OtherResourceType>
        <gprop:GenericProperty key="vol_name">vdsdev0</gprop:GenericProperty>
        <gprop:GenericProperty key="service_name">primary-vds0</gprop:GenericProperty>
        <gprop:GenericProperty key="block_dev">
          opt/SUNWldm/domain_disks/testdisk1</gprop:GenericProperty>
        <gprop:GenericProperty key="vol_opts">ro</gprop:GenericProperty>
        <gprop:GenericProperty key="mpgroup">mpgroup-name</gprop:GenericProperty>
      </Item>
    </Section>
</Envelope>
```

Disk (disk) Resource

A `disk` resource is always contained within a `<Content>` section. It must have `<gprop:GenericProperty>` tags with the following keys:

- `vdisk_name` – Name of the virtual disk
- `service_name` – Name of the virtual disk server to which this virtual disk is to be bound
- `vol_name` – Virtual disk service device with which this virtual disk is to be associated

Optionally, the `disk` resource can also have the `timeout` property, which is the timeout value in seconds for establishing a connection between a virtual disk client (`vdc`) and a virtual disk server (`vds`). If there are multiple virtual disk (`vdisk`) paths, then the `vdc` can try to connect to a different `vds`. The timeout ensures that a connection to any `vds` is established within the specified amount of time.

EXAMPLE 19–14 Example disk XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>disk</rasd:OtherResourceType>
        <gprop:GenericProperty key="vdisk_name">vdisk0</gprop:GenericProperty>
        <gprop:GenericProperty
          key="service_name">primary-vds0</gprop:GenericProperty>
        <gprop:GenericProperty key="vol_name">vdsdev0</gprop:GenericProperty>
        <gprop:GenericProperty key="timeout">60</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Virtual Switch (vsw) Resource

A `vsw` resource can be either in a `<Content>` section as part of a domain description, or it can appear on its own in an `<Envelope>` section. It must have a `<gprop:GenericProperty>` tag with the `service_name` key, which is the name to be assigned to the virtual switch.

Optionally, the `vsw` resource can also have the following properties:

- `<rasd:Address>` – Assigns a MAC address to the virtual switch
- `default-vlan-id` – Specifies the default virtual local area network (VLAN) to which a virtual network device or virtual switch needs to be a member, in tagged mode. The first VLAN ID (*vid1*) is reserved for the `default-vlan-id`.
- `dev_path` – Path of the network device to be associated with this virtual switch
- `id` – Specifies the ID of a new virtual switch device. By default, ID values are generated automatically, so set this property if you need to match an existing device name in the OS.
- `inter_vnet_link` – Specifies whether to assign LDC channels for inter-vnet communication. The default value is `on`.
- `linkprop` – Specifies whether the virtual device should get physical link state updates. When the value is `phys-state`, the virtual device gets physical link state updates. When the value is blank, the virtual device does not get physical link state updates (the default setting).
- `mode` – `sc` for Oracle Solaris Cluster heartbeat support.
- `pvid` – Port virtual local area network (VLAN) identifier (ID) indicates the VLAN of which the virtual network needs to be a member, in untagged mode.
- `mtu` – Specifies the maximum transmission unit (MTU) of a virtual switch, virtual network devices that are bound to the virtual switch, or both. Valid values are in the range of 1500-16000. The `ldm` command issues an error if an invalid value is specified.
- `vid` – Virtual local area network (VLAN) identifier (ID) indicates the VLAN of which a virtual network and virtual switch need to be a member, in tagged mode.

EXAMPLE 19–15 Example vsw XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg2">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vsw</rasd:OtherResourceType>
        <rasd:Address>00:14:4f:fb:ec:00</rasd:Address>
        <gprop:GenericProperty key="service_name">test-vsw1</gprop:GenericProperty>
        <gprop:GenericProperty key="inter_vnet_link">on</gprop:GenericProperty>
        <gprop:GenericProperty key="default-vlan-id">1</gprop:GenericProperty>
        <gprop:GenericProperty key="pvid">1</gprop:GenericProperty>
        <gprop:GenericProperty key="mtu">1500</gprop:GenericProperty>
        <gprop:GenericProperty key="dev_path">switch@0</gprop:GenericProperty>
        <gprop:GenericProperty key="id">0</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Network (network) Resource

A `network` resource is always contained within a `<Content>` section. It must have `<gprop:GenericProperty>` tags with the following keys:

- `linkprop` – Specifies whether the virtual device should get physical link state updates. When the value is `phys-state`, the virtual device gets physical link state updates. When the value is blank, the virtual device does not get physical link state updates (the default setting).
- `vnet_name` – Name of the virtual network (`vnet`)
- `service_name` – Name of the virtual switch (`vswitch`) to which this virtual network is to be bound

Optionally, the `network` resource can also have the following properties:

- `<rasd:Address>` – Assigns a MAC address to the virtual switch
- `pvid` – Port virtual local area network (VLAN) identifier (ID) indicates the VLAN of which the virtual network needs to be a member, in untagged mode.
- `vid` – Virtual local area network (VLAN) identifier (ID) indicates the VLAN of which a virtual network and virtual switch need to be a member, in tagged mode.
- `mode` – `hybrid` to enable hybrid I/O for that virtual network.

Note – The NIU Hybrid I/O feature is deprecated in favor of SR-IOV.

EXAMPLE 19–16 Example network XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
```

EXAMPLE 19–16 Example network XML *(Continued)*

```
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>network</rasd:OtherResourceType>
        <gprop:GenericProperty key="linkprop">phys-state</gprop:GenericProperty>
        <gprop:GenericProperty key="vnet_name">ldg1-vnet0</gprop:GenericProperty>
        <gprop:GenericProperty
          key="service_name">primary-vsw0</gprop:GenericProperty>
        <rasd:Address>00:14:4f:fc:00:01</rasd:Address>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Virtual Console Concentrator (vcc) Resource

A `vcc` resource can be either in a `<Content>` section as part of a domain description, or it can appear on its own in an `<Envelope>` section. It can have `<gprop:GenericProperty>` tags with the following keys:

- `service_name` – Name to be assigned to the virtual console concentrator service
- `min_port` – Minimum port number to be associated with this `vcc`
- `max_port` – Maximum port number to be associated with this `vcc`

EXAMPLE 19–17 Example vcc XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vcc</rasd:OtherResourceType>
        <gprop:GenericProperty key="service_name">vcc1</gprop:GenericProperty>
        <gprop:GenericProperty key="min_port">6000</gprop:GenericProperty>
        <gprop:GenericProperty key="max_port">6100</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Variable (var) Resource

A `var` resource is always contained within a `<Content>` section. It can have `<gprop:GenericProperty>` tags with the following keys:

- `name` – Name of the variable
- `value` – Value of the variable

EXAMPLE 19–18 Example var XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>var</rasd:OtherResourceType>
        <gprop:GenericProperty key="name">test_var</gprop:GenericProperty>
        <gprop:GenericProperty key="value">test1</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Physical I/O Device (physio_device) Resource

A `physio_device` resource is always contained within a `<Content>` section. This resource can be modified by using the `add-io`, `set-io`, `remove-io`, `create-vf`, `destroy-vf`, and `set-domain` subcommands.

EXAMPLE 19–19 Example physio_device XML

The following examples show how to perform actions on virtual functions, physical functions, and root complexes.

- The following XML example fragment shows how to use the `ldm add-io` command to add the `/SYS/MB/NET0/IOVNET.PF0.VF0` virtual function to the `ldg1` domain.

```
<LDM_interface version="1.3">
  <cmd>
    <action>add-io</action>
    <data version="3.0">
      <Envelope>
        <References/>
        <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="ldg1">
          <Section xsi:type="ovf:VirtualHardwareSection_Type">
            <Item>
              <rasd:OtherResourceType>physio_device</rasd:OtherResourceType>
              <gprop:GenericProperty key="name">
              /SYS/MB/NET0/IOVNET.PF0.VF0</gprop:GenericProperty>
            </Item>
          </Section>
        </Content>
      </Envelope>
    </data>
  </cmd>
</LDM_interface>
```

- The following XML example fragment shows how to use the `ldm set-io` command to set the `iov_bus_enable_iov` property value to `on` for the `pci_1` root complex.

```
<LDM_interface version="1.3">
  <cmd>
    <action>set-io</action>
```

EXAMPLE 19–19 Example physio_device XML *(Continued)*

```
      <data version="3.0">
        <Envelope>
          <References/>
            <Section xsi:type="ovf:VirtualHardwareSection_Type">
              <Item>
                <rasd:OtherResourceType>physio_device</rasd:OtherResourceType>
                <gprop:GenericProperty key="name">pci_1</gprop:GenericProperty>
                <gprop:GenericProperty key="iov_bus_enable_iov">
                on</gprop:GenericProperty>
              </Item>
          </Section>
        </Envelope>
      </data>
    </cmd>
</LDM_interface>
```

- The following XML example fragment shows how to use the `ldm set-io` command to set the `unicast-slots` property value to `6` for the `/SYS/MB/NET0/IOVNET.PF1` physical function.

```
<LDM_interface version="1.3">
  <cmd>
    <action>set-io</action>
    <data version="3.0">
      <Envelope>
        <References/>
          <Section xsi:type="ovf:VirtualHardwareSection_Type">
            <Item>
              <rasd:OtherResourceType>physio_device</rasd:OtherResourceType>
              <gprop:GenericProperty key="name">
              /SYS/MB/NET0/IOVNET.PF1</gprop:GenericProperty>
              <gprop:GenericProperty key="unicast-slots">6</gprop:GenericProperty>
            </Item>
          </Section>
      </Envelope>
    </data>
  </cmd>
</LDM_interface>
```

- The following XML example fragment shows how to use the `ldm create-vf` command to create the `/SYS/MB/NET0/IOVNET.PF1.VF0` virtual function with the following property values.
  - `unicast-slots=6`
  - `pvid=3`
  - `mtu=1600`

```
<LDM_interface version="1.3">
  <cmd>
    <action>create-vf</action>
    <data version="3.0">
      <Envelope>
        <References/>
          <Section xsi:type="ovf:VirtualHardwareSection_Type">
            <Item>
```

EXAMPLE 19–19 Example physio_device XML *(Continued)*

```
                <rasd:OtherResourceType>physio_device</rasd:OtherResourceType>
                <gprop:GenericProperty key="name">
                /SYS/MB/NET0/IOVNET.PF1.VF0</gprop:GenericProperty>
                <gprop:GenericProperty key="unicast-slots">6</gprop:GenericProperty>
                <gprop:GenericProperty key="pvid">3</gprop:GenericProperty>
                <gprop:GenericProperty key="mtu">1600</gprop:GenericProperty>
              </Item>
            </Section>
          </Envelope>
        </data>
      </cmd>
    </LDM_interface>
```

SP Configuration (spconfig) Resource

A service processor (SP) configuration (`spconfig`) resource always appears on its own in an `<Envelope>` section. It can have `<gprop:GenericProperty>` tags with the following keys:

- `spconfig_name` – Name of a configuration to be stored on the SP
- `spconfig_status` – The current status of a particular SP configuration. This property is used in the output of an `ldm list-spconfig` command.

EXAMPLE 19–20 Example spconfig XML

```
<Envelope>
    <Section xsi:type="ovf:ResourceAllocationSection_type">
      <Item>
        <rasd:OtherResourceType>spconfig</rasd:OtherResourceType>
        <gprop:GenericProperty
          key="spconfig_name">primary</gprop:GenericProperty>
        <gprop:GenericProperty
          key="spconfig_status">current</gprop:GenericProperty>
      </Item>
    </Section>
</Envelope>
```

DRM Policy Configuration (policy) Resource

A DRM policy (`policy`) resource appears in an `<Envelope>` section and can have `<gprop:GenericProperty>` tags with the following keys:

- `policy_name` – Name of the DRM policy
- `policy_enable` – Specifies whether the DRM policy is enabled or disabled
- `policy_priority` – Priority of the DRM policy
- `policy_vcpu_min` – Minimum number of virtual CPU resources for a domain
- `policy_vcpu_max` – Maximum number of virtual CPU resources for a domain

- `policy_util_lower` – Lower utilization level at which policy analysis is triggered
- `policy_util_upper` – Upper utilization level at which policy analysis is triggered
- `policy_tod_begin` – Effective start time of the DRM policy
- `policy_tod_end` – Effective stop time of the DRM policy
- `policy_sample_rate` – The sample rate, which is the cycle time in seconds
- `policy_elastic_margin` – Amount of buffer between the upper and lower CPU utilization bounds
- `policy_attack` – Maximum amount of a resource to be added during any one resource control cycle
- `policy_decay` – Maximum amount of a resource to be removed during any one resource control cycle

EXAMPLE 19–21 Example policy XML

```
<Envelope>
   <Section xsi:type="ovf:VirtualHardwareSection_Type">
     <Item>
       <rasd:OtherResourceType>policy</rasd:OtherResourceType>
       <gprop:GenericProperty key="policy_name">test-policy</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_enable">on</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_priority">1</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_vcpu_min">12</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_vcpu_max">13</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_util_lower">8</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_util_upper">9</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_tod_begin">07:08:09</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_tod_end">09:08:07</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_sample_rate">1</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_elastic_margin">8</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_attack">8</gprop:GenericProperty>
       <gprop:GenericProperty key="policy_decay">9</gprop:GenericProperty>
     </Item>
   </Section>
</Envelope>
```

Virtual Data Plane Channel Service (vdpcs) Resource

This resource is of interest only in a Netra DPS environment. A `vdpcs` resource can be either in a `<Content>` section as part of a domain description, or it can appear on its own in an `<Envelope>` section. The only property is the `<gprop:GenericProperty>` tag with the `service_name` key property value, which is the name of the virtual data plane channel service (`vdpcs`) resource being described.

EXAMPLE 19–22 Example vdpcs XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
```

EXAMPLE 19–22 Example vdpcs XML *(Continued)*

```
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vdpcs</rasd:OtherResourceType>
        <gprop:GenericProperty key="service_name">dg1-vdpcs</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Virtual Data Plane Channel Client (vdpcc) Resource

This resource is of interest only in a Netra DPS environment. A virtual data plane channel client resource is always contained within a `<Content>` section. It can have `<gprop:GenericProperty>` tags with the following keys:

- `vdpcc_name` – Name of the virtual data plane channel client (`vdpcc`)
- `service_name` – Name of the virtual data plane channel service `vdpcs` to which this `vdpcc` is to be bound

EXAMPLE 19–23 Example vdpcc XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>vdpcc</rasd:OtherResourceType>
        <gprop:GenericProperty key="vdpcc_name">vdpcc</gprop:GenericProperty>
        <gprop:GenericProperty
          key="service_name">ldg1-vdpcs</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Console (console) Resource

A `console` resource is always contained within a `<Content>` section. It can have `<gprop:GenericProperty>` tags with the following keys:

- `port` – Port to which to change this virtual console (`console`)
- `service_name` – Virtual console concentrator (`vcc`) service to which to bind this `console`
- `group` – Name of the group to which to bind this `console`
- `enable-log` – Enable or disable virtual console logging for this console

EXAMPLE 19–24 Example console XML

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" id="ldg1">
    <Section xsi:type="ovf:VirtualHardwareSection_Type">
      <Item>
        <rasd:OtherResourceType>console</rasd:OtherResourceType>
        <gprop:GenericProperty key="port">6000</gprop:GenericProperty>
        <gprop:GenericProperty key="service_name">vcc2</gprop:GenericProperty>
        <gprop:GenericProperty key="group">group-name</gprop:GenericProperty>
        <gprop:GenericProperty key="enable-log">on</gprop:GenericProperty>
      </Item>
    </Section>
  </Content>
</Envelope>
```

Domain Migration

This example shows what is contained in the `<data>` section for a `ldm migrate-domain` command.

- First `<Content>` node (without an `<ldom_info>` section) is the source domain to migrate.
- Second `<Content>` node (with an `<ldom_info>` section) is the target domain to which to migrate. The source and target domain names can be the same.
- The `<ldom_info>` section for the target domain describes the machine to which to migrate and the details needed to migrate to that machine:
  - `target-host` is the target machine to which to migrate.
  - `user-name` is the login user name for the target machine, which must be SASL 64-bit encoded.
  - `password` is the password to use for logging into the target machine, which must be SASL 64-bit encoded.

Note – The Logical Domains Manager uses `sasl_decode64()` to decode the target user name and password and uses `sasl_encode64()` to encode these values. SASL 64 encoding is equivalent to `base64` encoding.

EXAMPLE 19–25 Example `migrate-domain` <data> Section

```
<Envelope>
  <References/>
  <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="ldg1"/>
  <Content xsi:type="ovf:VirtualSystem_Type" ovf:id="ldg1"/>
    <Section xsi:type="ovf:ResourceAllocationSection_Type">
      <Item>
        <rasd:OtherResourceType>ldom_info</rasd:OtherResourceType>
        <gprop:GenericProperty key="target">target-host</gprop:GenericProperty>
        <gprop:GenericProperty key="username">user-name</gprop:GenericProperty>
```

EXAMPLE 19–25 Example `migrate-domain` <data> Section *(Continued)*

```
        <gprop:GenericProperty key="password">password</gprop:GenericProperty>
      <Item>
    </Section>
  </Content>
</Envelope>
```

XML Schemas

The XML schemas that are used by the Logical Domains Manager are located in the `/opt/SUNWldm/bin/schemas` directory. The file names are as follows:

- `cim-common.xsd` – `cim-common.xsd` schema
- `cim-rasd.xsd` – `cim-rasd.xsd` schema
- `cim-vssd.xsd` – `cim-vssd.xsd` schema
- `cli-list-constraint-v3.xsd` – `cli-list-constraint-v3.xsd` schema
- `combined-v3.xsd` – `LDM_interface` XML schema
- `event-v3.xsd` – `LDM_Event` XML schema
- `ldmd-binding.xsd` – `Binding_Type` XML schema
- `ldmd-property.xsd` – `GenericProperty` XML schema
- `ovf-core.xsd` – `ovf-core.xsd` schema
- `ovf-envelope.xsd` – `ovf-envelope.xsd` schema
- `ovf-section.xsd` – `ovf-section.xsd` schema
- `ovf-strings.xsd` – `ovf-strings.xsd` schema
- `ovfenv-core.xsd` – `ovfenv-core.xsd` schema
- `ovfenv-section.xsd` – `ovfenv-section.xsd` schema

Glossary

This glossary defines terminology, abbreviations, and acronyms in the Oracle VM Server for SPARC documentation.

A

API Application programming interface.

ASN Abstract Syntax Notation.

`auditreduce` Command to merge and select audit records from audit trail files (see the `auditreduce`(1M) man page).

auditing Tracking changes to the system and identifying the user who made the changes.

authorization A way in which to determine who has permission to perform tasks and access data by using Oracle Solaris OS rights.

B

`bge` Broadcom Gigabit Ethernet driver on Broadcom BCM57xx devices.

BSM Basic Security Module.

`bsmconv` Command to enable the BSM (see the `bsmconv`(1M) man page).

`bsmunconv` Command to disable the BSM (see the `bsmunconv`(1M) man page).

C

CMT Chip multithreading.

compliance Determining whether a system's configuration is in compliance with a predefined security profile.

configuration Name of the logical domain configuration that is saved on the service processor.

constraints To the Logical Domains Manager, constraints are one or more resources you want to have assigned to a particular domain. You either receive all the resources you ask to be added to a domain or you get none of them, depending upon the available resources.

control domain A privileged domain that creates and manages other logical domains and services by using the Logical Domains Manager.

CWQ Control Word Queue; cryptographic unit.

D

DHCP Dynamic Host Configuration Protocol.

DIO Direct I/O.

DMA Direct Memory Access is the ability to directly transfer data between the memory and a device (for example, a network card) without involving the CPU.

DMP Dynamic Multipathing (Veritas).

domain See logical domain.

DPS Data plane software.

DR Dynamic reconfiguration.

`drd` Oracle Solaris 10 OS dynamic reconfiguration daemon for Logical Domains Manager (see the `drd`(1M) man page).

DRM Dynamic resource management.

DS Domain Services module (Oracle Solaris 10 OS).

DVD Digital versatile disc.

E

EFI Extensible firmware interface.

ETM Encoding Table Management module (Oracle Solaris 10 OS).

F

FC_AL Fiber Channel Arbitrated Loop.

FMA Fault Management Architecture.

`fmd` Oracle Solaris 10 OS fault manager daemon (see the `fmd`(1M) man page).

`format` Disk partitioning and maintenance utility (see the `format`(1M) man page).

`fmthard` Command to populate label on hard disks (see the `fmthard`(1M) man page).

G

Gb Gigabit.

guest domain Uses services from the I/O and service domains and is managed by the control domain.

GLDv3 Generic LAN Driver version 3.

H

hardening Modifying Oracle Solaris OS configuration to improve security.

hypervisor Firmware layer interposed between the operating system and the hardware layer.

I

I/O domain Domain that has direct ownership of and direct access to physical I/O devices and that shares those devices to other logical domains in the form of virtual devices.

IB Infiniband.

IDE Integrated Drive Electronics.

IDR Interim Diagnostics Release.

ILOM Integrated Lights Out Manager, a dedicated system of hardware and supporting software that enables you to manage your server independently of the operating system.

I/O Input/output devices, such as internal disks and PCIe controllers and their attached adapters and devices.

`ioctl` Input/output control call.

IPMP Internet Protocol Network Multipathing.

K

kaio Kernel asynchronous input/output.

KB Kilobyte.

KU Kernel update.

L

LAN Local-area network.

LDAP Lightweight Directory Access Protocol.

LDC Logical domain channel.

ldm Logical Domains Manager utility (see the `ldm(1M)` man page).

ldmd Logical Domains Manager daemon.

lofi Loopback file.

logical domain A virtual machine comprised of a discrete logical grouping of resources, which has its own operating system and identity within a single computer system. Also called a *domain*.

Logical Domains Manager A CLI to create and manage logical domains and allocate resources to domains.

M

MAC Media access control address, which Logical Domains Manager can automatically assign or you can assign manually.

MAU Modular Arithmetic Unit.

MB Megabyte.

MD Machine description in the server database.

mem, memory Memory unit – default size in bytes, or specify gigabytes (`G`), kilobytes (`K`), or megabytes (`M`). Virtualized memory of the server that can be allocated to guest domains.

metadb Command to create and delete replicas of the Solaris Volume Manager metadevice state database (see the `metadb`(1M) man page).

metaset Command to configure disk sets (see the `metaset`(1M) man page).

mhd Command to perform multihost disk control operations (see the `mhd`(7i) man page).

MIB Management Information Base.

minimizing Installing the minimum number of core Oracle Solaris OS package necessary.

MMF Multimode fiber.

MMU Memory management unit.

mpgroup Multipathing group name for virtual disk failover.

mtu Maximum transmission unit.

N

ndpsldcc Netra DPS Logical Domain Channel Client. *See also* `vdpcc`.

ndpsldcs Netra DPS Logical Domain Channel Service. *See also* `vdpcs`.

NIS Network Information Services.

NIU Network Interface Unit (Oracle's Sun SPARC Enterprise T5120 and T5220 servers).

NTS Network terminal server.

NVRAM Non-volatile random-access memory.

nxge Driver for an NIU 10Gb Ethernet adapter.

O

OID Object identifier, which is a sequence of numbers that uniquely identifies each object in a MIB.

OVF Open Virtualization Format.

P

P2V Oracle VM Server for SPARC Physical-to-Virtual Conversion Tool.

PA Physical address.

PCI Peripheral component interconnect bus.

PCIe PCI EXPRESS bus.

PCI-X PCI Extended bus.

`pcpu` Physical CPU.

physical domain The scope of resources that are managed by a single Oracle VM Server for SPARC instance. A physical domain might be a complete physical system as is the case of supported SPARC T-Series platforms. Or, it might be either the entire system or a subset of the system as is the case of supported SPARC M-Series platforms.

physical function A PCI function that supports the SR-IOV capabilities as defined in the SR-IOV specification. A physical function contains the SR-IOV capability structure and is used to manage the SR-IOV functionality. Physical functions are fully featured PCIe functions that can be discovered, managed, and manipulated like any other PCIe device. Physical functions have full configuration resources, and can be used to configure or control the PCIe device.

`physio` Physical input/output.

PICL Platform Information and Control Library.

`picld` PICL daemon (see the `picld`(1M) man page).

PM Power management of virtual CPUs and memory.

`praudit` Command to print contents of an audit trail file (see the `praudit`(1M) man page).

PRI Priority.

R

RA Real address.

RAID Redundant Array of Inexpensive Disks, which enables you to combine independent disks into a logical unit.

RPC Remote Procedure Call.

S

SASL Simple Authentication and Security Layer.

SAX Simple API for XML parser, which traverses an XML document. The SAX parser is event-based and used mostly for streaming data.

system controller (SC) Also see service processor.

service domain Logical domain that provides devices, such as virtual switches, virtual console connectors, and virtual disk servers, to other logical domains.

SMA System Management Agent.

SMF Service Management Facility.

SMI Structure of Management Information, which defines and groups managed objects for use by a MIB.

SNMP Simple Network Management Protocol.

service processor (SP) The SP, also known as the system controller (SC), monitors and runs the physical machine.

SR-IOV Single root I/O virtualization.

SSH Secure Shell.

`ssh` Secure Shell command (see the `ssh`(1) man page).

`sshd` Secure Shell daemon (see the `sshd`(1M) man page).

SunVTS Sun Validation Test Suite.

`svcadm` Manipulates service instances (see the `svcadm`(1M) man page).

T

TLS Transport Layer Security.

U

UDP User Diagram Protocol.

unicast Network communication that takes place between a single sender and a single receiver.

`uscsi` User SCSI command interface (see the `uscsi`(7I) man page).

UTP Unshielded twisted pair.

V

var	Variable.
VBSC	Virtual blade system controller.
vcc, vconscon	Virtual console concentrator service with a specific port range to assign to guest domains.
vcons, vconsole	Virtual console for accessing system-level messages. A connection is achieved by connecting to the `vconscon` service in the control domain at a specific port.
vcpu	Virtual central processing unit. Each core in a server is represented as a virtual CPU.
vdc	Virtual disk client.
vdisk	A virtual disk is a generic block device associated with different types of physical devices, volumes, or files.
vdpcc	Virtual data plane channel client in a Netra DPS environment.
vdpcs	Virtual data plane channel service in a Netra DPS environment.
vds, vdiskserver	Virtual disk server enables you to import virtual disks into a logical domain.
vdsdev, vdiskserverdevice	Virtual disk server device is exported by the virtual disk server. The device can be an entire disk, a slice on a disk, a file, or a disk volume.
virtual function	A PCI function that is associated with a physical function. A virtual function is a lightweight PCIe function that shares one or more physical resources with the physical function and with other virtual functions that are associated with the same physical function. Virtual functions are only permitted to have configuration resources for its own behavior.
VNIC	Virtual network interface card, which is a virtual instantiation of a physical network device that can be created from the physical network device and assigned to a zone.
vldc	Virtual logical domain channel service.
vldcc	Virtual logical domain channel client.
vnet	Virtual network device implements a virtual Ethernet device and communicates with other `vnet` devices in the system by using the virtual network switch (`vswitch`).
vNTS	Virtual network terminal service.
vntsd	Oracle Solaris 10 OS virtual network terminal server daemon for domain consoles (see the `vntsd`(1M) man page).
volfs	Volume Management file system (see the `volfs`(7FS) man page).
vsw, vswitch	Virtual network switch that connects the virtual network devices to the external network and also switches packets between them.
VTOC	Volume table of contents.
VxDMP	Veritas Dynamic Multipathing.

VxVM Veritas Volume Manager.

X

XFP eXtreme Fast Path.

XML Extensible Markup Language.

XMPP Extensible Messaging and Presence Protocol.

Z

ZFS Zettabyte File System (Oracle Solaris 10 OS).

`zpool` ZFS storage pool (see the `zpool`(1M) man page).

ZVOL ZFS Volume Emulation Driver.

Index

C

E

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U

V

W

X

Z