MOVING TO DELL
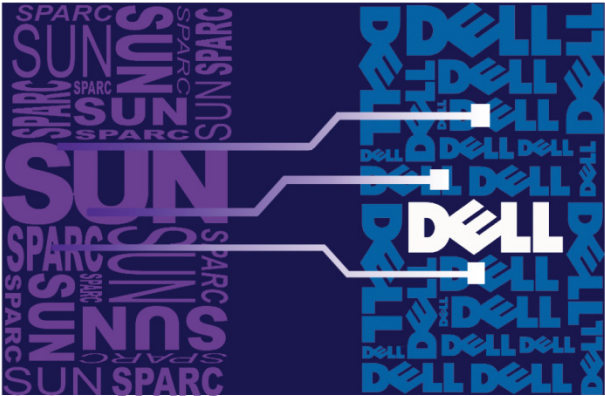

MAKING THE MOVE

MIGRATING TO
RED HAT ENTERPRISE LINUX 5.4 ON
DELL POWEREDGE R910
WITH ORACLE 11*g* ENTERPRISE EDITION

FROM
SOLARIS 10 ENTERPRISE ON
A SPARC-BASED SERVER
WITH ORACLE 10*g* ENTERPRISE EDITION

Making the transition from a Sun SPARC Solaris server to a newer and faster Intel-based Dell PowerEdge server running Red Hat Enterprise Linux is a complex process. This guide will highlight key steps that will help make this process go smoothly.

This guide is part of a package of materials that covers both planning and implementing such a migration. Other materials include a set of performance comparison reports, TCO analysis, a migration planning guide, and summary planning and migration videos.

Table of contents

Introduction

Dell PowerEdge R910

The Dell™ PowerEdge™ R910 is an excellent server for upgrading critical applications running on Sun™ SPARC® Solaris™ 10 Enterprise (Solaris 10) to Red Hat® Enterprise Linux® 5.4. This Migration Guide reviews the approach that Principled Technologies (PT) and Dell Inc. (Dell) recommend for a migration of Oracle® 10*g* databases to Oracle 11*g* on the Dell PowerEdge R910 server and Red Hat Enterprise Linux 5.4.

PT has performed hands-on testing and research and drawn on real-world experiences to document best practices and help systems administrators and database administrators simplify operations and take advantage of new features in Red Hat Enterprise Linux 5.4 and Oracle 11*g*. For our test data, we migrated a 1GB Oracle database that we generated using the DVD Store™ Version 2 (DS2) test tool. (For more information about DS2, see http://www.delltechcenter.com/page/DVD+Store.)

As a migration solution, the Dell PowerEdge R910 provides an expandable and capable platform for migrated Solaris applications. The Dell PowerEdge R910 can support 1 TB of RAM, four Intel Xeon processors, and 16 internal drives.

Red Hat Enterprise Linux uses an open source development model that delivers enhanced capabilities and new levels of performance, scalability, and security for commercial computing deployments. Red Hat Enterprise Linux 5 provides advanced features in virtualization, security, network storage support, manageability, and many other areas. Additionally, Red Hat Network provides the opportunity to automate much of the work of keeping your servers up to date.

The Dell PowerEdge R910 with Intel® Xeon® Nehalem EX processors and Red Hat Enterprise Linux delivers an improved level of Xeon-based computing. The Dell PowerEdge R910 has the scale, reliability, flexibility, and manageability needed to replace the most demanding enterprise UNIX workloads.

Scope of this Guide

This Migration Guide reviews the approach that Principled Technologies and Dell recommend for migrating from Solaris 10 11/06 to Red Hat Enterprise Linux 5.4 using Oracle Database as an example application. We cover installing Red Hat Enterprise Linux

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

5.4 and Oracle 11*gR2* on the Dell PowerEdge R910 and migrating user databases from a Sun server to the Dell PowerEdge R910.

New features of the Dell PowerEdge R910

The new Dell PowerEdge R910 will take full advantage of the new Intel® Nehalem-EX technologies. With much higher memory bandwidth and up to 16 DIMMS per socket for a possible total of 64 DIMMS, this machine proves more than a replacement for more expensive, larger RISC systems. Figure 1 shows an excerpt from Intel's official release of the Nehalem-EX processor. [1]

<div style="border:1px solid green;">

The Nehalem-EX Advantage

- Intel Nehalem Architecture built on Intel's unique 45nm high-k metal gate technology process
- Up to eight cores per processor
- Up to 16 threads per processor with Intel Hyper-threading
- Scalability up to eight sockets via QuickPath Interconnects and greater with third-party node controllers
- QuickPath Architecture with four high-bandwidth links
- 24 MB of shared cache
- Integrated memory controllers
- Intel Turbo Boost Technology
- Intel scalable memory buffer and scalable memory interconnects
- Up to 9x the memory bandwidth of previous generation
- Support for up to 16 memory slots per processor socket
- 2.3 billion transistors

</div>

Figure 1. Intel's Official Nehalem-EX Advantage press release.

In addition, the newer processors and machines are more power efficient, providing better performance while consuming less energy depending on the configuration.

New features of Red Hat Enterprise Linux 5.4

Red Hat Enterprise Linux introduces a wide variety of new features. While there are far too many to discuss in this Guide, the following list mentions some of the more significant ones of particular interest to administrators:

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[1] Intel Fact Sheet: Intel Previews Intel Xeon 'Nehalem-EX' Processor
http://www.intel.com/pressroom/archive/releases/20090526comp.htm

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

- **Virtualization.** Virtualization is provided in all Red Hat Enterprise Linux server products, including support for virtualized guest operating systems. Red Hat Enterprise Linux also includes advanced I/O performance and virtualization technologies, such as Single Root I/O Virtualization (SR-IOV).
- **Security.** SELinux enhancements include multi-level Security and targeted policies for all services. Also, IPSEC enhancements improve security and performance.
- **Auditing.** Red Hat Enterprise Linux 5 provides per process I/O accounting. New Audit features provide powerful new search/reporting and real-time monitoring.
- **Network storage enhancements.** Red Hat Enterprise Linux 5 includes support for technologies including Autofs, FS-Cache, and iSCSI support. FibreChannel over Ethernet (FCoE) is now supported over standard network interfaces. Support for root device multipath IO (MPIO) improves availability. New drivers for support 10GigE NICs are included.
- **Management.** There are numerous improvements to make system management simpler. Notably, the yum utility and Red Hat Network automate keeping your systems up to date. Specialized channels on Red Hat Network automatically provide the packages you need to configure your server for such purposes such as running Oracle or SAP applications.

New features of Oracle 11*g* and Oracle 11*g* R2

These new Oracle versions introduce a wide variety of new features. While there are far too many to discuss in this Guide, the following list mentions some of the more significant ones of particular interest to administrators:

- **Database replay.** Oracle 11*g* allows you to record all the activity of a workload on a production system and then play it back with perfect fidelity on the original database. It also lets you replay the operations on a different database, which is useful for testing. Database Replay is part of Oracle 11g's Real Application Testing option.
- **SQL Performance Analyzer.** SQL Performance Analyzer enhances SQL Tuning Sets by allowing you to compare the performance of SQL statements in a tuning set before a database change with the performance of those statements

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

after the change. SQL Performance Analyzer is part of Oracle's Real Application Testing option.

- **Enhanced partitioning options.** Oracle 11*g* allows you to partition tables in new and useful ways. For example, by using Interval Partitioning, instead of defining specific ranges of values for your partition, such as start date and end date, you can simply specify an interval, such as "month," and Oracle will handle the creation of new partitions. Another form of partitioning, Reference Partitioning, allows you to use a foreign key to partition a table based on a column that is not present in the table you are partitioning.

- **Secure Files.** This feature provides data compression, encryption, and duplication of large object (LOB) data, while giving faster access to unstructured data stored in LOB columns. Oracle claims that the write access is actually faster than a standard Linux file system, while read access is comparable.

- **Grid Infrastructure software.** Grid Infrastructure is Oracle's new software addition that combines Automatic Storage Management (ASM), the Oracle listener, Oracle Restart, and Oracle clusterware in clustered environments. You will need to install this before your Oracle 11*g* install if you plan to use ASM.

- **New Automatic Storage Management features.** Oracle 11*g* R2 introduces new functionality to ASM, which was introduced in Oracle 10*g*. Oracle 11*g* R2 adds to the existing ASM functionality to allow it to manage all data in Oracle. This allows consolidation of all storage management onto ASM, eliminating the need for additional management software.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Pre-migration considerations

| Pre-migration considerations | Installation | Migration | Post-migration considerations |
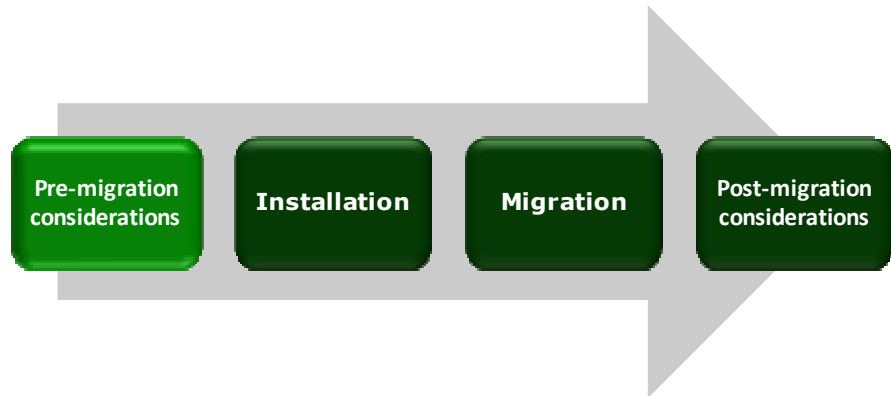
In this Guide, we discuss a migration that crosses different
processor architectures, different operating systems, and different
versions of the database software. Therefore, we selected the data
pump/tablespaces method as a safe and effective approach to
moving databases between the systems.

To learn more about the different migration methods available and
other topics to help you best prepare for your migration, please see
our corresponding Planning Guide.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Installing and setting up Red Hat Enterprise Linux 5.4 and Oracle 11*g* in this environment
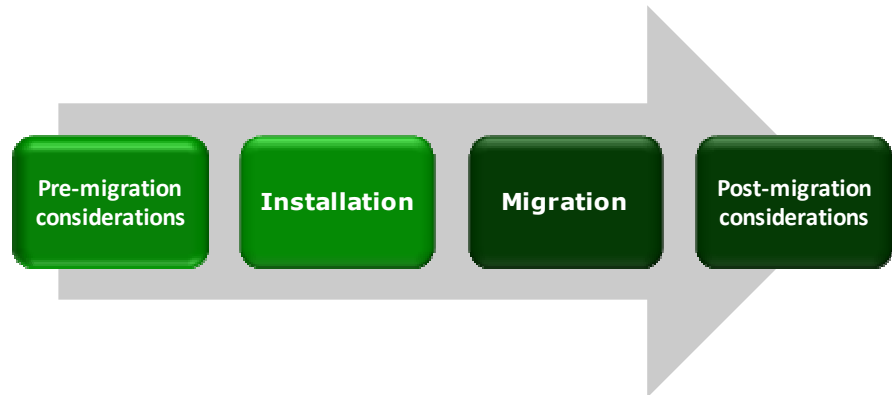
In this section, we focus on installing and setting up Red Hat Enterprise Linux 5.4 and Oracle 11*g* on the Dell PowerEdge R910 Server. We begin by defining our environment. Next, we present an overview of the steps we took to configure the internal and external drives and to install and configure both Red Hat Enterprise Linux 5.4 and Oracle 11*g*.

Defining our environment

Our legacy server was a Sun Fire V440 running Solaris 10 11/06 Operating System for SPARC-based systems (64-bit) and Oracle 10*g* Enterprise Edition Release 10.2.0.1.0 for Solaris on SPARC-based systems (64-bit). Our destination server was an Intel Xeon® Processor E7450-based Dell PowerEdge R910 running Red Hat Enterprise Linux 5.4 for x86-64 and Oracle 11*g* Enterprise Edition Release 11.2.0.1.0 for Linux on x86_64-based systems. We connected all components via a gigabit switch. Figure 2 illustrates our setup.
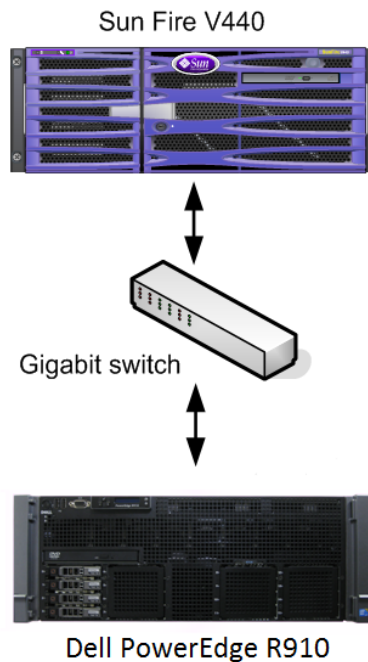
Figure 2. The setup we used in our hands-on research for this Migration Guide.

For a more detailed breakdown of the systems that we used to facilitate our migration, see Appendix A

Configuring the RAID drives

Overview

Oracle 11*g*'s Automatic Storage Management, or ASM, relieves administrators of much of the responsibility for allocating and managing the storage.

We had four internal disk drives in our Dell PowerEdge R910. We configured them as two RAID 1 arrays of two drives each, as Figure 3 shows.

 NOTE: Plan on at least 10 minutes for drive configuration.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Figure 3. The drive configuration we used in our hands-on research for this Guide.

The first array holds the OS and Oracle software.

We used the next RAID to create an ASM disk group.

NOTE: Oracle recommends that you allocate an amount of swap space equal to three quarters of the RAM for servers with more than 8 GB of RAM. In our case, that was 64 GB. Given the size of our disks, not enough space remained on this array to hold the data dump file, so we reserved the remaining RAID for the dump file.
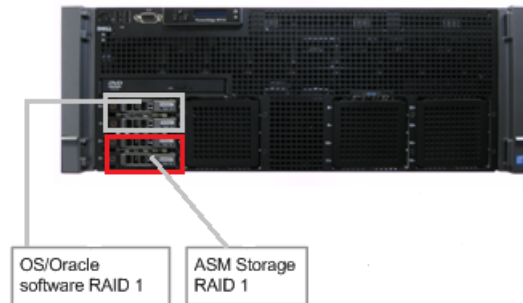
When you add a new disk to an ASM disk group, Oracle automatically rebalances the data to redistribute it across the drives.

Installing Red Hat Enterprise Linux 5.4

This section provides an overview of the operating system installation process. We include approximate wait times for each step. (Appendix C provides complete, detailed installation instructions.) We downloaded the operating system from http://rhn.redhat.com and burned it to a DVD. We were then able to install the OS from this DVD. You must register with Red Hat Network to download the OS; the following instructions assume you have a valid installation number.

NOTE: Plan on taking at least 35 minutes to install Red Hat Enterprise Linux 5.4 on the Dell PowerEdge R910 server. Each step takes at least 1 minute. We provide the

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

approximate time each step takes in parentheses. These times exclude any time needed for data entry.

1. Insert the Red Hat Enterprise Linux 5.4 DVD into the DVD drive, and reboot the system. When the installer prompts you, press Enter to install in graphical mode (Figure 4).

Figure 4. Selecting your install mode.

2. Select English as the language and U.S. English as the default keyboard.
3. Enter your installation number.
4. Accept the default of installing Red Hat Enterprise Linux. Modify the default disk layout to give Oracle the swap space it requires (Figure 5).

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition
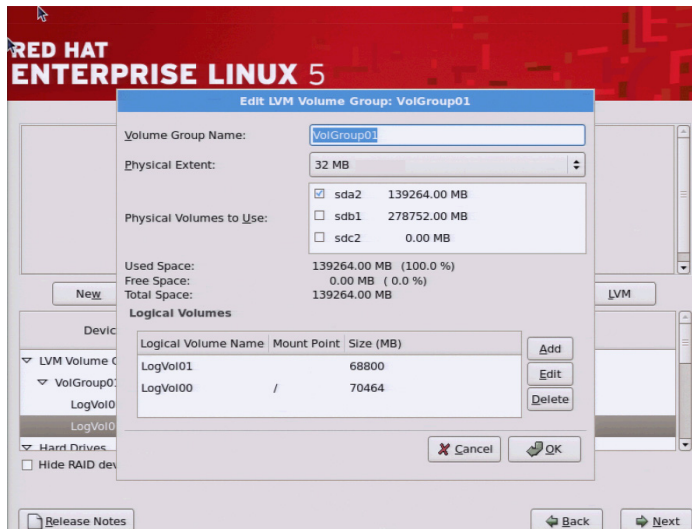
Figure 5. Increasing swap space.

5. Accept the default installation locations for the
operation system, and the boot loader (Figure 6).

Figure 6. Accepting default installation locations.

6. Configure your network information (Figure 7).

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition
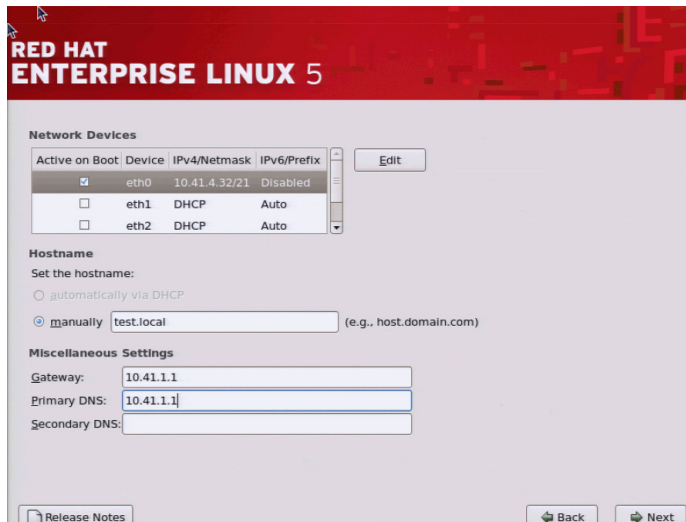
Figure 7. Configuring network information.

7. Set your time zone, and enter the root password. Because we will not be installing Oracle in a VM, we deselect Virtualization. Click Next to start the installation (Figure 8). The installer should eject the DVD automatically. (11 minutes)
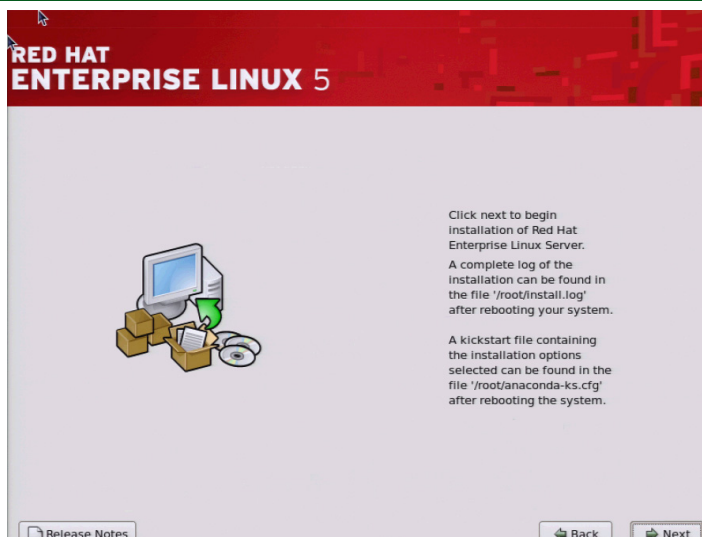
Figure 8. Beginning installation.

8. After the reboot, accept the license agreement (Figure 9).

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition
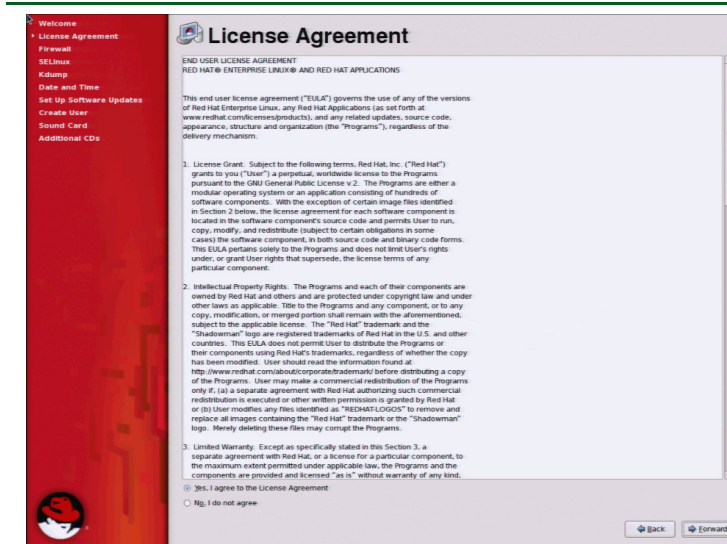
Figure 9. Accepting the License Agreement.

9. Enable secure http, and disable SELinux (Figure 10). ASM will not be able to mount the disks if SELinux is running.
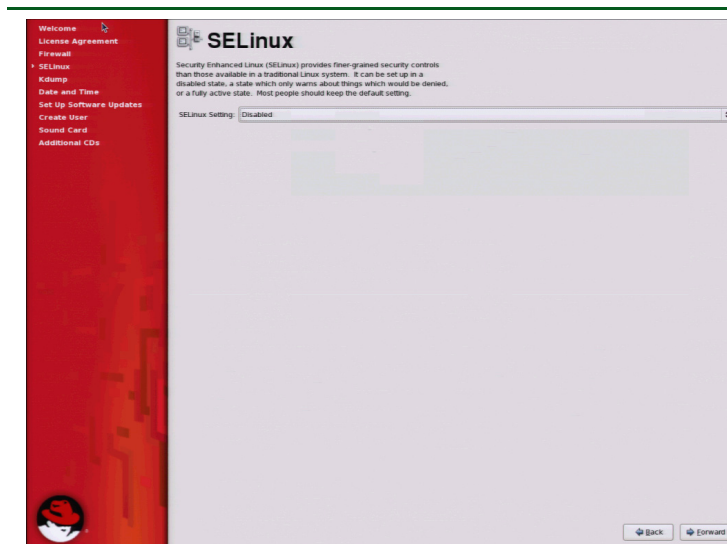
Figure 10. Disabling SELinux.

10. Set the date and time. Register with Red Hat Network (RHN) if appropriate (Figure 11).

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition
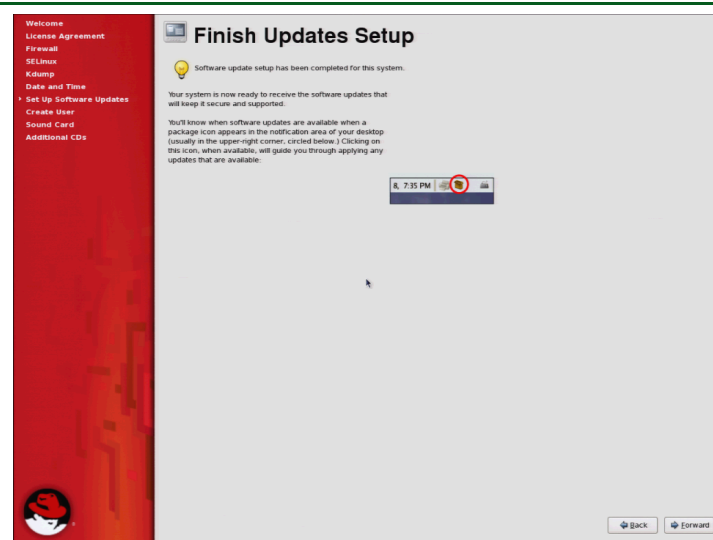
Figure 11. Finishing RHN Setup.

11. Skip creating a user account. Click Continue when you're prompted about using just the root account. Accept the remaining defaults, and click Finish to reboot the system. Make sure that the DVD is not in the system. (10 minutes)

BEST PRACTICES: Configure all database servers with static IP addresses. Doing so assures that Oracle resources remain available even in the event of a DHCP server failure. It also increases the stability of your networking and DNS environments.

Installing Oracle 11*g* on the Dell PowerEdge R910 running Red Hat Enterprise Linux 5.4

Performing Oracle pre-installation tasks

Before you can install Oracle, you must first perform a number of preliminary tasks. For further details, see *Oracle® Database Installation Guide 11g (11.2) for Linux*, Chapter 2 Oracle Database Preinstallation Requirements at http://download.oracle.com/docs/cd/E11882_01/install.112/e10840/pre_install.htm#BABFDGHJ

We provide an overview of these tasks here and give detailed instructions for each in Appendix D.

Our server met many of the prerequisites for installing Oracle 11*g*, so we do not discuss checking those prerequisites here. The Oracle

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

document we cite above covers that topic in detail. Among the
tasks we discuss in detail in <u>Appendix D</u> are the following:

1. Using the xhosts command to make sure that Oracle
   has access to the X server
2. Installing operating system packages that were not
   part of the default install
3. Verifying that the networking is configured correctly
   and is working
4. Modifying the kernel parameters
5. Creating the Oracle account, its related groups, and
   login script
6. Modifying the security limits and profile of the Oracle
   owner account

Configuring the data drive

The next step is to prepare the data drive for Oracle to use. We
used the Linux fdisk utility to do the following to each disk:

1. Use fdisk command to let us modify the partition
   table for the data disk.
2. Because we just formatted it, there are no partitions
   on the disk. Use fdisk's `n` command to edit the
   partition table. We created a single primary partition
   and gave it all the space on the drive.
3. Use fdisk's `w` command to make the changes
   permanent.

Once the fdisk utility finishes, use the Linux `chown` and `chmod`
commands to give the Oracle account rights and ownership to the
partition on the data disk, effectively giving the Oracle account
control of all the space on the disk.

Installing Oracle 11*g* Grid Infrastructure on the Dell PowerEdge R910 running Red Hat Enterprise Linux 5.4

In order to use ASM on your Red Hat Enterprise Linux 5.4 Oracle
11*g* installation, you must first install the Oracle 11*g* Grid
Infrastructure. For detailed instructions, see <u>Appendix E</u>. We
downloaded the Grid Infrastructure setup file from
<u>http://www.oracle.com/technology/software/products/database/index.html</u>, copied it to the Dell PowerEdge R910, and unzipped it
locally:

- linux.x64_11gR2_grid.zip

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

1. **Working as the Oracle user, go to the directory where you unzipped the Oracle Grid Infrastructure 11*g* R2 distribution, and type `./runInstaller` to start the Oracle Universal Installer.**

NOTE: The command is case-sensitive, and the `./` prefix is necessary. As seen in Figure 12, you are doing a Grid Infrastructure installation for a standalone server.
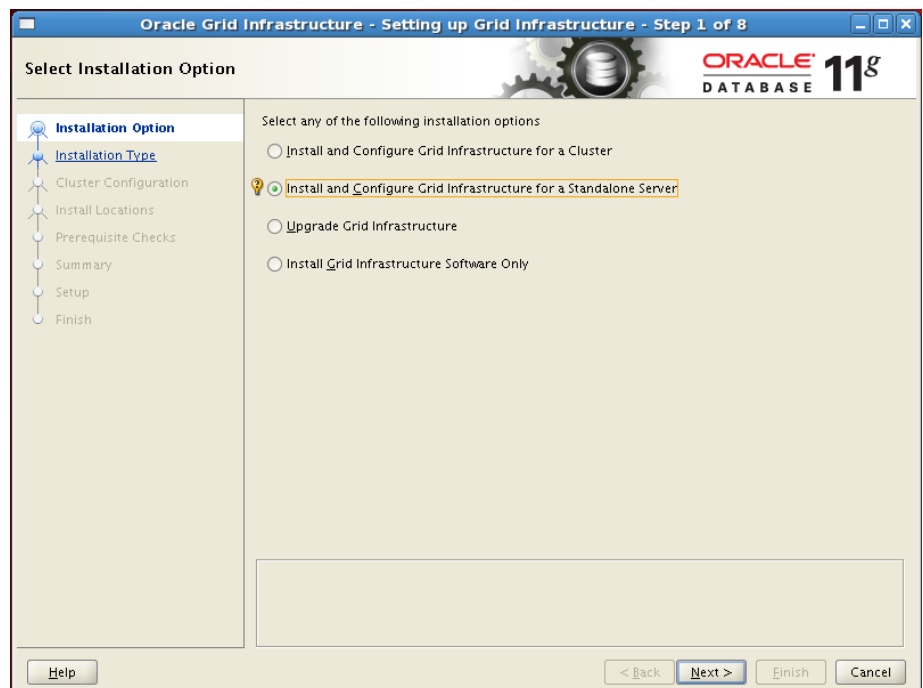
Figure 12. Select Install and Configure Grid Infrastructure for a Standalone Server.

2. **When you create your ASM group, leave the defaults if you want ASM to create its own RAID for your ASM disks. If you created your own RAID using a RAID controller, then select External.**
3. **Accept the defaults on the next few screens.**

NOTE: On the Product-Specific Prerequisite Checks screen, we received one warning that some of our kernel settings were above, rather than at, the values Oracle checked for. If you receive such a message, ignore it.

4. **Review your settings, and start the installation. (15 minutes)**

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

5. When the progress bar completes, Oracle asks you to
run two scripts as root. Open a terminal as root, and
cut and paste the paths to the scripts into the
command line terminal. Click OK.

6. At the End of Installation screen, click Exit, and click
Yes to confirm that you really want to exit.

Installing Oracle 11*g*

We provide an overview of installing Oracle here. For detailed
instructions, see [Appendix E](). We downloaded Oracle 11*g* from
http://www.oracle.com/technology/software/products/database/index.html. We copied the linux.x64_11gR2_database_1of2.zip and
linux.x64_11gR2_database_2of2.zip files to the Dell PowerEdge
R910, and unzipped them locally by right-clicking each file and
choosing Extract Here.

1. Working as the Oracle user, go to the directory where
you unzipped the Oracle 11*g* distribution, and type
`./runInstaller` to start the Oracle Universal
Installer.

NOTE: The command is case-sensitive, and the `./`
prefix is necessary. You are doing an Advanced
installation, but you are not creating a starter
database (Figure 13).
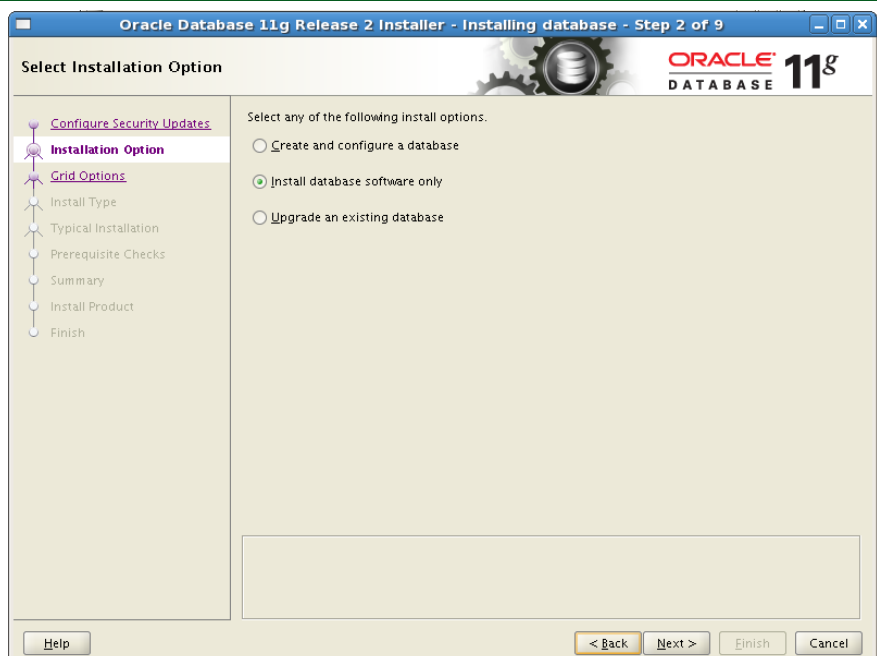
Figure 13. Select Install database software only.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

2. Fill out the Configure Security Updates screen to receive future information and updates for Oracle.

3. On the next two screens, select Install database software only and Single instance database installation.

4. Accept the defaults on the next few screens. If you have followed the instructions so far, you should have no warnings when Oracle checks its prerequisites.

5. Review your settings, and start the installation. (3 minutes)

6. When the progress bar completes, Oracle asks you to run two scripts as root. Open a terminal as root, then cut and paste the paths to the scripts into the command line terminal. Click OK.

7. The Configuration Assistants screen appears next (Figure 14). The two configuration assistants should start successfully, and you will automatically advance to the next screen.
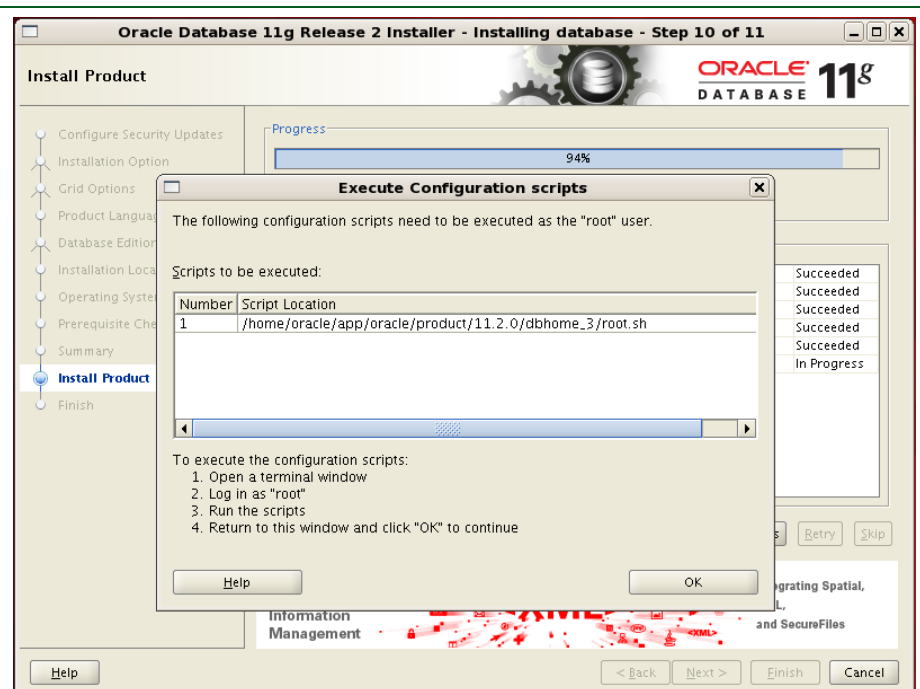
Figure 14. Installing the Configuration Assistants.

8. At the End of Installation screen, click Exit, and click Yes to confirm that you really want to exit.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Creating an empty database

1. After exiting, set your Oracle environment variables as we describe in Appendix D, and type `dbca` inside a terminal window to launch the Database Configuration Assistant (Figure 15).
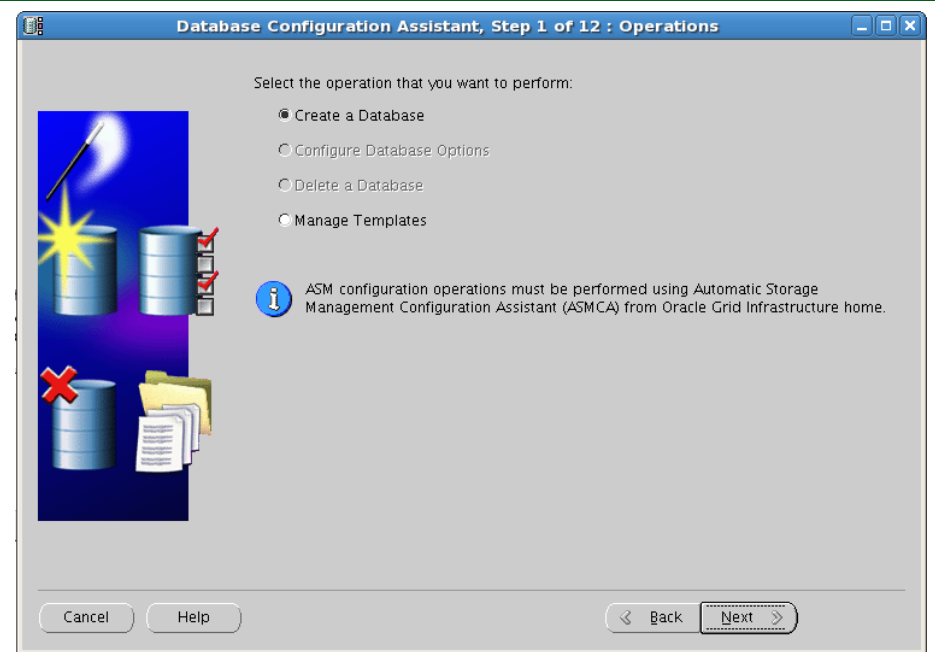
Figure 15. The Database Configuration Assistant.

2. When the Welcome screen appears, click Next. Create a custom database, and give it a name.
3. Accept the defaults for the Management Options, enter a password for the database, and select ASM for the storage. Enter the ASM password, and select the diskgroup you configured earlier.
4. Accept the default for the remaining screens (Figure 16), and click Finish. The Database Configuration Assistant screen appears and shows a progress bar. (43 minutes)

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Figure 16. Creating the database.

5. When the Database creation complete screen
appears, click Exit.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Migrating to Oracle 11*g*
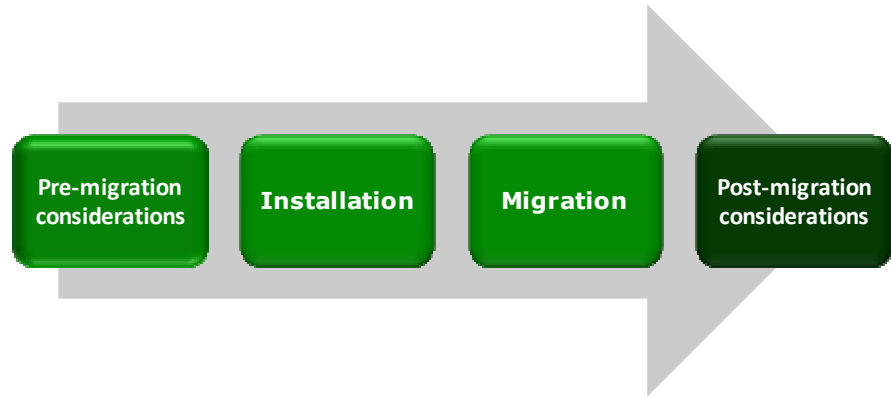
In this section, we provide specific details about migrating user databases from Oracle 10*g* to Oracle 11*g*. We provide an overview of the processes of migrating your database from Solaris 10 and Oracle 10*g* on the Sun Fire V440 to Red Hat Enterprise Linux 5.4 and Oracle 11*g* on the Dell PowerEdge R910.

Migrating your data using Transportable Tables and Data Pump

In this section, we provide an overview of the processes involved in migrating your database to Red Hat Enterprise Linux 5.4 and Oracle 11*g* R2 on the Dell PowerEdge R910. We provide detailed instructions in Appendix F. I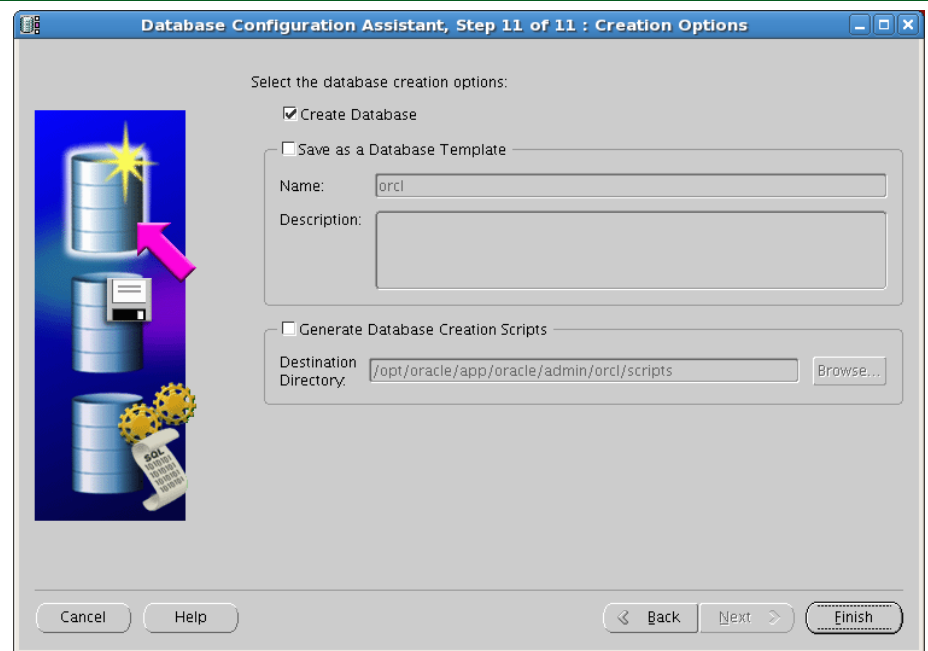n most cases, the best practice is to convert the datafiles on the source system. In our case, the x86-64-bit format conversion was unavailable on the source system and the datafile conversion was performed on the destination system.

We migrated 1 GB of data we generated using the DVD Store Version 2 (DS2) test tool. For more information about DS2, see http://www.delltechcenter.com/page/DVD+Store.

NOTE: Oracle refers to the user data and its associated metadata as a schema. We use that term where appropriate.

Exporting and converting your Oracle 11*g* database
Using your Sun server, export the Transportable Tablespaces, and convert datafiles using the Data Pump export utility and the convert command in the RMAN utility. See Appendix F for details.

Importing the tablespaces into Oracle 11*g* R2 server
On the Dell PowerEdge R910 server running Red Hat

23

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Enterprise Linux 5.4, perform the following steps:

1. Create a directory in OS and Oracle to import the tablespace set info.
2. Convert the datafiles to the correct platform.
3. Create the DS2 user to manage the database.
4. Import the tablespaces using the Data Pump import utility.

See Appendix F for details.

Once your import is complete, check your database, and verify that all the components imported correctly. You may have to correct some problems. For example, we had to recompile some of our procedures.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Post-migration considerations
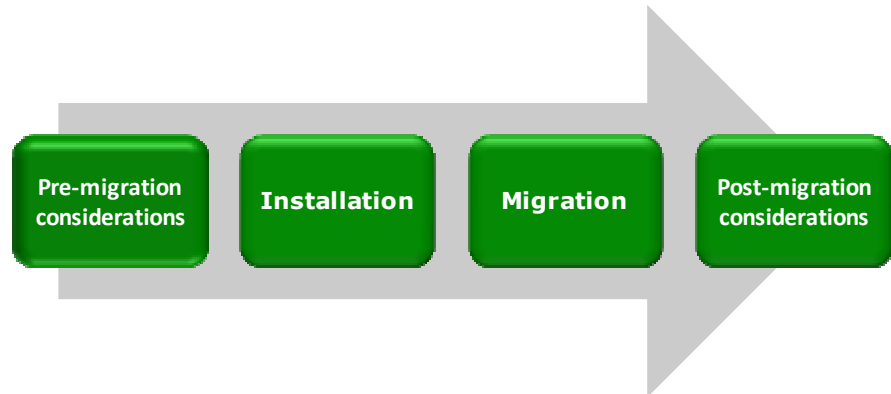
After you have completed your side-by-side migration, you will typically need to perform some additional tasks. Your specific list of post-migration tasks will depend heavily on your pre-migration research and planning. In this section, we briefly discuss several of the most common tasks, but this list is not comprehensive. For more information, see http://download.oracle.com/docs/cd/B28359_01/server.111/b28300/afterup.htm

Environmental and configuration changes

Updating environment variables. In the Linux environment, you'll need to make sure that the following environment variables point to the new Oracle directories:

- ORACLE_HOME
- PATH

Also make sure that your oratab file and any scripts that may set the home directory use the correct path.

Updating SSL users. If you have externally authenticated SSL users, you must upgrade them as well. Do so with the following command:

```
$ORACLE_HOME/rdbms/bin/extusrupgrade --dbconnectstring
<hostname:port_no:sid> --dbuser <db admin> --
dbuserpassword <password> -a
```

Changing passwords on DBA accounts. Oracle recommends you change the passwords on all Oracle-supplied accounts. One good way to make sure this happens is to lock all those accounts,

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

except for SYS and SYSTEM, and set their passwords to expire
immediately. This technique forces users to change those
passwords the next time they log into those accounts.

> **NOTE:** In Oracle 11*g,* you can enforce case sensitivity in
> passwords.

You can use following SQL statement to check the status of the
accounts:

```
SQL> SELECT username, account_status
     FROM dba_users ORDER BY username;
```

To cause passwords to expire, issue the following SQL statement:

```
SQL> ALTER USER username PASSWORD EXPIRE ACCOUNT LOCK;
```

Updating the initialization parameter file. Oracle 11*g*
introduces new initialization parameters and deprecates others.
You will need to review your parameter file and make any changes
necessary to support your particular system.

For more information see Oracle Database Upgrade Guide 11*g*
Release 1 (11.1, no upgrade guide has been released for Release
2) at
http://download.oracle.com/docs/cd/B28359_01/server.111/b2830
0/toc.htm

Backing up your database

Having successfully migrated to Red Hat Enterprise Linux 5.4 and
Oracle 11*g*, you should make a full backup of your production
database. This will ensure that you do not have to repeat the
import should any problems occur. It will also serve as a baseline
for all future backups.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Summing up

Red Hat Enterprise Linux 5.4 and Oracle 11*g* introduce many new features and enhancements. The Dell PowerEdge R910 with Intel Xeon Nehalem EX processors offers the reliability, flexibility, and manageability needed to replace the most demanding enterprise Unix workloads. As this Guide has explained, the process of deploying these products on a Dell PowerEdge R910 Server and migrating your Oracle 10*g* databases to the new environment is relatively straightforward; you can perform a basic installation and migration in less than a day. Spending some up-front time planning can help you avoid potential problems during your migration.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Appendix A. Test Server configuration

Figures 17 and 18 present the hardware and software we used in our Oracle 10*g* and Oracle 11*g* database servers.

Server	Processor	Memory	Disk
Sun Fire V440 (legacy database server)	4 x UltraSparc™ IIIi 1.59 GHz	32 GB	4 x Fujitsu® Ultra320 SCSI, 73 GB
Dell PowerEdge R910 (migration database server)	4 x Intel Xeon X7560	64 GB	4 x Seagate® SAS, 15K RPM, 73 GB

Figure 17. Servers we used in our hands-on testing and research for this Guide.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Server	Server operating system	Oracle version
Sun Fire V440 (legacy database server)	Sun Solaris 10 11/06 Operating System for SPARC-based systems (64-bit)	Oracle 10*g* Enterprise Edition Release 10.2.0.1.0 for Solaris on SPARC-based systems (64-bit)
Dell PowerEdge R910 (migration database server)	Red Hat Enterprise Linux 5.4 for x86-64	Oracle 11*g* R2 Enterprise Edition Release 11.2.0.1.0 for Linux on x86_64-based systems

Figure 18. Software we used in our hands-on testing and research for this Guide.

We also used an 8-port gigabit switch.

BEST PRACTICE: Use the latest tested and validated software, firmware, and driver versions for NICs, storage arrays, and other components. You can find these software components at http://support.dell.com/support/downloads/index.aspx?c=us&l=en&s=gen.

Appendix B. Methodology: Creating the RAID disk groups

For our installation, we decided to use two RAID groups, which we allocated as follows:

- Operating system files and Oracle files
- ASM storage

We explain below how we configured these two disk groups. The directions in Appendix B assume you have not configured any virtual disks on your RAID controllers.

Allow at least 10 minutes to complete the installation.

1. During the boot sequence, the message "Press <Ctrl><R> to Run Configuration Utility" Appears. Press <Ctrl><R>. Note: You have only a few seconds to do this.
2. First, configure the mirrored RAID for the OS.
3. While PERC H700 Integrated is highlighted, press F2, and select Create New VD.
4. With the RAID level field highlighted, press Enter to open the drop-down list, and select RAID 1.
5. Using the Tab key for navigation, move to the Physical Disks section, and use the space bar to select the first two drives (Drives 0 and 1). Tab to highlight OK, and press Enter.
6. A message box appears telling you that initializing the RAID is highly recommended, but destructive. Press Enter to clear the message.
7. Highlight PERC H700 Integrated, press F2, and select Create New VD.
8. With the RAID level field highlighted, press Enter to open the drop-down list, and select RAID 1.
9. Using the Tab key for navigation, move to the Physical Disks section, and use the space bar to select the first two drives (Drives 2 and 3). Note that the drives you allocated earlier no longer appear in the available list. Tab to highlight OK, and press Enter.
10. A message box appears telling you that initializing the RAID is highly recommended, but destructive. Press Enter to clear the message.
11. Highlight Virtual Disk 0, and press F2.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

12. Select Initialization, and select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.

13. Highlight Virtual Disk 1, and press F2.

14. Select Initialization, and select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.

15. Exit the RAID utility by pressing ESC, and reboot the server.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Appendix C. Methodology: Installing Red Hat Enterprise Linux 5.4 on the Dell PowerEdge R910

Install Red Hat Enterprise Linux 5.4 by following these steps. We provide approximate times for each group of steps in the first step of that group.

Allow at least 35 minutes to complete the installation. We used version Red Hat Enterprise Linux 5.4, which we downloaded from http://rhn.redhat.com and burned to a DVD. You must register with Red Hat Network to download the OS; the following instructions assume you have a valid installation number.

NOTE: In this appendix, we use the primary network interface name, which in our case was eth0. You should use the name of the primary network interface that you encounter, which may differ slightly from what we present here.

1. Reboot and wait for the GNU GRUB boot screen to appear. (3 minutes)
2. Press Enter to install in graphical mode.

NOTE: We chose to skip the media test, but that is your choice.

3. Click Next at the splash screen.

NOTE: Although we are installing Red Hat Enterprise Linux 5.4, the splash screen says Red Hat Enterprise Linux 5.

4. Accept the default language for installation--English--and click Next.
5. Accept the default keyboard type--U.S. English--and click Next.
6. Enter your installation number, and click OK.
7. Accept the default of Install Red Hat Enterprise Linux Server, and click Next.
8. On the next screen, choose Remove all partitions on selected drives, and create default layout. Deselect sdb, sdc. Select Review, and modify partitioning layout. Click Next.
9. At the warning, click Yes.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

> **NOTE:** During our experiments, Oracle warned that it expected a minimum of 48,339 MB of swap space. The default layout gives us 30,336 MB of swap space. So, we have to take some space from the root volume and use it for swap space.

10. Click VolGroup00, and click Edit.
11. Click LogVol00, which should have a mount point of '/'. Click Edit.
12. Reduce the size from 36,412 to 20,896, and click OK.
13. Click LogVol01, which should not list a mount point, and click Edit.
14. Increase the size from 30,336 to 48,352. Click OK.

> **NOTE:** When we used 48,339, the install procedure reduced the number to 48,320. So, we used the smallest number that would meet Oracle's recommendations. We will create the partitions on the other two drives later.

15. Accept the defaults to install the GRUB boot loader and install Red Hat Enterprise Server Linux on LogVol00, and click Next.
16. Although Oracle will support a server using DHCP, we followed the best practice given above and set fixed IP addresses for all four of our NICs. Repeat these steps for each NIC:

   a. If appropriate, select Active on Boot. Eth0 must be active on boot, and that is its default. The default for all other NICs is not to be active on boot.
   b. Select the NIC, and click Edit.
   c. Click Manual configuration.
   d. Enter the IP address.
   e. Enter the Prefix (Netmask).
   f. Deselect Enable IPv6 Support.
   g. Click OK.

17. Set the hostname and domain manually.
18. Under the section Miscellaneous settings, enter the IP addresses for the Gateway, Primary DNS, and Secondary DNS. Click Next.
19. Accept the default of Eastern Time for the time zone, and click Next.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

20. Enter the root password, and click Next.
21. Deselect Virtualization. Installing Oracle in a virtual machine is outside the scope of this Guide.

NOTE: The Virtualization option will not be available if you install without an installation number.

22. Accept the default of Customize later. Oracle recommends that you not customize the installation, but rather explicitly install the RPMs after the installation is complete. Click Next.
23. Click Next to begin the installation. (11 minutes)
24. When prompted, verify that the install ejected the DVD, and click Reboot.
25. After the reboot, click Forward at the Welcome screen.
26. Accept the license agreement, and click Forward.
27. On the Firewall screen, enable the trusted services appropriate to your installation. SSH is enabled by default. We also enabled HTTPS. Click Forward.

NOTE: When we installed without HTTPS, we saw Oracle error "ORA-03114: not connected to ORACLE" when we tried to create a database.

28. Click Yes to respond to the warning.
29. Use Disabled for the SELinux state. Click Forward.
30. When a warning that changing the SELinux setting requires rebooting the system appears, click Yes.
31. Accept the default of Kdump not being enabled, and click Forward.
32. Set the date and time, and click Forward.
33. If appropriate, you may register with Red Hat Network (RHN). However, for this Guide, we chose No, I'd prefer to register at a later time. Click Forward. If you choose to register with RHN, accept the default of Yes, I'd like to register now, and click Forward.
34. On the Choose server screen, we accepted the default of I'd like to receive updates from Red Hat Network. However, if your organization uses a proxy, you would specify it here. Click Forward.
35. On the Red Hat Login screen, specify your account name and password, and click Forward.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

36. On the Finish Updates Setup screen, click Forward.
37. On the Create Profile screen, fill in the System name. (It defaults to the IP address of the server.) Accept the defaults of sending the hardware profile and the package profile, and click Forward.
38. On the Review Subscription, check your information, and click Forward.
39. On the warning screen, click No thanks, I'll connect later.
40. On the Finish Updates Setup screen, click Forward.
41. Leave the Create a user fields blank, and click Next. Click Continue to confirm that you don't want to create a user other than root.
42. On the Sound Card screen, click Forward.
43. On the Additional CDs screen, click Finish.
44. Click OK to reboot. Make sure the installation DVD is not in the system. (10 minutes)

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Appendix D. Methodology: Installing Oracle 11*g* on the Dell PowerEdge R910

Performing Oracle pre-installation tasks

Before you can install Oracle, you must first perform a number of preliminary tasks. For further details, see *Oracle® Database Installation Guide 11gR2 (11.2) for Linux*, Chapter 2 Oracle Database Preinstallation Requirements at http://download.oracle.com/docs/cd/E11882_01/install.112/e10848/pre_install.htm#BABFDGHJ

Allow at least 35 minutes to complete the preparation.

1. Log in as root.
2. Right-click the wallpaper, and choose Open Terminal.
3. The server needs to display X applications. To work locally, you can use the command `xhost local:`
4. In the *Oracle® Database Installation Guide* , you will find a list of RPMs that Oracle requires. When we ran the Oracle Universal Installer (OUI) on a base OS, the OUI mentioned RPMs that were not in the document.
5. Some of the RPMs above have dependencies. We were able to install the RPMs by opening a console, changing our directory to the Server directory on the OS DVD, and using this command:

```
rpm -iv --force compat-libstdc++-33-3.2.3-
61.x86_64.rpm elfutils-libelf-0.137-
3.el5.x86_64.rpm elfutils-libelf-devel-
static-0.137-3.el5.x86_64.rpm elfutils-
libelf-devel-0.137-3.el5.x86_64.rpm gcc-
4.1.2-46.el5.x86_64.rpm gcc-c++-4.1.2-
46.el5.x86_64.rpm glibc-2.5-42.x86_64.rpm
glibc-common-2.5-42.x86_64.rpm glibc-devel-
2.5-42.x86_64.rpm glibc-devel-2.5-42.i386.rpm
glibc-headers-2.5-42.x86_64.rpm kernel-
headers-2.6.18-164.el5.x86_64.rpm libaio-
devel-0.3.106-3.2.x86_64.rpm libaio-devel-
0.3.106-3.2.i386.rpm libgomp-4.4.0-
6.el5.x86_64.rpm libstdc++-4.1.2-
46.el5.x86_64.rpm libstdc++-devel-4.1.2-
46.el5.x86_64.rpm sysstat-7.0.2-
3.el5.x86_64.rpm unixODBC-2.2.11-
7.1.x86_64.rpm unixODBC-devel-2.2.11-
```

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

```
7.1.x86_64.rpm unixODBC-2.2.11-7.1.i386.rpm
unixODBC-devel-2.2.11-7.1.i386.rpm
```

6. The installation did not add the entry association the host name with the IP address for eth0. We needed to do that. We edited /etc/hosts, editing the line "127.0.0.1", and adding one new line, resulting in two lines like this:

```
127.0.0.1 localhost.<domain> localhost
<IP address> <hostname>.domain> <host>
```

7. Verify that networking is set up correctly by using the following set of commands:

   - `cat /etc/nsswitch.conf | grep hosts` should contain an entry for "files."
   - `domainname` should not return any results.
   - `cat /etc/hosts | grep <hostname>` should have an entry for the fully qualified host name.

   NOTE: If you install Oracle on a system using DHCP or on a multihomed system, you will need to take additional steps. Please see the Oracle 11*g* Preinstallation tasks document for further details.

8. Change the kernel parameters by editing the /etc/sysctl.conf file and adding these lines:

```
kernel.sem=250 32000 100 128
net.core.rmem_default= 262144
net.core.rmem_max=4194304
net.core.wmem_default=262144
net.core.wmem_max=1048576
net.ipv4.ip_local_port_range=9000 65500
fs.aio-max-nr = 1048576
fs.file-max = 6815744
```

9. Use the command `/sbin/sysctl -p` to make the new parameters take effect.
10. Add the following line in the /etc/pam.d/login file:
    `session    required    pam_limits.so`
11. Create the Oracle inventory group with the following command: `/usr/sbin/groupadd oinstall`

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

12. Create the Oracle dba group with the following command: `/usr/sbin/groupadd dba`

13. Create the Oracle software owner user with the following command: `/usr/sbin/useradd –g oinstall –G dba oracle`

14. Set the password of the Oracle user with the following command: `passwd oracle`
The command prompts you for the new password.

15. Using a text editor, edit the file ".bash_profile" in /home/oracle. Append the following lines, and save the file:

```
umask 022
DISPLAY=:0.0
export DISPLAY
```

16. Add the following lines to the /etc/security/limits.conf file:

```
oracle              soft    nproc   2047
oracle              hard    nproc   16384
oracle              soft    nofile  1024
oracle              hard    nofile  65536
```

17. Edit the /etc/profile file, and add the following lines:

```
if [ $USER = "oracle" ]; then
        if [ $SHELL = "/bin/ksh" ]; then
              ulimit -p 16384
              ulimit -n 65536
        else
              ulimit -u 16384 -n 65536
        fi
        umask 022
fi
```

18. Oracle requires that the nobody account exists. In our installation, Linux created it by default. You can verify the account exists with this command: `id nobody`

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Preparing disks for Automatic Storage Management

Allow at least 10 minutes to prepare the disks.

1. While you are still logged in as root, type the command `uname –rm` and note the string that it outputs. That will determine the version of the ASMLib which you will download. In our case, the string was 2.6.18-164.el5 x86_64. So, we downloaded the following three RPMs:

   - http://oss.oracle.com/projects/oracleasm/dist/files/RPMS/rhel5/amd64/2.0.5/2.6.18-164.el5/oracleasm-2.6.18-164.el5-2.0.5-1.el5.x86_64.rpm
   - http://oss.oracle.com/projects/oracleasm-support/dist/files/RPMS/rhel5/amd64/2.1.3/oracleasm-support-2.1.3-1.el5.x86_64.rpm
   - http://otn.oracle.com/software/tech/linux/asmlib/files/RPMS/rhel5/amd64/2.0.4/oracleasmlib-2.0.4-1.el5.x86_64.rpm

2. Install ASMLib with the following command:

   ```
   rpm -Uvh oracleasm-2.6.18-164.el5-2.0.5-
   1.el5.x86_64.rpm \
   oracleasm-support-2.1.3-1.el5.x86_64.rpm \
   oracleasmlib-2.0.4-1.el5.x86_64.rpm
   ```

3. Configure ASMLib with the following command: `/etc/init.d/oracleasm configure`

4. When prompted for the Default user to own the driver interface, type `oracle`.

5. When prompted for the Default group to own the driver interface, type `dba`.

6. When prompted to Start Oracle ASM library on boot, type `y`.

7. When prompted to Scan for Oracle ASM disks on boot, type `y`.

8. For the device /dev/sdb do the following:

   a. Run fdisk. For example, fdisk /dev/sdb
   b. Type n to create a new partition.
   c. Type p to create a primary partition.
   d. Type 1 to make it partition 1.
   e. Type 1 for the starting cylinder.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

   f. Type 8844 for the size. This is all the space on the drive.

   g. Type w to make the change permanent. This automatically exits fdisk.

9. For ASM, Oracle must own the candidate drives. To give Oracle ownership, use these commands:

```
chown oracle:dba /dev/sdb1
chmod 660 / dev/sdb1
```

10. Mark sdb1 and sdc1 as belonging to ASM. Label ASM disks as VOL1 and VOL2 using the following command:

```
/etc/init.d/oracleasm createdisk VOL1
/dev/sdb1
```

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Appendix E. Methodology: Installing Oracle 11*g* on the Dell PowerEdge R910 running Red Hat Enterprise Linux 5.4

We downloaded Oracle 11*g* R2 from http://www.oracle.com/technology/software/products/database/index.html. We copied the linux.x64_11gR2_grid.zip file to the Dell PowerEdge R910, and unzipped it locally by right-clicking the file and choosing Extract Here.

Allow at least 20 minutes to set up Oracle Grid Infrastructure.

1. In a terminal window, run the command `xhost [hostname]`, replacing `[hostname]` with the fully qualified domain name of your server.
2. Use the command `su oracle` to become the Oracle user. You cannot run the Oracle Universal Installer when logged in as root.
3. Change your directory to the top level directory of the Oracle distribution you unzipped.
4. Type `./runInstaller`. The name is case sensitive and the leading `./` is required.
5. On the Select Installation Option screen, select Install and Configure Grid Infrastructure for a Standalone Server, and click Next.
6. On the Select Product Languages screen, leave the default of English, and click Next.
7. On the Create ASM Disk Group screen, leave the default name of DATA, select External redundancy, select your configured drives, and click Next.
8. On the Specify ASM Password screen, select Use same passwords for these accounts, put a password in the Specify Password and Confirm Password fields, and click Next.
9. On the Privileged Operating System Groups screen, select the groups for ASM access, and click Next.
10. On the Specify Installation Location screen, enter your planned Oracle installation location, and click Next.
11. On the Create Inventory screen, enter your planned Oracle inventory location, and click Next.
12. On the Summary screen, click Finish to start the installation.
13. After the installation is complete, follow the instructions on screen to run the two install scripts as root.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

14. On the Finish screen, click Close to finish the installation.

Installing Oracle 11*g*

We downloaded Oracle 11*g* from
http://www.oracle.com/technology/software/products/database/index.html. We copied the linux.x64_11gR2_database_1of2.zip and the linux.x64_11gR2_database_2of2.zip files to the Dell PowerEdge R910, and unzipped them locally by right clicking the files and choosing Extract Here.

Allow at least 15 minutes to complete the installation.

1. Log in as oracle. You cannot run the Oracle Universal Installer (OUI) when logged in as root.
2. Change your directory to the top level directory of the Oracle distribution you unzipped.
3. Type `./runInstaller`. The name is case sensitive and the leading `./` is required.
4. On the Configure Security Updates screen, uncheck the I wish to receive security updates via My Oracle Support checkbox, and click Next. If you want information on security updates, fill in your e-mail and leave that checkbox checked.
5. On the warning screen, click Yes.
6. On the Select Installation Option screen, select Install database software only, and click Next.
7. On the Node Selection Screen, select Single instance database installation, and click Next.
8. On the Select Product Languages screen, click Next.
9. On the Select Database Edition screen, accept the default, Enterprise Edition, and click Next.
10. On the Specify Installation Location screen, accept the default, and click Next.
11. On the Privileged Operating System Groups screen, accept the default, and click Next.
12. On the Summary screen, review your settings, and click Finish. The Install screen, which shows a progress bar, appears. (6 minutes)
13. When the progress bar completes, Oracle asks you to run a script as root. Open a terminal by right-clicking the desktop and selecting Open Terminal. You can cut and paste the paths to the scripts into the command line terminal.
14. In the Execute Configuration scripts dialog, click OK.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

15. The script is root.sh. It asks you to type in the name of the local bin directory, which is `/usr/local/bin`. We used /usr/local/bin_2 so as to not overwrite our grid files though.

16. In the Execute Configuration scripts dialog, click OK.

17. On the Finish screen, click Close.

Creating an empty database

Allow at least 50 minutes to create the database.

> **NOTE:** Make sure you are logged in as the oracle user for this process. If you are logged in as root or another user that does not have sufficient permissions then you will not be able to run the Database Configuration Assistant.

1. After exiting, set the ORACLE_HOME environment variable. In our case, the correct command was
   `ORACLE_HOME=/home/oracle/app/oracle/product/11.2.0/dbhome_1; export ORACLE_HOME`

2. Set your PATH variable by typing
   `PATH=$ORACLE_HOME/bin:$PATH`

3. Type `dbca` to launch the Database Configuration Assistant.

4. When the Database Configuration Assistant: Welcome screen appears, click Next.

5. On the Database Configuration Assistant, step 1 of 12: Operations screen, select Create a Database, and click Next.

6. On the Database Configuration Assistant, step 2 of 12: Database Templates screen, select Custom Database, and click Next.

7. On the Database Configuration Assistant, step 3 of 12: Database Identification screen, enter the Global Database Name. By default, Oracle uses this name for the SID as well.

8. On the Database Configuration Assistant, step 4 of 12: Management Options screen, accept the defaults, and click Next.

9. On the Database Configuration Assistant, step 5 of 12: Database Credentials screen, select Use the Same Administrative Password for All Accounts, and enter the passwords. Click Next.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

10. On the Database Configuration Assistant, step 6 of 12: Database File Locations, select Automatic Storage Management (ASM), browse to your ASM enabled drive, and click Next.
11. When the ASM Credentials screen pops up, enter the ASM password, and click OK.
12. On the Database Configuration Assistant, step 7 of 12: Recovery Configuration screen, accept the default, and click Next.
13. On the Database Configuration Assistant, step 8 of 12: Database Content screen, accept the default, and click Next.
14. On the Database Configuration Assistant, step 9 of 11: Initialization Parameters screen, click Next.
15. On the Database Configuration Assistant, step 10 of 11: Database Storage screen, accept the defaults, and click Next.
16. On the Database Configuration Assistant, step 11 of 11: Creation Options screen, click Finish.
17. On the Confirmation screen, click OK.
    The Database Configuration Assistant screen appears and shows a progress bar. (47 minutes)
18. When the Database creation complete screen appears, click Exit.

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Appendix F. Methodology: Migrating the DS2 data

Exporting data on the Sun Fire V440 running Solaris 10 and Oracle 10*g*

In our examples, we used a sample schema called DS2, which contained four tablespaces. The total size of our schema objects was about 1 GB. Exporting the 1GB schema on the Sun Fire V440 system was very simple.

In this explanation, the directory /u02 is an example. You may store the dump file where ever you wish. We also chose to put the workspaces in Read-Only mode. If you have a larger database and downtime is an issue, you can choose to run the same process from a backup of the database to minimize any inconvenience.

Allow at least 10 minutes to complete the export. This step can take much longer with larger user databases than our 1 GB example database.

1. In order to make sure the correct database will be accessed, use the following command as the oracle user: `ORACLE_SID=ORCL; export ORACLE_SID`
2. Make tablespaces in the set Read-Only. Use the following command from a SQL*Plus command prompt: `ALTER TABLEPSACE` *tablespacename* `READ ONLY;` (You must repeat this step for all Tablespaces in the set.)
3. Create directory for dump, and set permissions in OS and in Oracle. Use the following commands:

   ```
   $ mkdir /u02
   $ chmod  777 /u02
   SQL>CREATE DIRECTORY dump_dir AS '/u02';
   SQL>GRANT READ,WRITE ON DIRECTORY dump_dir
   TO PUBLIC;
   ```

4. Use Data Pump export utility, and set selected tablespaces for transportable set. Use the following command:

   ```
   $ expdp system/password DUMPFILE=expdat.dmp
   DIRECTORY=dump_dir TRANSPORT_TABLESPACES =
   tablespace1,tablespace2,…
   ```

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

Importing data on the Dell PowerEdge R910 running Red Hat Enterprise Linux 5.4 and Oracle 11*g*

Make sure that you have copied expdat.dmp and data files to the Dell PowerEdge R910 before proceeding.

1. Create the directory for import dump, and set permissions in OS and in Oracle. Use the following commands:

```
$ mkdir /u02
$ chmod  777 /u02
SQL>CREATE DIRECTORY dump_dir AS '/u02';
SQL>GRANT READ,WRITE ON DIRECTORY dump_dir
TO PUBLIC;
```

2. Convert datafiles from big-endian format to little-endian format placing files with ASM:

```
$ rman TARGET /
RMAN> CONVERT DATAFILE '/u02/data1.dbf'
2>    FROM PLATFORM 'Solaris[tm] OE (64-
bit)'
3>    FORMAT '+DATA/data1.dbf';
```

(Repeat for each datafile.)

3. We are calling the owner of this database ds2. Create the user for the database using this command in sqlplus: `create user ds2 identified by <PASSWORD>;`

4. Because ds2 is a user we are creating to manage the data for the DS2 database, we grant him all privileges using this command: `grant all privileges to ds2;` (Obviously, you should carefully consider the privileges you grant each new user account.)

5. Use Data Pump import utility, and set selected datafiles import. Use the following command:

```
$ impdp system/password DUMPFILE=expdat.dmp
DIRECTORY=dump_dir TRANSPORT_DATAFILES =
+DATA/data1.dbf,+DATA/data2.dbf,…
```

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
server with Oracle 10*g* Enterprise Edition

6. From SQL> prompt, put tablespaces back into read/write mode using the following command: `ALTER TABLESPACE tablespace1 READ WRITE;`

(Repeat for each tablespace.)

Migrating to Red Hat Enterprise Linux 5.4 on Dell PowerEdge R910 with
Oracle 11*g* Enterprise Edition from Solaris 10 Enterprise on a SPARC-based
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About Principled Technologies

We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help you assess how it will fare against its competition, its performance, whether it's ready to go to market, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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