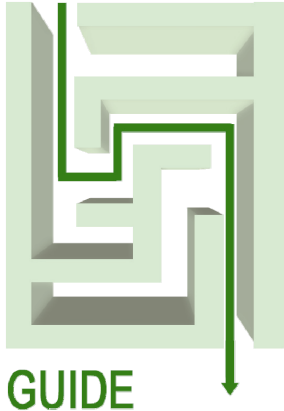


MIGRATION



**MIGRATING FROM
SOLARIS™ 9 ENTERPRISE ON SUN FIRE™ V440
WITH ORACLE® 9i ENTERPRISE EDITION
TO
RED HAT® ENTERPRISE LINUX® 5.2 ON DELL™ R900
WITH ORACLE® 11g ENTERPRISE EDITION**

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Introduction



Dell PowerEdge R900

The Dell™ PowerEdge™ R900 is an excellent server for upgrading critical database applications from Oracle® 9i running on Solaris™ 9 to Oracle 11g, the latest release of Oracle's data management platform, running on Red Hat® Enterprise Linux® 5.2 (RHEL 5.2). This Migration Guide reviews the approach that Principled Technologies® (PT) and Dell recommend for a tested and validated migration of Oracle 9i databases to Oracle 11g on the Dell PowerEdge R900 server and RHEL 5.2.

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 RHEL 5.2 and Oracle 11g. For our test data, we migrated a 20GB 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 PowerEdge R900 provides a much more expandable and capable platform. For example, it can support 256 GB of RAM, as opposed to 32 GB in the Sun Fire V440, and eight internal drives instead of four. It also provides a much more capable RAID controller.

The PowerEdge R900 will also deliver far greater performance. In some of our testing, the PowerEdge R900 delivered over 14 times the performance of the Sun Fire V440.

Scope of this Guide

This Migration Guide reviews the approach that Principled Technologies and Dell recommend for migrating databases from Oracle 9i Enterprise Edition Release 9.2.0.1.0 for Solaris on SPARC™-based systems (64-bit) (Oracle 9i) running on Solaris 9 9/05 Operating System for SPARC-based systems (64-bit) (Solaris 9) to Oracle 11g Enterprise Edition Release 11.1.0.6.0 for Linux on x86_64-based systems (Oracle 11g), running on Red Hat Enterprise Linux 5.2 for x86-64. We cover installing RHEL 5.2 and Oracle 11g on the PowerEdge R900 and migrating user databases from the Sun™ Fire™ V440 to the PowerEdge R900.

New features of Oracle 10g and Oracle 11g

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:

Features Oracle 10g introduced

- **Automated Storage Management.** Storage allocation is one of the most significant issues for any administrator. Oracle 10g R2 can manage the storage for you by, for example, integrating new storage arrays and rebalancing the data. We use ASM in this Guide.
- **Flashback features.** While Oracle 9i provided some flashback capabilities, Oracle 10g expands them considerably. In Oracle 10g, you can flash back the entire database or recover a table you have accidentally dropped using only a few SQL statements. (While the earlier Flash Query option could retrieve data, restoring the table itself was cumbersome.)
- **Help with SQL tuning.** Oracle 10g comes with the Automatic Workload Repository, which automatically takes snapshots of performance metrics, and the Automatic Database Diagnostic Monitor, which can analyze those metrics and make recommendations to improve performance.
- **Improved data movement.** Oracle 10g's Data Pump is a faster, enhanced import and export utility. Its Transportable Tablespaces feature allows you to move data using OS file copy operations, which are typically much faster than importing and exporting.



NOTE: The Data Pump does not support data exported from Oracle 9i. While Oracle 9i had a version of transportable tablespaces, you cannot use it when moving data to a system with different byte ordering. (The PowerEdge R900 and the Sun Fire V440 have different byte ordering.) Therefore, neither of these technologies was an option for this Guide.

Features Oracle 11g introduced

- **Database replay.** Oracle 11g 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 after the change. SQL Performance Analyzer is part of Oracle's Real Application Testing option.
- **Enhanced partitioning options.** Oracle 11g 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.

Pre-migration considerations



This section reviews some of the topics you should consider prior to migrating your databases.

Considerations for moving your applications

Whether an application is one you have developed in house or one you purchased, you have several choices when moving it from Solaris 9 on SPARC-based systems to RHEL 5.2 on x86 (64-bit) systems.

Java-based applications

These applications should run as is in the new RHEL 5.2 x86 (64-bit) environment. Sun developed the original Java language in the 1990s and has maintained a strong commitment to Java ever since. Because Java applications run in a Java Virtual Machine, they are largely machine-independent.

When you have the source code for the application

Frequently, applications for which you have source are those your organization developed. Because Linux and Solaris are both UNIX-based systems, porting an application requires less work than porting to a non-UNIX-based operating system, such as Windows. One big advantage is the availability of the GNU tool set on both Solaris and Linux. If the developer built your application using the Solaris versions of the GCC tools, you will not encounter language issues when you port. However, you may have to contend with differences in the system APIs.

When you do not have the source code for the application

You will not typically have the source for an application you purchased. If such an application is available in an x86 (64-bit) version, you have the option of moving to the native version.

Oracle, of course, is a prime example of an application that both Solaris 9 (SPARC) and RHEL 5.2 (x86 64-bit) support. The bulk of this Guide focuses on how to migrate an Oracle installation from the Solaris 9 SPARC environment to the RHEL 5.2 x86 (64-bit) environment.

You may be able to run your application using QuickTransit from Transitive (<http://www.transitive.com>). QuickTransit for Solaris/SPARC-to-Linux/x86-64 can transparently run many Solaris SPARC applications on Linux without re-compilation. QuickTransit may also be useful when a software package's installer is missing, because it can successfully run many applications that you simply copy from the SPARC environment. Because we are migrating from Solaris 9, you should verify that QuickTransit supports your legacy application, and that the application vendor supports the application running in this configuration. For specific information about QuickTransit for Solaris/SPARC-to-Linux/x86-64, see http://www.transitive.com/products/sol_sparc_lin_x8664.

A note about application data

You should never simply copy the raw data files from one system to another system of a different architecture. The data formats that applications write to disk are not generally portable. Bit orders, padding, and alignment are examples of elements that can differ as you move from one system to another. Most applications, however, provide some ability to back up or export data to portable formats. The restore/import process on the target system is likely to resolve any issues with the data layout.

Migration path

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 export-and-import method as a safe and effective approach to moving databases between the systems.

Unfortunately, the Oracle Database Upgrade Assistant (DBUA) is not an option for migrating the database to Oracle 11g before moving it to the target server. As per the documentation at http://download.oracle.com/docs/cd/B28359_01/server.111/b28301/software003.htm#sthref874, the earliest version of Oracle you can upgrade directly to 11g is Oracle 9i R2, 9.2.0.4. We are using Oracle 9i, build number 9.2.0.1.0.

Installing and setting up Red Hat Enterprise Linux 5.2 and Oracle 11g in this environment



In this section, we focus on installing and setting up RHEL 5.2 and Oracle 11g on the Dell PowerEdge R900 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 RHEL 5.2 and Oracle 11g.

Defining our environment

Our legacy server was a Sun Fire V440 running Solaris 9 9/05 Operating System for SPARC-based systems (64-bit) and Oracle 9i Enterprise Edition Release 9.2.0.1.0 for Solaris on SPARC-based systems (64-bit). Our destination server was an Intel® Xeon® processor E7450-based PowerEdge R900 running Red Hat Enterprise Linux 5.2 for x86-64 and Oracle 11g Enterprise Edition Release 11.1.0.6.0 for Linux on x86_64-based systems. We connected all components via a gigabit switch. Figure 1 illustrates our setup.

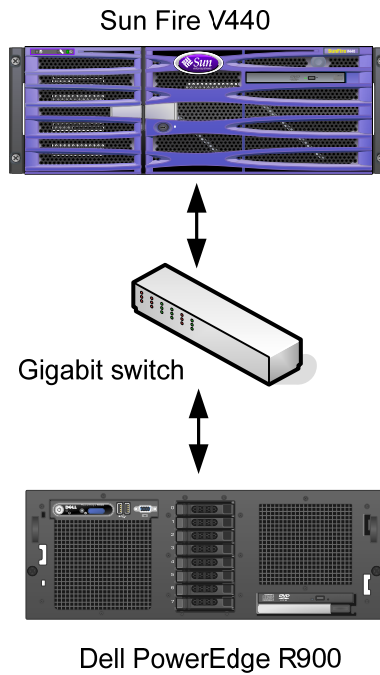


Figure 1. The setup we used in our hands-on testing and research for this Migration Guide.

Figures 2 and 3 present the hardware and software we used in our Oracle 9i and Oracle 11g database servers.

Server	Processor	Memory	Disk
Sun V440 (legacy database server)	4 x UltraSparc™ IIIi 1.59 GHz	32 GB	4 x Fujitsu® Ultra320 SCSI, 73 GB
Dell PowerEdge R900 (migration database server)	4 x Intel Xeon processor E7450 (6-core, 2.4GHz, 12MB L3 cache)	64 GB	8 x Seagate® SAS, 15K RPM, 73 GB

Figure 2. Servers we used in our hands-on testing and research for this Guide.

Server	Server operating system	Oracle version
Sun V440 (legacy database server)	Sun Solaris 9 9/05 Operating System for SPARC-based systems (64-bit)	Oracle 9i Enterprise Edition Release 9.2.0.1.0 for Solaris on SPARC-based systems (64-bit)
Dell PowerEdge R900 (migration database server)	Red Hat Enterprise Linux 5.2 for x86-64	Oracle 11g Enterprise Edition Release 11.1.0.6.0 for Linux on x86_64-based systems

Figure 3. Software we used in our hands-on testing and research for this Guide.

We also used a 16-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>.

Configuring the RAID drives

Overview

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

We had eight internal disk drives in our PowerEdge R900. We configured them as four RAID 1 arrays of two drives each, as Figure 4 shows.



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

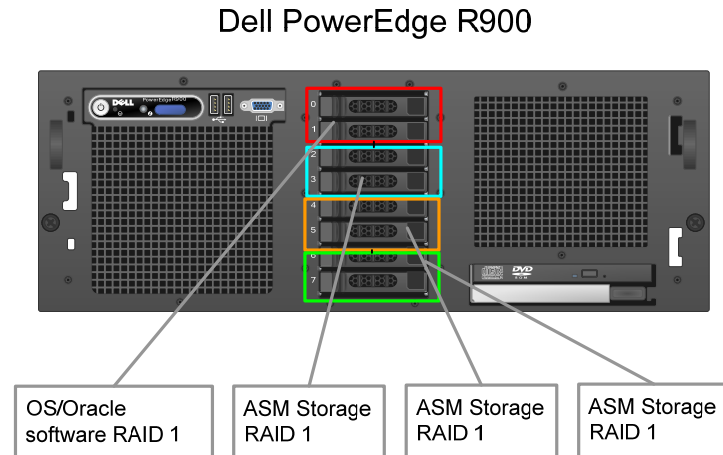


Figure 4. The drive configuration we used in our hands-on testing and research for this Guide.

The first array holds the OS and Oracle software.

We used the next two RAIDs to create an ASM disk group.

We reserved the remaining RAID to hold the dump file from our Oracle 9i server. After we imported our 20GB database into an Oracle 11g database, we unmounted the array and added it to the ASM diskgroup.



NOTES: 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 48 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 5.2

This section provides an overview of the operating system installation process. We include approximate wait times for each step. ([Appendix B](#) provides complete, detailed installation instructions.) We downloaded the operating system from <http://rhn.redhat.com> and burned it to a DVD, from which we installed. You must register with the Red Hat Network to download

the OS; the following instructions assume you have a valid installation number.



NOTE: Plan on at least 35 minutes for installing RHEL 5.2 on the Dell PowerEdge R900 server. Each step takes at least 1 minute. We provide the approximate amount of time each step takes in parentheses. These times exclude data entry time.

1. Insert the RHEL 5.2 DVD into the DVD drive, and reboot the system. When the installer prompts you, press Enter to install in graphical mode (Figure 5).



Figure 5. 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 6).



Figure 6. Swap space increased.

5. Accept the default installation locations for the operation system and boot loader (Figure 7).



Figure 7. Accept default installation locations.

6. Configure your network information (Figure 8).



Figure 8. Configure 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. The installer should eject the DVD automatically. (11 minutes)
8. After the reboot, accept the license agreement, enable secure http, and disable SELinux. ASM will not be able to mount the disks if SELinux is running.
9. Set the date and time. Register with the Red Hat Network (RHN) if appropriate.
10. Create a user 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.

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 (11.1) for Linux*, Chapter 2 Oracle Database Preinstallation Requirements at http://download.oracle.com/docs/cd/B28359_01/install.111/b32002/pre_install.htm#BABFDGHJ

We provide an overview of these tasks here and give detailed instructions for each in [Appendix C](#).

Our server met many of the prerequisites for installing Oracle 11g, so we do not discuss checking those prerequisites here. The Oracle document we cite above covers that topic in detail. Among the tasks we discuss in detail in [Appendix C](#) 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 drives

The next step is to prepare the data drives 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 each 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 each disk, effectively giving the Oracle account control of all the space on the disk.

Installing Oracle 11g on the PowerEdge R900 running Red Hat Enterprise Linux 5.2

We provide an overview of installing Oracle here. For detailed instructions, see [Appendix C](#). We downloaded Oracle 11g from <http://www.oracle.com/technology/software/products/database/index.html>. We copied the `linux.x64_11gR1_database.zip` file to the

PowerEdge R900, and unzipped it locally by right-clicking the file and choosing Extract Here.

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



2. **NOTES:** 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 9).



Figure 9. Select Advanced Installation.

3. 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 (Figure 10).



Figure 10. Checking the prerequisites.

4. Choose to configure Automatic Storage Management (ASM), enter the ASM password, and configure your diskgroup (Figure 11).



Figure 11. Configuring ASM.

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 12). The two configuration assistants should start successfully, and you will automatically advance to the next screen.



Figure 12. Installing the Configuration Assistants.

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

Creating an empty database

1. After exiting, set your Oracle environment variables as we describe in [Appendix C](#), and type `dbca` inside a terminal window to launch the Database Configuration Assistant (Figure 13).

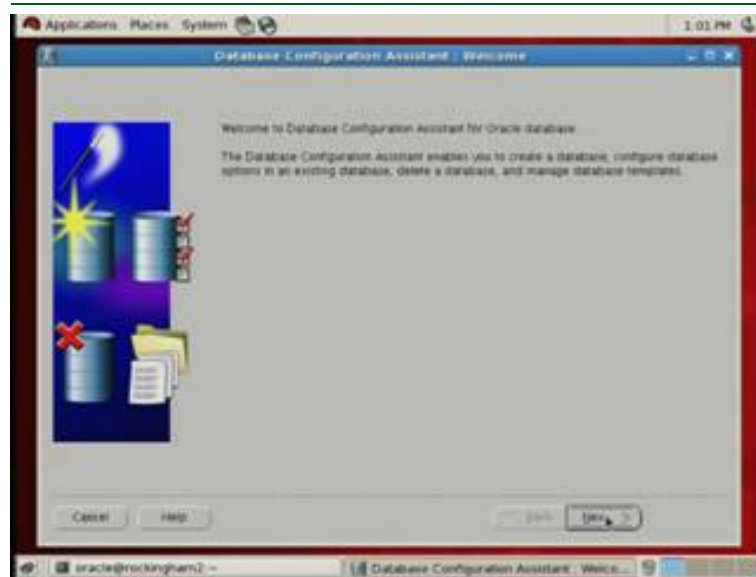


Figure 13. The Database Configuration Assistant.

2. When the Welcome screen appears, click Next. Create a custom database and give it a name (Figure 14).

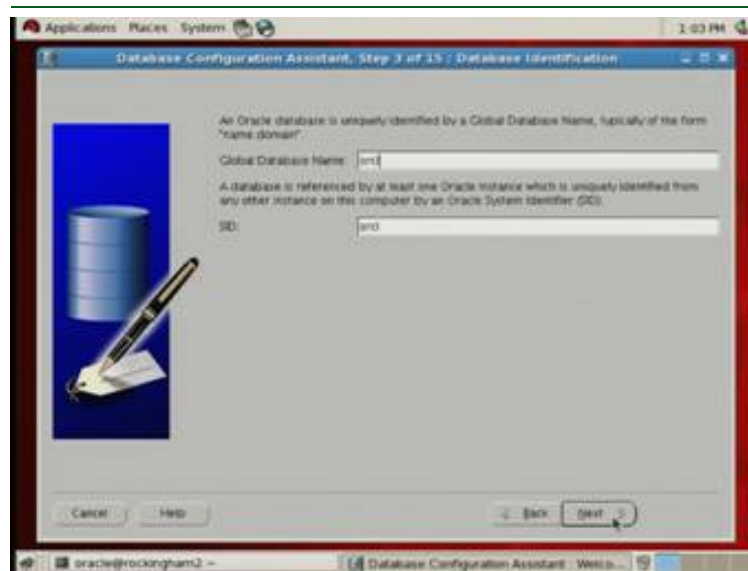


Figure 14. Naming the database.

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 then select the diskgroup you configured earlier (Figure 15).

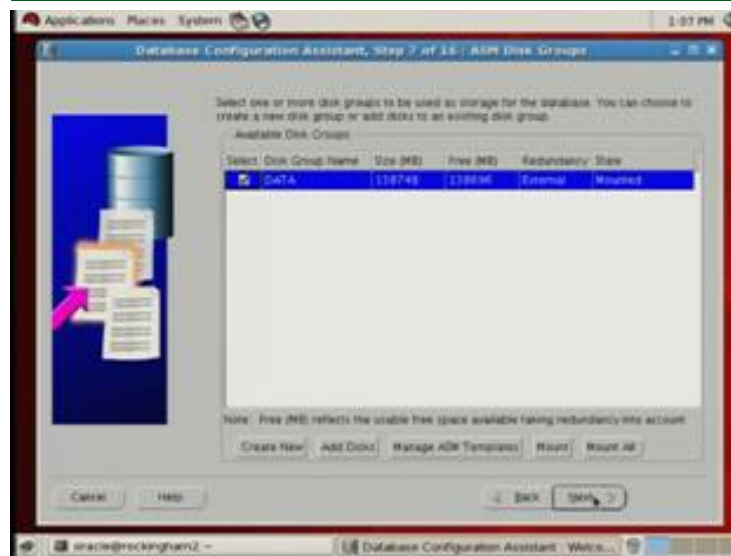


Figure 15. Choosing the diskgroup.

4. Accept the default for the remaining screens, and then click Finish. The Database Configuration Assistant screen appears and shows a progress bar (Figure 16). (43 minutes)



Figure 16. Installing the database.

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

Migrating to Oracle 11g



In this section we provide specific details about migrating user databases from Oracle 9i to Oracle 11g. We give an overview of the processes of migrating your database from Solaris 9 and Oracle 9i on the Sun Fire V440 to RHEL 5.2 and Oracle 11g on the Dell PowerEdge R900.

Migrating your data using export and import

In this section, we provide an overview of the processes involved in migrating your database to RHEL 5.2 and Oracle 11g on the Dell PowerEdge R900. We provide detailed instructions in [Appendix E](#).

Exporting your Oracle 9i database

Using the Sun Fire V440 server, export the schema using the command line utility exp. Figure 17 shows a sample portion of its output. See [Appendix E](#) for details.

Export times vary. Exporting our 20 GB schema on our Sun Fire V440 took 42 minutes.

```
Connected to: Oracle9i Enterprise Edition Release
9.2.0.1.0 - 64bit Production
With the Partitioning, OLAP and Oracle Data Mining
options
JServer Release 9.2.0.1.0 - Production
Export done in US7ASCII character set and AL16UTF16
NCHAR character set
server uses WE8ISO8859P1 character set (possible charset
conversion)
. exporting pre-schema procedural objects and actions
. exporting foreign function library names for user DS2
. exporting PUBLIC type synonyms
. exporting private type synonyms
. exporting object type definitions for user DS2
About to export DS2's objects ...
. exporting database links
. exporting sequence numbers
. exporting cluster definitions
. about to export DS2's tables via Conventional Path ...
. . exporting table                CATEGORIES
16 rows exported
. . exporting table                CUSTOMERS
. . exporting partition            US_PART
20000000 rows exported
. . exporting partition            ROW_PART
20000000 rows exported

.....

Export terminated successfully without warnings.
```

Figure 17. Truncated sample output from an Oracle 9i export.

Importing the database into Oracle 11g server

On the RHEL 5.2, PowerEdge R900 server, take the following steps:

1. In the empty database you created earlier, create the database user for the schema you will import.
2. Create the tablespaces, storing them in ASM managed storage.
3. Run the import utility. Import times vary. Importing our 20 GB schema on our Dell PowerEdge 900 took 60 minutes.

```
Connected to: Oracle Database 11g Enterprise Edition
Release 11.1.0.6.0 - 64bit Production
With the Partitioning, OLAP, Data Mining and Real
Application Testing options

Export file created by EXPORT:V09.02.00 via conventional
path
import done in US7ASCII character set and AL16UTF16
NCHAR character set
import server uses WE8MSWIN1252 character set (possible
charset conversion)
. importing DS2's objects into DS2
. . importing table                "CATEGORIES"
16 rows imported
. . importing partition            "CUSTOMERS": "US_PART"
20000000 rows imported
. . importing partition            "CUSTOMERS": "ROW_PART"
20000000 rows imported
. . importing partition            "CUSTOMERS": "MAXVAL"
0 rows imported
. . importing table                "CUST_HIST"
119990751 rows imported
. . importing table                "INVENTORY"
200000 rows imported
. . importing partition            "ORDERLINES": "JAN2004"
9994988 rows imported
. . importing partition            "ORDERLINES": "FEB2004"
10001088 rows imported
. . importing partition            "ORDERLINES": "MAR2004"
9997816 rows imported
. . importing partition            "ORDERLINES": "APR2004"
10001861 rows imported
. . importing partition            "ORDERLINES": "MAY2004"
10005091 rows imported
. . importing partition            "ORDERLINES": "JUN2004"
9998739 rows imported
. . importing partition            "ORDERLINES": "JUL2004"
10003418 rows imported
. . importing partition            "ORDERLINES": "AUG2004"
9998633 rows imported
. . importing partition            "ORDERLINES": "SEP2004"
9995732 rows imported

...

About to enable constraints...
Import terminated successfully without warnings.
```

Figure 18. Truncated sample output from Oracle 11g import.



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.

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 a couple 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, except for SYS and SYSTEM, and then 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 11g 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 11g 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 11g Release 1 (11.1) at http://download.oracle.com/docs/cd/B28359_01/server.111/b28300/toc.htm

Backing up your database

Having successfully migrated to RHEL 5.2 and Oracle 11g, you should make a full backup of your production database. This will ensure that you not have to repeat the import should any problems occur. It will also serve as a baseline for all future backups.

Summing up

RHEL 5.2 and Oracle 11g introduce many new features and enhancements. As this Guide has explained, the process of deploying these products on a Dell PowerEdge Server and migrating your Oracle 9i 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.

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Information in this document is subject to change without notice.

Appendix A. Methodology: Creating the RAID disk groups

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

- operating system files and Oracle files
- storage for dump file, later added to ASM storage
- ASM storage
- ASM storage

We explain below how we configured these four disk groups. The directions in this appendix 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 Controller 0 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). Then 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 Controller 0, 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. Then 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 Controller 0, press F2, and select Create New VD.
- 12.** With the RAID level field highlighted, press Enter to open the drop-down list, and select RAID 1.
- 13.** Using the Tab key for navigation, move to the Physical Disks section, and use the space bar to select the first two drives (Drives 4 and 5). Note that the drives you allocated earlier no longer appear in the available list. Then tab to highlight OK, and press Enter.
- 14.** A message box appears telling you that initializing the RAID is highly recommended, but destructive. Press Enter to clear the message.
- 15.** Highlight Controller 0, press F2, and select Create New VD.
- 16.** With the RAID level field highlighted, press Enter to open the drop-down list, and select RAID 1.
- 17.** Using the Tab key for navigation, move to the Physical Disks section. Note that only two drives remain on the available list. Select these, then tab to highlight OK, and press Enter.
- 18.** A message box appears telling you that initializing the RAID is highly recommended, but destructive. Press Enter to clear the message.
- 19.** Highlight Virtual Disk 0, and press F2.
- 20.** Select Initialization, and then select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.
- 21.** Highlight Virtual Disk 1, and press F2.
- 22.** Select Initialization, and then select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.
- 23.** Highlight Virtual Disk 2, and press F2.
- 24.** Select Initialization, and then select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.
- 25.** Highlight Virtual Disk 3, and press F2.
- 26.** Select Initialization, and then select Fast Init. Highlight OK, and when the system prompts you with any warnings, press Enter.
- 27.** Exit the RAID utility, and reboot the server.

Appendix B. Methodology: Installing Red Hat Enterprise Linux 5.2 on the PowerEdge R900

Install Red Hat Enterprise Linux 5.2 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 5.2, which we downloaded from <http://rhn.redhat.com> and burned to a DVD. You must register with the 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 RHEL 5.2, the splash screen says "Red Hat Enterprise Linux 5."
- 4.** Accept the default of English to use as the language during the installation, and click Next.
- 5.** Accept the default of U.S. English as the appropriate keyboard for the system, and click Next.
- 6.** Enter your installation number, and click Next.
- 7.** Accept the default of Install Red Hat Enterprise Linux Server, and click Next.
- 8.** For each drive, ignore the warning "The partition table of sd<x> was unreadable." Click OK to the warning about erasing all data.
- 9.** On the next screen, choose Remove all partitions on selected drives and create default layout. Then deselect sdb, sdc, and sdd. Finally, select Review and modify partitioning layout. Click Next.
- 10.** At the warning, click Yes.
Note: During our experiments, Oracle warned that it expected a minimum of 48,339 MB of swap space. The default layout gives us 1,984 MB of swap space. So, we have to take some space from the root volume

and use it for swap space. Click VolGroup00, and then click Edit.

- 11.** Click LogVol00, which should have a mount point of `/'`. Click Edit.
- 12.** Reduce the size from 62764 to 20896, and click OK.
- 13.** Click LogVol01, which should not list a mount point, and click Edit.
- 14.** Increase the size from 1984 to 48352. Click OK.
Note: when we used 48339, the install procedure reduced the number to 48320. So, we used the smallest number that would meet Oracle's recommendations. We will create the partitions on the other three 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 eight of our NICs. Repeat these steps for each NIC:
 - 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.
 - Select the NIC, and click Edit.
 - Click Manual configuration.
 - Enter the IP address.
 - Enter the subnet mask.
 - Deselect Enable IPv6 Support.
 - 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.
- 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.
- 34.**On the warning screen, click No thanks, I'll connect later.
- 35.**On the Finish Updates Setup screen, click Forward.
- 36.**Create a regular user account, filling in the username, full name, and password. We did not create the Oracle owner account here, because we have not had the opportunity to create the required groups for that account.
- 37.**On the Sound Card screen, click Forward.
- 38.**On the Additional CDs screen, click Finish.
- 39.**The system will reboot. Make sure the installation DVD is not in the system. (10 minutes)

Appendix C. Methodology: Installing Oracle 11g on the PowerEdge R900

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 (11.1) for Linux*, Chapter 2 Oracle Database Preinstallation Requirements at

http://download.oracle.com/docs/cd/B28359_01/install.111/b32002/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 document, 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 setting 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-0.125-3.el5.x86_64.rpm elfutils-libelf-devel-static-0.125-3.el5.x86_64.rpm elfutils-libelf-devel-0.125-3.el5.x86_64.rpm gcc-4.1.2-42.el5.x86_64.rpm gcc-c++-4.1.2-42.el5.x86_64.rpm glibc-2.5-24.x86_64.rpm glibc-common-2.5-24.x86_64.rpm glibc-devel-2.5-24.x86_64.rpm glibc-devel-2.5-24.i386.rpm glibc-headers-2.5-24.x86_64.rpm kernel-headers-2.6.18-92.el5.x86_64.rpm libaio-devel-0.3.106-3.2.x86_64.rpm libgomp-4.1.2-42.el5.x86_64.rpm libstdc++-4.1.2-42.el5.x86_64.rpm libstdc++-devel-4.1.2-42.el5.x86_64.rpm sysstat-7.0.2-1.el5.x86_64.rpm unixODBC-2.2.11-7.1.x86_64.rpm unixODBC-devel-2.2.11-7.1.x86_64.rpm
```


- 6.** The installation did not add the entry association the host name with the IP address for eth0. We need to do that. Edit /etc/hosts, editing the line “127.0.0.1”, and adding one new line, so that you end up with two lines like this:

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

- 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”.
- `hostname` should list a hostname for this system.
- `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 11g 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= 4194304  
net.core.rmem_max=4194304  
net.core.wmem_default=262144  
net.core.wmem_max=262144  
net.ipv4.ip_local_port_range=1024 65000
```

- 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 this command: `/usr/sbin/groupadd oinstall`

- 12.** Create the Oracle dba group with this command: `/usr/sbin/groupadd dba`

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

- 14.** Set the password of the oracle user with this 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 these lines:

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

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

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 `2.6.18-92.el5 x86_64`. So, we downloaded the following three RPMs:
 - http://oss.oracle.com/projects/oracleasm/dist/files/RPMS/rhel5/amd64/2.0.4/2.6.18-92.el5/oracleasm-2.6.18-92.el5-2.0.4-1.el5.x86_64.rpm
 - http://oss.oracle.com/projects/oracleasm-support/dist/files/RPMS/rhel5/amd64/2.0.4/oracleasm-support-2.0.4-1.el5.x86_64.rpm
 - http://www.oracle.com/technology/software/tech/linux/asmlib/files/RPMS/rhel5/amd64/2.0.3/oracleasmlib-2.0.3-1.el5.x86_64.rpm
2. Install ASMLib with this command:

```
rpm -Uvh oracleasm-2.6.18-92.el5-2.0.4-1.el5.x86_64.rpm \
```

```
oracleasm-support-2.0.4-1.el5.x86_64.rpm \  
oracleasm-lib-2.0.3-1.el5.x86_64.rpm
```

- 3.** Configure ASMLib with this 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 Start Oracle ASM library on boot, type `y`.
- 7.** When prompted Fix permissions of Oracle ASM disks on boot, type `y`.
- 8.** For each of the devices `/dev/sdb`, `/dev/sdc` and `/dev/sdd`, do the following:
 - Run `fdisk`. For example, `fdisk /dev/sdb`
 - Type `n` to create a new partition.
 - Type `p` to create a primary partition.
 - Type `1` to make it partition 1.
 - Type `1` for the starting cylinder.
 - Type `8844` for the size. This is all the space on the drive.
 - 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`
 - `chown oracle:dba /dev/sdc1`
 - `chown oracle:dba /dev/sdd1`
 - `chmod 660 /dev/sdb1`
 - `chmod 660 /dev/sdc1`
 - `chmod 660 /dev/sdd1`
- 10.** Now we need to mark `sdb1` and `sdc1` as belonging to ASM. We will label ASM disks as `VOL1` and `VOL2` using these commands:

```
/etc/init.d/oracleasm createdisk VOL1 /dev/sdb1  
/etc/init.d/oracleasm createdisk VOL2 /dev/sdc1
```

Appendix D. Methodology: Installing Oracle 11g on the PowerEdge R900 running Red Hat Enterprise Linux 5.2

We downloaded Oracle 11g from <http://www.oracle.com/technology/software/products/database/index.html>. We copied the linux.x64_11gR1_database.zip file to the PowerEdge R900, and unzipped it locally by right clicking the file 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 Select Installation Method screen, deselect Create Starter Database.
- 5.** Click Advanced Installation. The fields under Basic Installation turn gray, but their values hold. Click Next.
- 6.** The OUI dialog disappears for few seconds, and then reappears. In the Specify Inventory Directory and credentials screen, accept the default, and click Next.
- 7.** In the Select Installation Type screen, accept the default, Enterprise Edition, and click Next.
- 8.** On the Specify Home Details Screen, accept the default, and click Next.
- 9.** On the Product-Specific Prerequisite Checks screen, you should see the message 0 requirements to be verified. Click Next.
- 10.** On the Select Configuration Option Screen, select Configure Automatic Storage Management (ASM), and enter the ASM password. Click Next.
- 11.** On the Configure Automatic Storage Management screen, accept the default Disk Group Name of DATA, choose External for the type of Redundancy, and select both available disks. (Note: Because you configured your storage as a set of RAIDs earlier, the RAID controller provides the redundancy.) Click Next.
- 12.** On the Privileged Operating System Groups screen, accept the defaults, and click Next.

- 13.** On the Oracle Configuration Manager Registration, accept the default of Enable being deselected, and click Next.
- 14.** On the Summary screen, review your settings, and click Install. The Install screen, which shows a progress bar, appears. (3 minutes)
- 15.** When the progress bar completes, Oracle asks you to run two scripts 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.
- 16.** The first script is `orainstRoot.sh`. You only see this script the first time you install Oracle on a system. Should you need to reinstall Oracle, you will not run it again.
- 17.** The second script is `root.sh`. It asks you to type in the name of the local bin directory, which is `/usr/bin`. Before this script completes, it starts the CSS service. Once you see the message "Oracle CSS service is installed and running under init(1M)," you may close the terminal Window.
- 18.** In the Execute Configuration scripts dialog, click OK. Next, the Configuration Assistants screen appears. The two assistants should start successfully, and you will automatically advance to the next screen. (1 minute)
- 19.** On the End of Installation screen, click Exit, then click Yes to confirm that you really want to exit.

Creating an empty database

Allow at least 50 minutes to create the database.

- 1.** After exiting, set the `ORACLE_HOME` environment variable. In our case, the correct command was
`ORACLE_HOME=/home/oracle/app/oracle/product/11.1.0/db_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 15: Operations screen, select Create a Database, and click Next.

- 6.** On the Database Configuration Assistant, step 2 of 15: Database Templates screen, select Custom Database, and click Next.
- 7.** On the Database Configuration Assistant, step 3 of 15: 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 15: Management Options screen, accept the defaults, and click Next.
- 9.** On the Database Configuration Assistant, step 5 of 15: Database Credentials screen, accept the default of using the same password for the listed accounts, and enter the passwords. Click Next.
- 10.** On the Database Configuration Assistant, step 6 of 15: Storage Options, select Automatic Storage Management (ASM), 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 15: ASM Disk Groups, select the group you created during ASM installation. Then click Next.
- 13.** On the Database Configuration Assistant, step 8 of 15: Database File Locations, accept the default, and click Next.
- 14.** On the Database Configuration Assistant, step 9 of 15: Recovery Configuration screen, accept the default, and click Next.
- 15.** On the Database Configuration Assistant, step 10 of 15: Database Content screen, accept the default, and click Next.
- 16.** On the Database Configuration Assistant, step 11 of 15: Initialization Parameters, accept the default, and click Next.
- 17.** On the Database Configuration Assistant, step 12 of 15: Security Settings, accept the default, and click Next.
- 18.** On the Database Configuration Assistant, step 13 of 15: Automatic Maintenance Tasks, accept the default, and click Next.
- 19.** On the Database Configuration Assistant, step 14 of 15: Database storage, accept the default, and click Next.
- 20.** On the Database Configuration Assistant, step 15 of 15: Creation Options screen, click Finish.

- 21.** On the Confirmation screen, click OK.
The Database Configuration Assistant screen appears and shows a progress bar. (44 minutes)
- 22.** When the Database creation complete screen appears, click Exit.

Appendix E. Methodology: Migrating the DS2 data

Exporting data on the Sun Fire V440 running Solaris 9 and Oracle 9i

In our examples, we used a sample schema called DS2, which contained four tablespaces. The total size of our schema objects was about 20 GB. Exporting the 20GB 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.

Allow at least 1 hour to complete the export.

1. You must run the catexp.sql script before using the import and export utilities. Depending on your current directory, you may have to specify the path to the script, which is in the rdbms/admin directory in your Oracle home directory.
2. To export the database, use this command: `exp ds2/<PASSWORD> FILES=/u02/ds2.dmp LOG=ds2.log STATISTICS=none OWNER=ds2 (42 minutes)`
This command logs into the database as the user ds2 and exports the ds2 user's schema objects out to a file called ds2.dmp located at /u02.

Importing data on the PowerEdge R900 running RHEL 5.2 and Oracle 11g

Note: You created the empty database previously.

Allow at least 1 hour and 15 minutes to complete the import.

1. While logged in as root, prepare sdd1 to hold our dump file and mount it with these commands:
`mkfs /dev/sdd1`
`mkdir /space`
`chmod 666 /space`
`chown oracle:oinstall /space`
`mount /dev/sdd1 /space`
Note: Should you need to reboot before completing the import, you will need to mount sdd1 a second time.
2. Log out of the root account, and log in as oracle.

3. Copy the dump file to the /space directory. Transfer times will vary, but it took us 21 minutes to copy the file.
4. Edit the file \$ORACLE_HOME/dbs/init.ora. (Assuming you accepted the default name of "orcl" for your database.) Add the line `SESSIONS=750`. In our experiments, we exceeded the default value of 170 concurrent sessions during our import.
5. As the Oracle user, start sqlplus with this command at a shell: `sqlplus`. When prompted for username, use `sys as sysdba`. When prompted for a password, use the one you selected earlier.
6. You need to restart the database to get the sessions parameter to take effect. Type `shutdown immediate;(1 minutes)`
7. Type `startup;` (2 minutes)
8. Type `show parameter sessions;` make sure sessions has the new value of 750.
9. As we note above, you need to run the `catexp.sql` script. Use the script `@catexp.sql` for this. Depending on your current directory, you may have to specify the path to the script, which is in the `rdbms/admin` directory in your Oracle home directory.
10. We are calling the owner of this database ds2. Create the user for the database using this command:
`create user ds2 identified by <PASSWORD>;`
11. 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.)
12. Our schema has four tablespaces: `custtbs`, `ds_misc`, `indxtbs`, and `ordertbs`. Create them using the following commands:
 - `CREATE TABLESPACE "CUSTTBS"
LOGGING DATAFILE '+DATA' SIZE 18000M
REUSE AUTOEXTEND ON NEXT 500M MAXSIZE
32767M EXTENT MANAGEMENT LOCAL
SEGMENT SPACE MANAGEMENT AUTO;(3
minutes)`
 - `CREATE TABLESPACE "DS_MISC"
LOGGING DATAFILE '+DATA' SIZE 1000M
REUSE AUTOEXTEND ON NEXT 500M MAXSIZE`

```
32767M      EXTENT MANAGEMENT LOCAL  
SEGMENT SPACE MANAGEMENT AUTO; (2  
minutes)
```

- CREATE TABLESPACE "INDXTBS"
LOGGING DATAFILE '+DATA' SIZE 12000M
REUSE AUTOEXTEND ON NEXT 500M MAXSIZE
32767M EXTENT MANAGEMENT LOCAL
SEGMENT SPACE MANAGEMENT AUTO; (2
minutes)
- CREATE TABLESPACE "ORDERTBS"
LOGGING DATAFILE '+DATA' SIZE 12000M
REUSE AUTOEXTEND ON NEXT 500M MAXSIZE
32767M EXTENT MANAGEMENT LOCAL
SEGMENT SPACE MANAGEMENT AUTO; (2
minutes)

Notice the +DATA syntax, which tells Oracle to put the tablespaces in ASM storage. Note: We created the tablespaces using the parameters from the DS2 scripts.

13.Type EXIT; to exit sqlplus.

14.Import the ds2 data with this command:

```
imp ds2/<PASSWORD> FILE=/space/<NAME>.dmp  
LOG=<NAME>.log FROMUSER=ds2  
STATISTICS=recalculate (60 minutes)
```

15.The import is complete. Check the log when imp finishes to verify a successful installation.

Adding the final RAID array to ASM

Allow at least 20 minutes to complete the configuration.

- 1.** Log in as root.
- 2.** Unmount the /space directory using the umount command:
umount /space
- 3.** Earlier, we set the ownership and permissions for /dev/sdd1. However, we should verify that nothing has changed. Check the ownership by using this command:
ls -l /dev/sdd1
You should see that the owner is still Oracle.
- 4.** Now we need to mark sdd1 as belonging to ASM. Label this ASM disk as VOL3 using this command:
/etc/init.d/oracleasm createdisk VOL3
/dev/sdd1
- 5.** Log out of the root account and log in as oracle.
- 6.** Start dbca, and click Next on the Welcome screen.

- 7.** On the Database Configuration Assistant step 1 of 15: Operations, Select Configure Automatic Storage Management. The title will change to say step 1 of 4.
- 8.** On the Database Configuration Assistant step 2 of 4: ASM Disk Groups screen, Select Add Disks.
- 9.** On the Add Disks screen, select the remaining disk. In our case, it showed up as ORCL:VOL3. Click OK.
- 10.** When you return to the Database Configuration Assistant step 2 of 3: ASM Disk Groups screen, click Finish.
- 11.** When dbca asks if you want to perform another operation, click No.
ASM automatically rebalances the data across all drives, including the one you just added.
(Approximately 14 minutes, an estimate we based on the activity of the disk lights)

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