

MIGRATE YOUR LEGACY IBM® DATABASE ENVIRONMENT TO THE LATEST ORACLE® TECHNOLOGIES



MOVING TO ORACLE LINUX™ WITH ORACLE DATABASE 11^g
FROM IBM AIX® WITH DB2® ON AN IBM POWER® SYSTEM



A migration guide commissioned by Intel Corp. and Oracle

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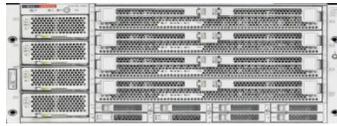
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Preface

Since the initial publication of this migration guide, Oracle has introduced the Sun Fire™ X4800 M2 server. This new version of the server includes the latest Intel® Xeon® processor E7-8800, which is a faster processor that adds two additional cores. Like its predecessor, the Sun Fire X4800 M2 server is an expandable four- to eight-socket server supporting 8 to 10 cores per socket, 2 TB of memory, and over 4.8 TB of internal storage. In addition, the Sun Fire X4800 M2 server now supports up to eight 2.5-inch solid state drives, and should show reduced power consumption.

The process of upgrading from an IBM® AIX® Power System™ to the Sun Fire X4800 M2 should be the same as we describe for the earlier model and should yield even better reduced implementation times and reduced cost. The following migration guide describes that process in detail.

Introduction



Sun Fire X4800 Server

With its ability to yield significant benefits such as increased performance, improved RAS through hot-plug capabilities, reduced implementation time, and reduced costs, Oracle's Sun Fire™ X4800 Server is an excellent system for upgrading critical applications running on IBM® AIX Power® Systems to Oracle® Linux™. Migrating to Oracle's Sun Fire X4800 Server powered by the Intel® Xeon® Processor 7500 series is a straightforward process that highlights some of these benefits. Such a migration also presents opportunities for server consolidation that can reduce server footprint in the datacenter, resulting in decreased hardware, maintenance, and support costs.

To help you evaluate options for replacing your older IBM AIX Power systems (such as an IBM Power 5), Principled Technologies (PT) has performed hands-on testing and research of a migration to the Intel Xeon platform.

The Sun Fire X4800 Server, based on the Intel Xeon Processor 7500 series, is a much more capable system than the IBM Power system we tested. (See [Appendix A](#) for detailed system information.) The Sun Fire X4800 Server is an expandable four- to eight-socket server supporting up to 64 processor cores, 1 TB of RAM, and over 2 TB of internal storage. With Intel's latest Intel Xeon Processor 7500 series, we see even greater functionality and an even greater performance increase over the Intel Xeon Processor 7400 series. In addition, we expect to see a greater ability to configure high-availability systems with the support of hot-swappable I/O, disks, service processor, cooling fans, and power supplies.

Oracle Linux, an enterprise-class Linux distribution, is free to download, use, and distribute. Oracle Linux offers choice, high quality, lower cost support and binary compatibility with Red Hat Enterprise Linux. In the Features of Oracle Linux section of this Guide, we describe some of the Oracle Linux 5.5 features.

Scope of this Guide

This Guide reviews the approach that we recommend for planning and implementing the migration of applications on an IBM Power System running AIX to Oracle's Sun Fire X4800 Server with the Intel Xeon Processor 7560 running Oracle Linux 5.5 Operating System. We explain how to move a sample application with an IBM DB2 database on an IBM Power System to an Oracle Database 11g Release 2 database on an Oracle Sun Fire X4800 Server running Oracle Linux 5.5. We also explain how to install Oracle Linux and Oracle Database 11g Release 2 on the Oracle Sun Fire X4800 Server and

migrate user databases from the IBM Power System to the Oracle Sun Fire X4800 Server.

Note: In September 2010, the nomenclature Oracle Enterprise Linux (OEL) changed to Oracle Linux. All references in this document reflect this change.

Features of the Sun Fire X4800 Server with the Intel Xeon Processor 7500 series

With high scalability, dense computing capability, high reliability, and built-in virtualization, the Oracle Sun Fire X4800 is excellent for consolidation, virtualization, running database applications, and running enterprise high-performance computing applications. Its 5RU form factor provides enterprise-class configurations: up to 64 processing cores, and 1 TB of RAM (in 128 slots). Additionally, it supports up to eight internal SAS disk drives and up to eight hot-swappable PCIe 2.0 ExpressModule slots. Its available RAS features, including Oracle Integrated Lights Out Manager (ILOM) running on a hot-swappable service processor module, add to the impressive features of this powerful, highly expandable server.

The Sun Fire X4800 Server takes full advantage of the new Intel Xeon Processor 7500 series in delivering performance and cost savings over older IBM Power systems. Configurable with over four times the memory capability and the capacity for up to 16 DIMMS per CPU socket, for a possible total of 128 DIMMS, this machine proves an effective replacement for more expensive, larger, reduced instruction set computing (RISC) systems. In addition, the newer processors and systems are even more power efficient, providing even better performance while consuming less energy depending on the configuration.

The Intel Xeon Processor 7500 series itself provides plenty of headroom for consolidation via virtualization of business-critical applications. The Intel Xeon Processor 7500 series offers a threefold performance increase on benchmarks compared to earlier processor generations and can be expected to replace 20 single-core servers with one new system.¹ Additional features include up to 24 MB of L3 cache and a reduction in power consumption through the use of power saving modes, or increases in performance through the use of Intel's Turbo Boost feature, which allows for dynamic clock speed increases when environmental conditions and workload allow.

¹ Extracted from the Intel Xeon Processor 7500 series press release at http://www.intel.com/pressroom/archive/releases/2010/20100330comp_sm.htm

At the time this Guide was written, Oracle Linux 5.5 was the latest release of the Oracle Linux operating system available. Oracle Linux 5.5 replaced the previous Release 5.3 (which was certified compliant with the Linux Standard Base standard). Being fully binary compatible with Red Hat Linux, the operating system shares all of its features, in addition to many additional features written to take full advantage of the Intel Xeon Processor 7500 series processor and Oracle's Sun Fire servers. Technologies like ASMLib, a support library that highlights and simplifies database administration for ease of integration with Oracle Database 10g and later, and Oracle Cluster File System 2, which Oracle developed and is now a part of the Linux kernel, are just two notable features in this product.

As of September 19, 2010, Oracle also announced the Unbreakable Enterprise Kernel for Oracle Linux, which is based on a stable 2.6.32 kernel and includes optimizations developed in collaboration with Oracle's Database, Middleware, and Hardware engineering teams to ensure stability and optimal performance for the most demanding enterprise workloads.

According to Oracle's white paper from October 2010, in addition to performance improvements for large systems, the Unbreakable Enterprise Kernel contains many new features that are relevant to Linux running in the data center, including the following:

- Hardware fault management to avoid system crashes and improve application uptime
- Power management features to reduce power consumption when a system is idle
- Data integrity features to avoid corrupt data from being written
- Fallocate() system call to quickly pre-reserve space in large files

More features and information are available at <http://www.oracle.com/us/technologies/linux/025994.htm>. The white paper on the new Unbreakable Enterprise Kernel is available at <http://www.oracle.com/us/technologies/linux/uek-for-linux-177034.pdf>.

Planning the migration

This section reviews some of the topics you should consider prior to migrating your platform and any applications.

Considerations for moving your applications

Java-based applications

Sun developed the original Java language in the 1990s and, continuing on through its acquisition by Oracle, has maintained a strong commitment to Java ever since. Because Java applications run in a Java Virtual Machine, they are largely machine-independent and run as is in the Oracle Linux for x86 (64-bit) environments.

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. As an example, DB2 provides portable export formats that Oracle Linux can import. The restore/import process on the target system is likely to resolve any issues with the data layout. In our example, we show how easy this process is by using the Oracle SQL developer tools that take advantage of the performance of the system.

Considerations for moving platforms

Application compatibility

One benefit of moving from the IBM AIX to Oracle Linux is a greater range of available applications. Before migrating, make sure that your other AIX applications have an Oracle Linux version, can be recompiled for Linux, or that you can find compatible programs. A few examples of available applications can be located on Oracle's Web site at <http://solutions.oracle.com>.

Frequently, applications for which you have source code are those your organization developed. Because AIX and Linux are both UNIX-based systems, porting an application requires less work than porting to a non-UNIX-based operating system, such as Microsoft® Windows®. Best practices would suggest taking the opportunity to recompile such applications where possible, using the latest tools available utilizing the most current Operating systems and libraries. This may pay significant dividends in application performance and stability while also allowing the code to take full advantage of the new processor features and compiler optimizations.

Difference in operating systems

Oracle Linux and AIX are both UNIX-based operating systems. However, there are differences in the way that they operate, both in some of the commands and in the configuration files.

For a quick reference guide to commands, refer to Rosetta Stone for Unix (<http://bhami.com/rosetta.html>).

Considerations for moving your database

Database administration

A key benefit for moving from IBM DB2 to Oracle Database 11g is in the ease and fewer operating steps involved in the administration of your database, including installation and day-to-day tasks. Oracle Database 11g has a single point of management in its Oracle Enterprise Manager tool, where IBM DB2 has a Command Center that gives access to individual consoles. The Oracle Enterprise Manager can also be accessed via a Web interface while the DB2 Command Center console tools must be installed at the client.

Inexpensive disk storage

The Automatic Storage Management (ASM) that is part of Oracle Database 11g lets you greatly reduce related storage cost. A prime example is that of benefiting from the decreasing price of high-volume, low-cost SATA drives. You can utilize many different storage options and can even configure your existing storage.



NOTE

The Sun Fire X4800, as tested, does not qualify SATA drives at this time, and we are mainly referring to options with external storage and the potential for utilizing your existing inventory.

Another option to consider is the Sun Storage F5100 Flash Array, which offers faster I/O and a lower total cost of ownership (TCO). Designed to accelerate database applications and cut transaction times in half, it can greatly increase your database performance while also lowering energy costs.

Limitations

Depending on the complexity of the application and size of your data, you should consider several factors when using the Oracle SQL Developer Tool. Stored procedures and functions may not port easily and may need to be rewritten to run in Oracle Database 11g. Very large databases will take more time to process, which leads to longer downtime for migration and possibly a different manual method for moving the data, which increases the time and complexity of the migration.

In planning the move, keep the following key issues in mind:

- Database size/storage
- Downtime
- Method for migrating the database
- Complexity of the applications and any related stored procedures that may reside in the associated database

All of these points are inter-related and relevant to a successful migration.

Database size/storage

Make sure your storage is adequate to accommodate the current size of your data and, if using the same storage, you need room to host both existing data and new data that will be converted.

Downtime

The associated downtime greatly depends on the amount of data and complexity of applications to be moved. In most cases, you will be able to get both systems operational and plan for when the final data will be migrated.

Method of database migration

In most cases, using Oracle's Development Tool is sufficient and very easy to use, as our example demonstrates. If your databases are fairly large, a more manual process may be required in exporting and importing the data, using command-line tools on each database server.

Complexity of applications

More complex applications and large terabyte databases may require assistance from Oracle Services and Support.

Installing and setting up Oracle Linux and Oracle Database 11g Release 2

In this section, we focus on how to install and set up Oracle Linux 5.5 and Oracle Database 11g Release 2 on the Sun Fire X4800 Server. We begin by defining the specific environment we used in our work. Next, we present an overview of the steps needed to configure both Oracle Linux Update 5 and Oracle Database 11g Release 2. Performance tuning of the system is recommended for optimal configuration for apps such as Oracle Database 11g Release 2. Oracle recommends you contact their services for assistance in changing the appropriate settings.

The Sun Fire X4800 Server is not configurable with a DVD drive, but many methods are available for installation. The Oracle-recommended method for installing Oracle Linux is the Sun Installation Assistant (<http://docs.sun.com/doc/821-0694>). Another option utilizes Kickstart and requires a PXE boot server. This is more likely to be used in a data center environment and would take advantage of operating system images stored on a file server. Additionally, Oracle Integrated Lights Out Management (ILOM) provides remote functionality and comes integrated into the server, providing the ability to remotely connect a virtual CD/DVD drive to the server based on a laptop's DVD drive or simply from an ISO image file. This can provide a simple and more flexible means to perform one-off OS, application, data, or patch installations.

For our example migration we present in this Guide, we performed our installations via remote console. We were able to redirect our DVD drive remotely using the ILOM Web interface, launching the remote console for the Oracle Linux installation, and then using the redirection to accomplish the database installation.

Configuring the IBM storage

Overview

Oracle Database 11g's Automatic Storage Management, or ASM, relieves administrators of much of the responsibility for allocating and managing storage. ([Appendix B](#) provides more detail.)

We used the existing IBM disk array for our configuration. We split it into two LUNs and used the second LUN for our ASM drive.

NOTE

Plan on at least 45 minutes for completing the drive configuration.

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.

This section provides an overview of the operating system installation process. ([Appendix C](#) provides complete, detailed installation instructions). We downloaded the operating system from <http://edelivery.oracle.com/linux> and burned it to a DVD, from which we performed the installation. Updates are available for Unbreakable Linux Support customers by subscribing to channel, but they are also accessible through public yum. The following instructions assume you have a valid installation number.

The actual setup is done by utilizing the integrated ILOM Remote Keyboard/Video/Mouse functionality, providing a remote graphical console connected via the ILOM management network interface. Please see the Sun Fire X4800 Server Installation Guide (<http://docs.sun.com/app/docs/doc/821-0285?l=en>) for setup information.

NOTE

Allow at least 2 hours for installing Oracle Linux 5.5 on the Sun Fire X4800 Server.

1. Insert the Oracle Linux 5.5 DVD into the DVD drive, and reboot the system.
2. When the installer prompts you, press Enter to install in graphical mode. (See Figure 1.)

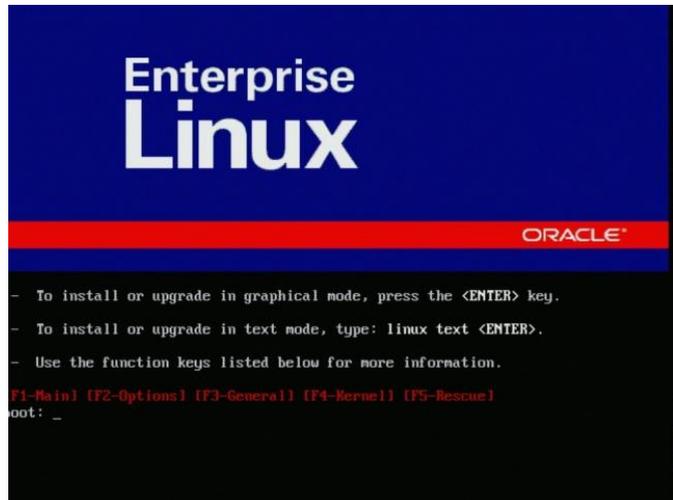


Figure 1. Selecting your install mode.

3. Select English as the language and U.S. English as the default keyboard.
4. Enter your installation number.
5. Accept the default installation of Red Hat Enterprise Linux and let the installation remove the Linux partition and create a default layout. (See Figure 2.)

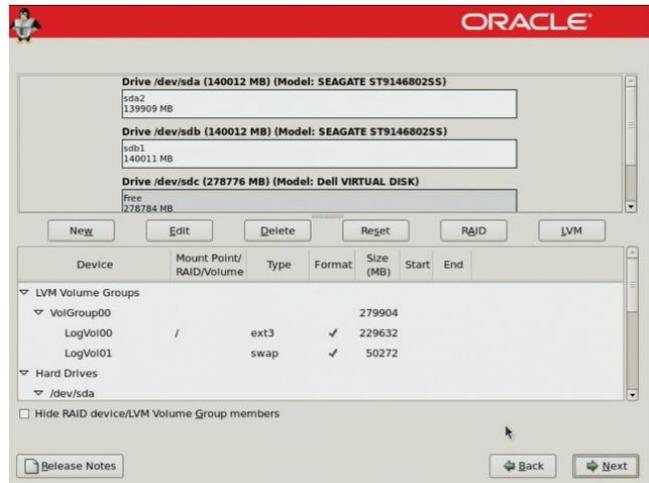


Figure 2. Remove partition and create default layout.

- Accept the default installation locations for the operation system and boot loader. (See Figure 3.)



Figure 3. Accept default installation locations.

- Configure your network information. (See Figure 4.)

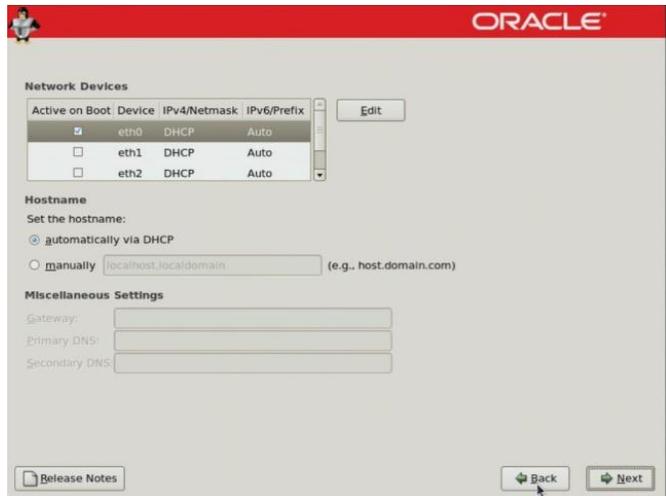


Figure 4. Configure Network information.

- Set your time zone and enter the root password. To start the installation, click Next. (See Figure 5.) The installer should eject the DVD automatically. (11 minutes)



Figure 5. Begin installation.

- After the reboot, accept the license agreement (Figure 6), and disable SELinux. (See Figure 7.)



Figure 6. Accept the license agreement.



Figure 7. Disable SELinux.

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. (3 minutes)



Configure all database servers with static IP addresses. Doing so will increase the stability of your networking and DNS environments.

Installing Oracle Database 11g Release 2 on the Sun Fire X4800 Server running Oracle Linux OS

We provide an overview of installing Oracle Database 11g Release 2 here. For detailed instructions, see [Appendix E](#). We downloaded the following files from <http://www.oracle.com/technetwork/database/enterprise-edition/downloads/112010-linx8664soft-100572.html>, copied them to the Sun Fire X4800 Server, and unzipped them locally:

- linux.x64_11gR2_grid.zip
- linux.x64_11gR2_database_1of2.zip
- linux.x64_11gR2_database_2of2.zip

1. Working as the Oracle user, go to the directory where you unzipped the Oracle Grid Infrastructure 11g R2 distribution and type `./runInstaller` to start the Oracle Universal Installer.
2. Select the option for doing a Grid Infrastructure installation. (See Figure 8.)

NOTE

The command is case-sensitive, and the `./` prefix is necessary.

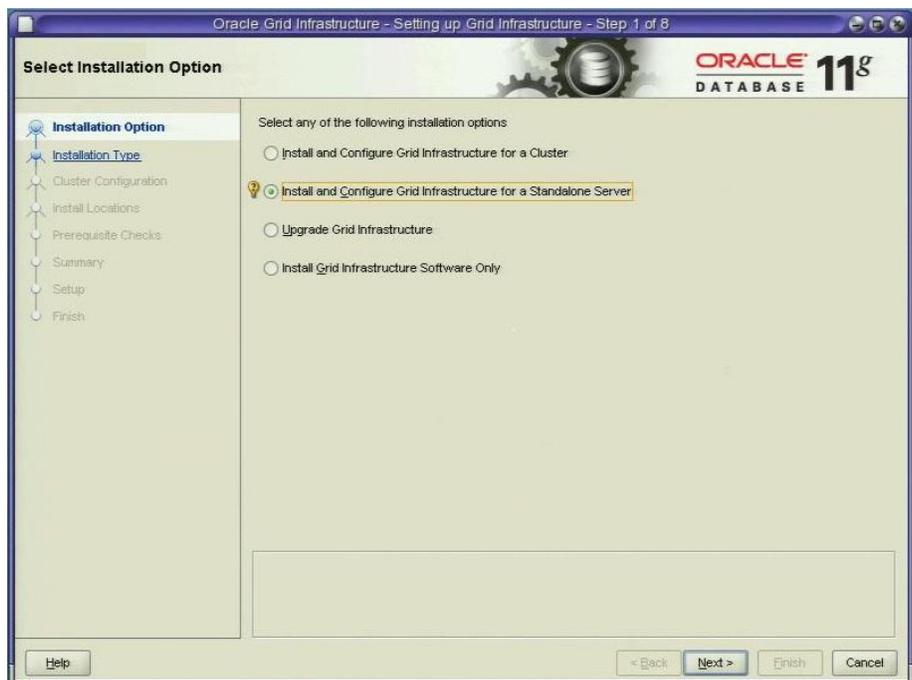


Figure 8. Installing and configuring Grid Infrastructure.

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 the install checked for. If you receive such a message, ignore it.

4. Review your settings, and start the installation. (15 minutes)
5. At the End of Installation screen, click Exit, and click Yes to confirm that you really want to exit.
6. After the installation completes, go to the directory where you unzipped the Oracle Grid Infrastructure 11g R2 distribution, and type `./runInstaller` to start the Oracle Universal Installer.

NOTE

As before, the command is case-sensitive, and the `./` prefix is necessary.

7. Accept the defaults for the next several screens.
8. Review the settings for the database installation, and start the installation. (See Figure 9.) (15 minutes)
9. When the progress bar completes, the install asks you to run two more scripts as root. Open a terminal as root, and cut and paste the paths to the scripts into the command line terminal. Click OK.

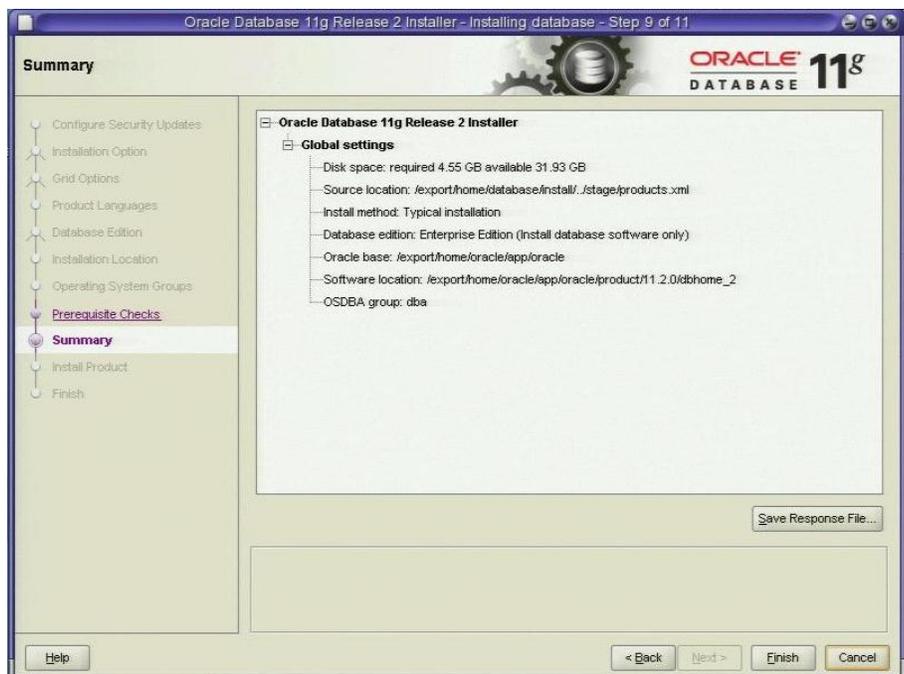


Figure 9. Review the database settings.

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

Creating an empty database

1. After exiting, set your Oracle Database 11g R2 environment variables as we describe in [Appendix E](#). From a command prompt, type `dbca` to launch the Database Configuration Assistant. (See Figure 10.)

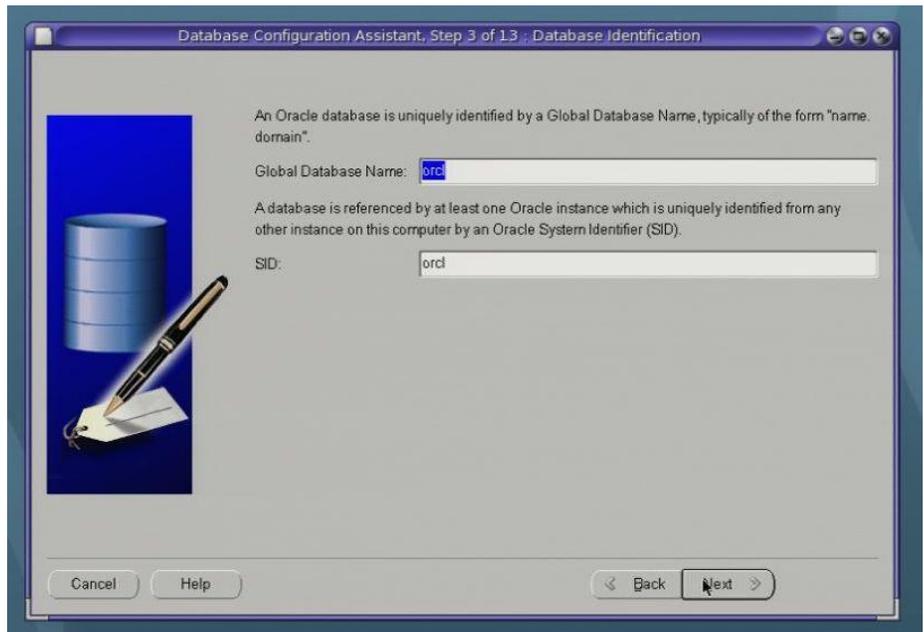


Figure 10. Naming the database.

2. 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 selected earlier.
3. Accept the default for the remaining screens, and click Finish. (30 minutes)
4. When the Database creation complete screen appears, click Exit.

Migrating the Oracle Database 11g database

In this section, we provide details about migrating an IBM DB2 user database. We demonstrate the ease of this process by moving a sample application and database running on IBM AIX 5L V5.3 to Oracle Linux and Oracle Database 11g Release 2 on the Sun Fire X4800 Server using Oracle's SQL Developer Migration Tools. We include a more detailed process in [Appendix F](#). The Oracle SQL Developer is an excellent tool for helping manage Oracle databases and database migration. Depending on the size and complexity of your application and data, you should also consider using the services available through Oracle Service and Support.

Migrating your data

For our example, we used Oracle's SQL Developer Migration Tools application, which is a free download from Oracle's Web site at <http://www.oracle.com/technology/software/products/sql/index.html>. We provide detailed instructions in [Appendix F](#). For more information on the sample application and database, please refer to [Appendix A](#), where we define our test environment.

NOTE

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

1. Export and convert your IBM DB2 database. Create a set of offline capture scripts using SQL Developer. Go to Tools→Migration→Third party database offline capture→Create database capture scripts. It then prompts you for a location to store the exported files. (See Figure 11.)

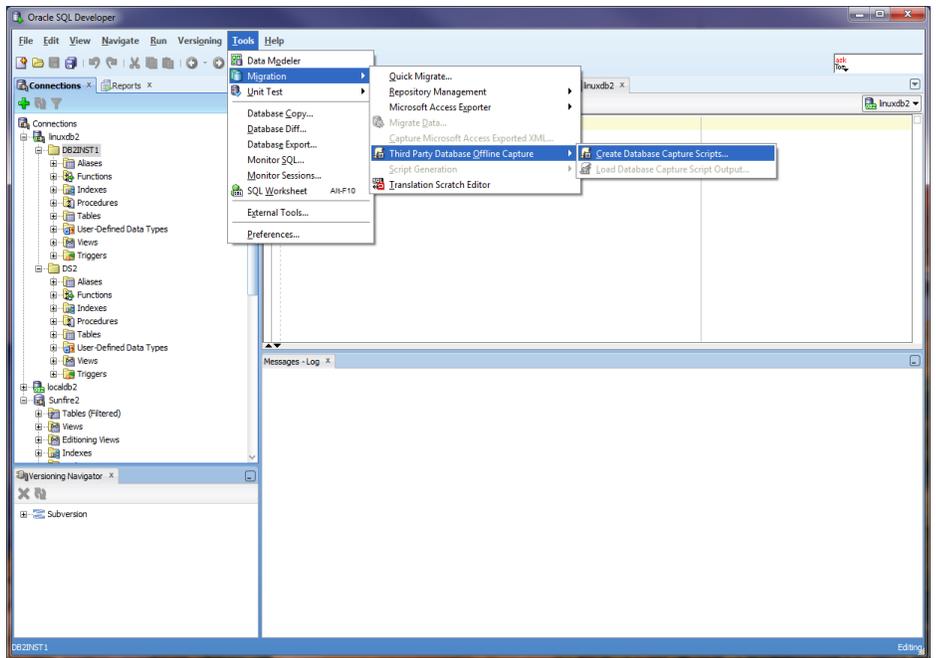


Figure 11. Oracle SQL Developer Generate Database scripts for DB2 to Oracle Database 11g R2 migration.

2. Copy files to database server, and run the startDump.sh that was created from the location the files were copied to. This will generate folders and DAT files containing the schema and table structures for the database you selected.
3. Copy files back to the Oracle SQL Developer machine and load files to generate captured model by going to Tools→Migration→Third party database offline capture→Load database capture script output...
4. Convert the IBM DB2 model to an Oracle Database 11g model. Right-click the captured model, and select Convert to Oracle Database 11g Model.
5. Create and run the unload_script.sh to extract the data from the database on the source machine and store the data in a delimited ASCII file. Doing so also generates the control files that the SQL*Loader will use to import the data back into the correct location on the target server.
6. Copy all files to the target server in a directory.

Importing the database into Oracle Database 11g Release 2

1. Generate the scripts for creating the database and schema by right-clicking Converted Model and selecting Generate. This displays the script in the right pane.
2. From the drop-down list on the top right corner of the workspace pane, select the connection where the user has privileges to

execute the scripts, create users, and grant privileges. Right-click, and select Run Script.

3. On the Sun Fire X4800 Server, take the following step: Using Oracle SQL Developer, import the offline exported data. It should automatically create the appropriate schema and data. See [Appendix F](#) for details.



NOTE

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 few of the most common tasks, but this list is not comprehensive. For more information, see http://download.oracle.com/docs/cd/E11882_01/install.112/e10840/post_inst_task.htm#CHDCGCJ1.

Environmental and configuration changes

Updating environment variables. In the Oracle Linux environment, you will need to make sure that the following environment variables point to the new Oracle Database 11g directories:

```
ORACLE_HOME  
PATH
```

Connecting to the database. Oracle Database 11g has several connection methods. Locally, there is SQL*Plus, accessible by typing `sqlplus` in a properly pathed terminal. On a client machine, you can use `xclient` or Oracle's freely available database tool, Oracle SQL Developer, to connect to the database.

Creating new users. While the export scripts will move the schema and data from your AIX server to your Sun Fire X4800 Server, it will not move users. You will have to create new users for your database. You can create new users in SQL*Plus with the following command:

```
SQL>CREATE USER username IDENTIFIED BY password;
```

You can modify user privileges with the following command:

```
SQL>GRANT privilege1, privilege2, ...  
TO user1, user2, ...;
```

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 Database 11g -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.

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. Tuning may be required on the database based on the load and utilization metrics of the system. This can include reviewing and making changes to your init.ora parameter file to make changes necessary to support your particular system.

Oracle Database 11g performance tuning. To get an additional boost in performance, you may want to consider some best practices like partitioning and compression. For performance tuning details, please see the Oracle Database Performance Tuning Guide 11g at http://download.oracle.com/docs/cd/E11882_01/server.112/e16638/toc.htm.

Backing up your database

After the successful migration of the DB2 database from the AIX environment to the Oracle Linux/Oracle Database 11g R2 environment, 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. Oracle provides excellent tools in Recovery Manager (RMAN) and using the Enterprise Manager to configure RMAN backups only takes a few steps. Please see the Oracle Database Backup and Recovery User's Guide for detailed information at http://download.oracle.com/docs/cd/E11882_01/backup.112/e10642/toc.htm.

Summing up

Moving your IBM DB2 on AIX Power Systems to Oracle Database 11g on Oracle's Sun Fire X4800 Server with the Intel Xeon Processor 7560 gives the ability to provide better performance at a lower cost, as well as lower maintenance and support costs for hardware.

Considerations

Although moving across platforms, moving applications, and moving databases can be challenging tasks, moving to Oracle Linux on the Sun Fire X4800 Server from IBM AIX and DB2 can be a manageable effort considering the size of application and databases. The hardware and operating system are easy to configure, and, with proper planning, migrating applications and data is straightforward. As we have demonstrated in this Guide, the process of deploying these products on a Sun Fire X4800 Server, including migrating your database to the Oracle Database 11g environment, can take less than a day. Spending time planning can help you avoid potential problems during your migration. Please note that larger terabyte size databases or more complex applications may require Oracle Services and Support.

Conclusion

Lower energy consumption and the possibilities of virtualization further reduce the server footprint in the data center. Whether you are replacing existing systems or establishing an original installation, the Intel Xeon Processor 7500 series running in the Sun Fire X4800 Server is a good combination for a low-cost, high-performance system. You will also find that the extremely efficient database administration of Oracle Database 11g reduces costs associated with day-to-day administration.

The Automatic Storage Management feature of Oracle Database 11g can assist in managing your database storage. Additionally, you can reduce your time associated with administrating the operating system and the database by using the inherent and freely downloadable features available from Oracle. Tools such as the Oracle SQL Developer and the Oracle Systems Management console will make any migration and administration more manageable and will prove to be great assets.

The Intel Xeon Processor 7500 series on the Sun Fire Server can provide better performance while also reducing costs. The combined performance enhancement coupled with the added benefits of the OS and database administration features will help solidify and capitalize on this investment, which is much less than that for comparable IBM Power systems.

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Appendix A. Defining the test environment

Our test bed starting point consisted of an IBM System p5 505 Express server running AIX 5L V5.3 and DB2 connected to an IBM TotalStorage® DS4300 storage array. Our destination server was Oracle's Sun Fire X4800 Server running Oracle Linux Operating System for x86-based systems (64-bit) and Oracle Database 11g Release 2 Enterprise Edition for Oracle Linux on x86_64-based systems. We connected all components via a gigabit switch. Figure 12 illustrates our setup.

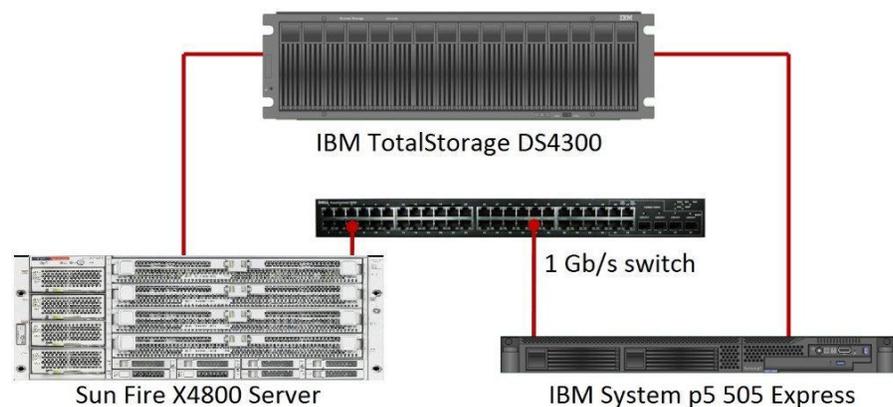


Figure 12. The setup we used in our hands-on testing and research for this Migration Guide.

TIP

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://wikis.sun.com/display/SystemsComm/Sun+Fire+X4800+Server+-+Downloads+and+Firmware>.

Figures 13 and 14 present the hardware and software we used in our Oracle Database 11g servers.

Server	Processor	Memory	Disk
IBM System p5 505 Express	2 x POWER5 2.1 GHz	16 GB	2 x IBM 80P6321, 10K SCSI, 146 GB
Sun Fire X4800	8 x Intel Xeon X7560 (2.26 GHz)	256 GB	8 x SAS, 10K, 300 GB

Figure 13. Servers we used in our hands-on testing and research for this Guide.

Server	Server operating system	Database version
IBM System p5 505 Express	AIX 5L V5.3 operating system	DB2 Enterprise Edition 9.1 AIX systems (64-bit)
Sun Fire X4800	Oracle Linux operating system for x86-based systems (64-bit)	Oracle11g R2 Enterprise Edition Release 11.2.0.1.0 for Oracle Linux on x86-64 based systems

Figure 14. Software we used in our hands-on testing and research for this Guide.

For our test data, we migrated a 20GB database that we generated using the DVD Store Version 2 (DS2) test tool. (For more information about DS2, please see <http://www.delltechcenter.com/page/DVD+Store.>)

Appendix B. Methodology: Configuring the IBM storage

Allow at least 45 minutes to prepare the disks.

1. Using IBM DS Storage Manager (<http://www-947.ibm.com/systems/support/supportsite.wss/docdisplay?Indocid=MIGR-5082865&brandind=5000028>), right-click the attached storage subsystem, and select Manage Storage Subsystem.
2. In the new window that opens, right-click Total Unconfigured Capacity in the Logical pane on the left, and select Create Logical Drive.
3. In the Introduction window, select Next.
4. In the Specify Array window, choose your RAID level (we chose 5), select the number of drives you wish to add to the array (we chose the maximum allowed), and select Next.
5. If an informational window about selecting drive space appears, click OK to continue.
6. In the Specify Capacity/Name window, accept the default of the maximum available capacity, name your logical drive, and select Next.
7. In the Specify Logical Drive-to-LUN Mapping window, make sure that the Default Mapping radio button is selected, choose Linux in the Host type drop-down menu, and select Finish.
8. If a Completed information window appears, select OK to continue.

NOTE

Depending on the size of the logical drive, it can take from 30 minutes to several hours for the logical drive to complete creation.

9. While the drive is initializing, select the Mappings View tab in the storage manager, right-click Default Group, and select Define Host.
10. In the Introduction window, select Next.
11. In the Specify Host Name/HBA Attributes window, write a name for your host in the Host name text box, select the host you are trying to add, select Add, and select Edit.
12. In the Edit Identifier/Alias window, enter a name that will help you to identify your server, and select OK.
13. In the Specify Host Name/HBA Attributes window, select Next.
14. In the Preview window, review your changes, and click Finish.
15. If you see an information window asking you to define another host, select No.

Appendix C. Methodology: Installing Oracle Linux on the Sun Fire X4800 Server

Install Oracle Linux by following these steps. Allow 40 minutes to 2 hours to complete a remote console installation. We used version Oracle Linux for x86-based systems (64-bit), which we downloaded from <http://edelivery.oracle.com/linux> and burned to a DVD.

NOTE

In this appendix, we use Eth0 as the primary network interface name. 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. At the splash screen, click Next.
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. For each drive, ignore the warning “The partition table of sd<x> was unreadable.” Click YES to the warning about erasing all data.
8. On the next screen, choose Remove all partitions on selected drives and create default layout. Check Review and modify partitioning layout. Click Next.
9. At the warning, click Yes.
10. Review and click Next.
11. Accept the defaults to install the GRUB boot loader and install Red Hat Enterprise Server Linux on LogVol00, and click Next.
12. We followed best practices and set fixed IP addresses for the NIC:

NOTE

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.

- a. Select the NIC, and click Edit.
- b. Click Manual configuration.
- c. Enter the IP address.
- d. Enter the subnet mask.
- e. Deselect Enable IPv6 Support.
- f. Click OK.

13. Set the hostname and domain manually.
14. Under the section Miscellaneous settings, enter the IP addresses for the Gateway, Primary DNS, and Secondary DNS, and click Next.
15. Accept the default of Eastern Time for the time zone, and click Next.
16. Enter the root password, and click Next.
17. Accept the default of Customize later. Click Next.
18. Click Next. Installation will take approximately 80 minutes.
19. When prompted, verify that the install ejected the DVD, and click Reboot.



NOTE

If the system is prompting you for a floppy to boot, you will need to reboot the system again, press <F12> for boot order, and select Hard Disk 0.

20. After the reboot, at the Welcome screen, click Forward.
21. Accept the license agreement, and click Forward.
22. On the Firewall screen, select Disable, and click Forward.
23. At the warning screen, click Yes.
24. Use Disabled for the SELinux state, and click Forward.
25. When a warning that changing the SELinux setting requires rebooting the system appears, click Yes.
26. Accept the default of Kdump not being enabled, and click Forward.
27. Set the date and time, and click Forward.
28. Create a regular user account, filling in the username, full name, and password.
29. On the Sound Card screen, click Forward.
30. On the Additional CDs screen, click Finish.
31. On System Reboot Message, click OK and the system will reboot. Make sure the installation DVD is not in the system.

Appendix D. Methodology: Pre-Installing Oracle Database 11g Release 2 on the Sun Fire X4800 Server

Oracle Database 11g Release 2 pre-installation tasks

Before you can install Oracle Database 11g Release 2, you must first perform a number of preliminary tasks. For further details, see *Oracle Database Installation Guide 11g Release 2 (11.2) for Linux*, Chapter 2, Pre-installation Requirements, at http://download.oracle.com/docs/cd/E11882_01/install.112/e16763/toc.htm

NOTE

The test server met many of the prerequisites for installing Oracle Database 11g Release 2, so we do not discuss checking those prerequisites here. The Oracle document we cite above covers this topic in detail.

Allow at least 30 minutes to complete the preparation.

1. Log in as root.
2. The server needs to display X applications. To work locally, you can use the command `xhost local`:
3. Verify that networking is set up correctly, using the following set of commands:
 - `cat /etc/nsswitch.conf | grep hosts` The output 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 Database 11g Release 2 on a system using DHCP or on a multi-homed system, you will need to take additional steps. Please see the Oracle Database 11g Release 2 Pre-installation tasks document for further details.

4. Create the Oracle inventory group with the following command:
`/usr/sbin/groupadd oinstall`
5. Create the Oracle dba group with the following command:
`/usr/sbin/groupadd dba`
6. Create the Oracle software owner user with the following command:
`/usr/sbin/useradd -g oinstall -G dba oracle`
7. Set the password of the Oracle user with the following command:
`passwd oracle`
8. When the command prompts you, enter the new password.

9. 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
oracle          hard    stack    10240
```

10. 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
```

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

12. Change the kernel parameters by editing the `/etc/sysctl.conf` file.

Add or edit the following entries:

- `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 = 4194304`
- `net.ipv4.ip_local_port_range = 9000 65000`
- `fs.aio-max-nr = 1048576`

13. Type the following command to make the parameters to take effect: `/sbin/sysctl -p`

14. Create the Oracle Database 11g base directory with the following commands:

```
mkdir -p /home/oracle/app/oracle
chown -R oracle:oinstall
/home/oracle/app/oracle
chmod -R 775 /home/oracle/app/oracle
```

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. Give the Oracle user ownership of the file with the following commands:

```
chown -R oracle:oinstall
/home/oracle/.bash_profile
chmod -R 770 /home/oracle/.bash_profile
```

Preparing disks for Automatic Storage Management

Allow at least 15 minutes to prepare the disks.

1. Log in as root, type the command `uname -rm` and note the output. This will determine the version of the ASMLib which will need to be downloaded from Oracle. In our test, we are at version 2.6.18-194.el5 x86_64.
2. Download the following three rpm files from <http://www.oracle.com/technology/tech/linux/asmlib/index.html>:
 - http://download.oracle.com/otn_software/asmlib/oracleasmlib-2.0.4-1.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://oss.oracle.com/projects/oracleasm/dist/files/RPMS/rhel5/amd64/2.0.5/2.6.18-194.el5/oracleasm-2.6.18-194.el5-2.0.5-1.el5.x86_64.rpm

The Kernel version number must match exactly.

3. Install ASMLib by typing the following command:

```
rpm -Uvh oracleasm-2.6.18-194.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
```

4. Configure ASM by typing the following command:

```
/etc/init.d/oracleasm configure
```

5. When the installation prompts you for the Default user to own the driver interface, type `oracle`
6. When the installation prompts you for the Default group to own the driver interface, type `dba`
7. When the installation prompts you to Start Oracle ASM library on boot, type `y`
8. When the installation prompts you to scan for Oracle ASM disks on boot, type `y`
9. Type `fdisk /dev/sd<x>` where `<x>` is the device for ASM to use as a disk. For example, `fdisk /dev/sdb`
10. Type `n` to create a new partition.
11. Type `p` to create a primary partition.
12. Type `1` to make it partition 1.
13. Type `1` for the starting cylinder. Never start at cylinder 0, as you would overwrite the partition table.

14. Type `xxxxc`, where `xxxx` is the number that will take all the space on the disk except for cylinder 0. For example, `8844c`.
15. Type `w` to make the partition table changes permanent. This will automatically exit `fdisk`.
16. For ASM, Oracle must own the candidate drives. To give Oracle ownership, use the following commands:
 - `chown oracle:dba /dev/sdb1`
 - `chmod 660 /dev/sdb1`
 - `chown -h oracle:dba /dev/sdb1`
17. Mark and label the drives as belonging to ASM using the following command for each device needed by the ASM:

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

Appendix E. Methodology: Installing Oracle Database 11g Release 2 on the Sun Fire X4800 Server running Oracle Linux

We downloaded Oracle Database 11g Release 2 from <http://www.oracle.com/technology/software/products/database/index.html>. We copied the `linux.x64_11gR2_grid.zip` file to the Sun Fire X4800 Server, 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. From the Oracle user's home directory, type `./bash_profile` to set up your environment. The `./` (dot-space-dot-slash) is necessary.
4. Change your directory to the top level directory of the Oracle distribution you unzipped.
5. Type `./runInstaller`. The name is case sensitive and the leading `./` is required. If you get a DISPLAY error, switch back to root users and type `xhost +`. Change user back to oracle and rerun `./runInstaller`.
6. On the Select Installation Option screen, select Install and Configure Grid Infrastructure for a Standalone Server, and click Next.
7. On the Select Product Languages screen, leave the default of English, and click Next.
8. On the Create ASM Disk Group screen, leave the default name of DATA, select External redundancy, select your configured drives, and click Next.
9. 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.
10. On the Privileged Operating System Groups screen, select the groups for ASM access, and click Next (For simplicity, we changed the groups to dba. Ask your administrator before setting your groups to dba).
11. On the Specify Installation Location screen, leave the defaults, and click Next.
12. On the Create Inventory screen, leave the defaults, and click Next.
13. On the Summary screen, click Finish to start the installation.
14. After the installation is complete, follow the instructions on screen to run the two install scripts as root.

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

Installing Oracle Database 11g Release 2

We downloaded Oracle Database 11g Release 2 from <http://www.oracle.com/technology/software/products/database/index.html>. We copied the `solaris.x64_11gR2_database_1of2.zip` and `solaris.x64_11gR2_database_2of2.zip` files to Sun Fire X4800 Server, and unzipped them locally by right-clicking the files and choosing Extract Here.

Allow at least 30 minutes to complete the Oracle Database 11g installation.

1. After the Oracle Grid Infrastructure install, change your directory to the top level directory of the Oracle distribution you unzipped.
2. Type `./runInstaller`. The name is case sensitive and the leading `./` is required.
3. On the Configure Security Updates screen, enter your Email address for You're my Oracle Support and your password for You're my Oracle Support password, and click Next.
4. On the Select Installation Method screen, select Install database software only.
5. On the Node Selection screen, select Single instance database installation, and click Next.
6. On the Select Product Languages screen, click Next.
7. In the Select Installation Type screen, accept the default, Enterprise Edition, and click Next.
8. On the Specify Installation Location screen, accept the default, and click Next.



NOTE

On the Product-Specific Prerequisite Checks screen, you might see one warning. Some of the kernel settings we specified earlier were above, rather than at, the values Oracle expected. If you receive this warning, you can ignore it.

9. On the Create Inventory screen, accept the default, and click Next.
10. On the Privileged Operating System Groups screen, accept the default, and click Next.
11. On the Summary screen, review your settings, and click Install. The Install screen, which shows a progress bar, appears. (15 minutes)
12. When the progress bar completes, the install 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.
13. The first script is `orainstRoot.sh`. You only see this script the first time you install Oracle Database 11g Release 2 on a system. Should you need to reinstall the database software, you will not run it again.

14. 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.
15. In the Execute Configuration scripts dialog, click OK.
16. On the Finish screen, click Close.

Creating an empty database

Allow at least 45 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/11.2.0/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 a password. Click Next.
10. On the Database Configuration Assistant, step 6 of 12: Database File Locations, select Automatic Storage Management (ASM), select the group you created during Grid Infrastructure installation, 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.

NOTE

When you accept the default, the title of the window changes from step 8 of 12 to step 8 of 11.

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Migrating your legacy IBM database environment to the latest Oracle technologies: Moving to Oracle Linux with Oracle Database 11g from IBM AIX with DB2 on an IBM Power System

14. On the Database Configuration Assistant, step 9 of 11: Initialization Parameters, accept the default, and click Next.
15. On the Database Configuration Assistant, step 10 of 11: Database Storage, click Next.
16. On the Database Configuration Assistant, step 11 of 11: Creation Options screen, click Finish.
17. On the Confirmation screen, click OK.
18. The Database Configuration Assistant screen appears and shows a progress bar. Database configuration will take approximately 30 minutes.
19. On the Database creation complete screen, click Exit.

Appendix F. Methodology: Migrating the DS2 data

Exporting schema and data on the IBM Power Server running AIX DB2 V9.7

1. Install and launch Oracle SQL Developer. (Make sure to install proper drivers to connect to DB2 database.)
2. Create a migration user in Oracle Database 11g and assign the role of Resources and system privileges of Create View and Create Session.
3. Make a new connection to the database using the migration user you just created and create repository by right-clicking on connection and selecting Migration Repository→Associate Migration Repository... This will build and create the repository for the migration while associating it to the migration user just created.
4. Make a new connection to your source database with the user who owns of the database.
5. Make another connection to the target database you intend to migrate to as well.
6. Navigate to Tools→Migration→Third Party Offline Capture→Create Database Capture Scripts... This will generate the files needed in a directory to be moved and executed on the source machine.
7. Copy the folder and files to source machine and launch the startDump program to create the model to be used for recreating the schema on the Oracle server.
8. Copy the folder, which should not contain dat files, back to the SQL Developer machine.
9. Load the offline captured information to create the Capture Model by going to Tools→Migration→Third Party Offline Capture→Load Database Offline Capture Scripts...
10. Now that the Captured model is loaded, run the conversion process by right-clicking on Captured Model and selecting Convert to Oracle Model... Verify the data rules, and click Apply to continue.
11. Review the Migration Log for any errors that can be addressed before scripts are generated for the actual migration and creation of the Oracle objects.

NOTE

Oracle SQL Developer comes with a Translation Scratch Editor that may assist you in procedural syntax when converting the code to the Oracle Database 11g Release 2 platform.

12. Generate the scripts by right-clicking Converted Model and selecting Generate, which then displays the script in the right-hand pane.
13. From the drop-down list on the top right corner of the workspace pane, select the connection where the user has privileges to execute the script on and will be able to create users and grant privileges to. (See Figure 15.)

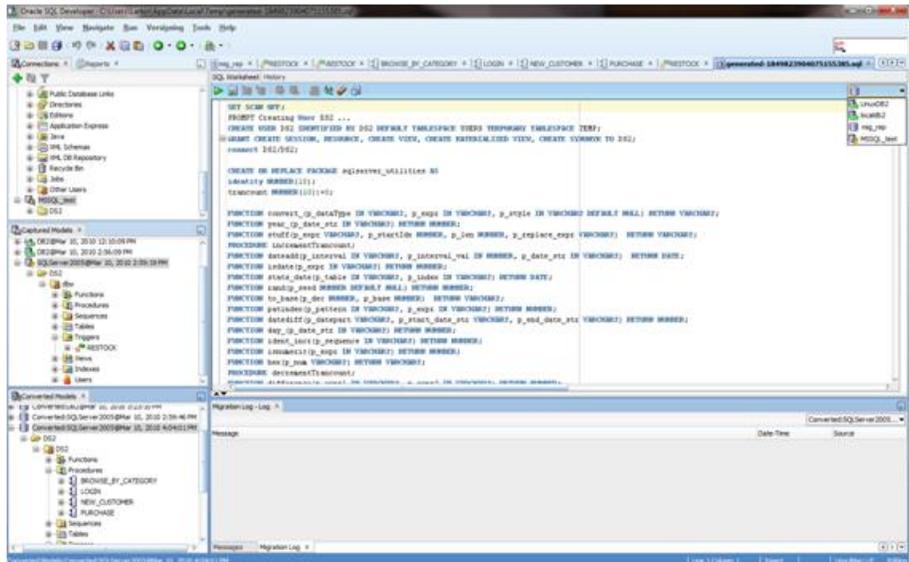


Figure 15. Select user connection to create database and user.

14. Run the script by right-clicking and selecting Run Script.
15. Create the scripts in Oracle SQL Developer to move the data offline by going to Tools→Migration→Generate Offline Data Move Scripts...
16. Copy exported scripts to source machine, and run the following from a command line: `unload_script.sh`

NOTE

You must be logged in and connected to the source database.

Importing data on the Sun Fire X4800 Server running Oracle Linux and Oracle Database 11g Release 2

1. Copy folders and all content of the data dump to the target Oracle database server and run the following command from a command line:

```
oracle_ctl.sh
```

NOTE

Please refer to Oracle document E15286-01 (Oracle SQL Developer Supplementary Information for IBM DB2 Migrations Release 2.1) (http://download.oracle.com/docs/cd/E15846_01/doc.21/e15286/title.htm) for details on content of the `unload_script.sh` and `oracle_ctl.sh`.

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