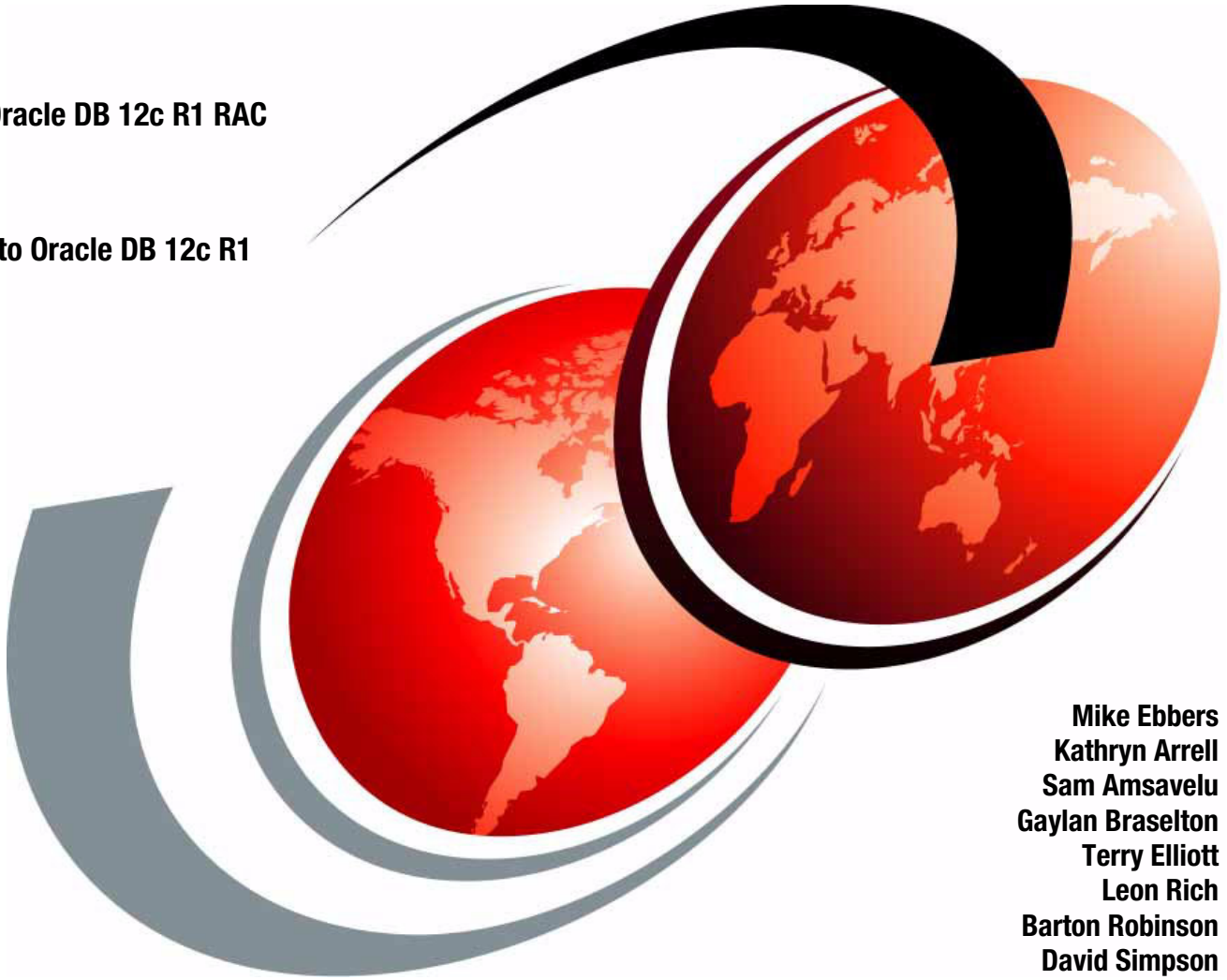
IBM

Experiences with Oracle Database 12c Release 1 on Linux on System z

- Setting up Linux for Oracle DB 12c R1
- Installing Oracle DB 12c R1 RAC
- Upgrading to Oracle DB 12c R1



Mike Ebbers
Kathryn Arrell
Sam Amsavelu
Gaylan Braselton
Terry Elliott
Leon Rich
Barton Robinson
David Simpson

Redbooks

ibm.com/redbooks

International Technical Support Organization

Experiences with Oracle Database 12c Release 1 on Linux on System z

May 2014

SG24-8159-00

Note: Before using this information and the product it supports, read the information in “Notices” on page vii.

First Edition (May 2014)

This edition applies to Oracle Database 12c Release 1 on Linux on IBM System z.

Contents

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not grant you any license to these patents. You can send license inquiries, in writing, to:
IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs.

Trademarks

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. These and other IBM trademarked terms are marked on their first occurrence in this information with the appropriate symbol (® or ™), indicating US registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at http://www.ibm.com/legal/copytrade.shtml

The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both:

AIX®
BladeCenter®
DataPower®
DB2®
DRDA®
ECKD™
FICON®
FlashCopy®
Global Business Services®
HiperSockets™
IBM®
Parallel Sysplex®
POWER7®
PowerVM®
POWER®
PR/SM™
Processor Resource/Systems Manager™
RACF®
Redbooks®
Redbooks (logo) ®
Smarter Cities®
System x®
System z9®
System z®
WebSphere®
z/OS®
z/VM®
z/VSE®
z10™
z9®
zEnterprise®

The following terms are trademarks of other companies:

Intel, Intel logo, Intel Inside logo, and Intel Centrino logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Windows, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

Java, and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Other company, product, or service names may be trademarks or service marks of others.

Preface

Oracle Database 12c Release 1 is now supported on Linux on IBM® System z®. This platform offers many advantages to customers who rely upon the IBM mainframe systems to run their businesses. Linux on System z takes advantage of the qualities of service in the System z hardware and in IBM z/VM®, making it a robust industrial strength version of Linux. This provides an excellent platform for hosting Oracle solutions that run in an enterprise.

This IBM Redbooks® publication shares experiences that are gained while installing and testing Oracle Database 12c Release 1:

- Recommendations about how to set up an infrastructure
- Installing an Oracle Grid Infrastructure
- Installing Oracle 12C R1 Real Application Clusters (RAC) and creating a RAC Database, including a multitenant database
- Using the Cloud Control Agent to manage Oracle Database 12c Release 1
- Installing Oracle WebLogic Server 12c
- Upgrading from an Oracle Database from 11gR2 to 12c Release 1

The audience for this publication includes database consultants, installers, administrators, and system programmers. This publication is not meant to replace Oracle documentation, but to supplement it with our experiences while installing and using Oracle products.

Authors

This book was produced by a team of specialists from around the world working at the International Technical Support Organization (ITSO), Poughkeepsie Center.

Mike Ebbers is a Consulting IT Specialist and Project Leader at the International Technical Support Organization, Poughkeepsie Center. He has worked with IBM mainframe hardware and software products since 1974 in the field, in education, and in the ITSO.

Kathryn Arrell is an Oracle Specialist at the IBM/Oracle International Competency Center at IBM San Mateo. Previously, she worked as an ERP specialist at the ITSO in Poughkeepsie, New York.

Sam Amsavelu is a Certified Consulting IT Architect in the IBM Advanced Technical Support Organization supporting Oracle on System z Linux and Siebel on System z customers. He has more than 25 years of IT experience in IBM products.

Gaylan Braselton is Sales Specialist for System z Oracle Solutions and responsible for System z Sales with Oracle for North America. He has worked with Oracle Solutions on System z since 2000.

Terry Elliott is an IBM System z Specialist working in the IBM/Oracle International Competency Center at IBM Foster City. He has over 30 years of experience in information technology. Before joining the IBM/Oracle International Competency Center, Terry was an ERP System z Performance Specialist.

Leon Rich is a System z IBM/Oracle Specialist working for the IBM System Enablement team at Oracle. He has over 30 years of information technology experience. Before joining the System Enablement Team, Leon was a software Integration/Performance specialist working with mainframe and server base systems.

Barton Robinson is Founder and CTO of Velocity Software, which provides VM Performance management products. He worked for IBM in Poughkeepsie in VM Planning, Washington Systems Center for VM Performance, and then in San Jose as a senior manager in the System Performance Evaluation Lab. After 25 years of developing performance software for Velocity Software, providing performance analysis and education, he continues to develop instrumentation and understanding for optimizing Linux performance in a z/VM environment.

David Simpson is a System z Oracle Specialist working for Advanced Technical Support (ATS) in the Americas Sales and Distribution team. David previously worked for IBM Global Business Services® to host Oracle systems for consulting engagements.

Thanks to the following people for their contributions to this project:

Roy Costa and Rich Conway
International Technical Support Organization, Poughkeepsie Center

Stephen McGarril and Eugene Ong
IBM STG WW Mainframe Benchmark Center

Damian Gallagher, David Ong, Sandra Skehin
Oracle Corporation

Now you can become a published author, too!

Here's an opportunity to spotlight your skills, grow your career, and become a published author—all at the same time! Join an ITSO residency project and help write a book in your area of expertise, while honing your experience using leading-edge technologies. Your efforts will help to increase product acceptance and customer satisfaction, as you expand your network of technical contacts and relationships. Residencies run from two to six weeks in length, and you can participate either in person or as a remote resident working from your home base.

Find out more about the residency program, browse the residency index, and apply online at:

ibm.com/redbooks/residencies.html

Comments welcome

Your comments are important to us!

We want our books to be as helpful as possible. Send us your comments about this book or other IBM Redbooks publications in one of the following ways:

- Use the online **Contact us** review Redbooks form found at:

  ibm.com/redbooks

- Send your comments in an email to:

  redbooks@us.ibm.com

- Mail your comments to:

  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400

Stay connected to IBM Redbooks

- Find us on Facebook:

  http://www.facebook.com/IBMRedbooks

- Follow us on Twitter:

  http://twitter.com/ibmredbooks

- Look for us on LinkedIn:

  http://www.linkedin.com/groups?home=&gid=2130806

- Explore new Redbooks publications, residencies, and workshops with the IBM Redbooks weekly newsletter:

  https://www.redbooks.ibm.com/Redbooks.nsf/subscribe?OpenForm

- Stay current on recent Redbooks publications with RSS Feeds:

  http://www.redbooks.ibm.com/rss.html

1

What is new with Oracle on Linux on IBM System z

This publication describes our early experiences with Oracle Database 12c Release 1 running on an IBM System z Linux guest using Red Hat or SUSE.

This chapter describes the latest changes that continue to make running Oracle on Linux on IBM System z an attractive solution. In two IBM Redbooks publications about Oracle on Linux on System z,[1] Chapter 1 lists the prime reasons why customers are running Oracle Solutions on System z.

This chapter does not repeat all those reasons but concentrates on the latest enhancements of hardware and software that are used to run Oracle Solutions on the mainframe:

- New hardware from IBM
- Latest version of the Linux distributions from Red Hat and SUSE
- Latest products from Oracle

This chapter also includes an excerpt from a blog about myths about the mainframe that describes why using the mainframe is an excellent solution for running Oracle solutions.

[1] *Experiences with Oracle Solutions on Linux for IBM System z*, SG24-7634 and *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104

1.1 Myths about the mainframe

Section 1.1.1, “Don't Believe the Myths” on page 2 and its subsections contain an excellent blog article on the myths of the mainframe, which was published on July 17, 2013.[2] It is included here to give you a perspective about why customers run solutions on the mainframe.

1.1.1 Don't Believe the Myths

The facts about mainframe outweigh the common misconceptions.

Here at SHARE, we believe the mainframe is the most-secure, lowest-cost, and best-performing mixed-workload computing platform on the planet. SHARE continues to serve the mainframe community, helping to show our members the best practices for managing the mainframe environment and optimizing the value that the mainframe delivers. It's the core of the computing environment for many companies.

Still, misconceptions and myths persist—like the idea that few mainframes remain in use today. The reality is SHARE represents more than 20,000 individuals from nearly 2,000 companies. Those companies include: state and federal government agencies, universities, retail, energy, manufacturing, banks, and insurance companies. More specifically:

- Ninety-six of the world's top 100 banks, 23 of the 25 top U.S. retailers, and nine of the world's 10 largest insurance companies run System z.
- Seventy-one percent of global Fortune 500 companies are System z clients.
- Nine out of the top 10 global life and health insurance providers process their high-volume transactions on a System z mainframe
- Mainframes process roughly 30 billion business transactions per day, including most major credit-card transactions, stock trades, and money transfers, as well as manufacturing processes and ERP systems.

That doesn't sound like a technology that is no longer in use, or going away anytime soon. Other common myths about the mainframe include:

1. They are old.
2. They don't run modern applications.
3. Mainframes are expensive.
4. The skills to manage mainframes are not available or you need more people.

Mainframes are old?

The mainframe is celebrating its 50th birthday in 2014. But, there have been generational differences between the mainframe introduced in 1964 and today's mainframe. The automobile is more than 100 years old, but no one suggests that automobiles are an old or outdated technology.

Are the cars of today different from the cars of 1964? Absolutely. Likewise, today's mainframe is faster, has more capacity, is more reliable and energy efficient than the mainframe of the 1960s, '70s, '80s, or even those delivered three years ago in 2010.

[2] SHARE Inc/Janet L. Sun, Reprinted by Permission. http://www.share.org/p/bl/et/blogid=2&per=5&sort=0&p=4

The modern mainframe, known as the IBM zEnterprise® System, delivered in 2010 improved single-system image performance by 60 percent, while keeping within the same energy envelope when compared to previous generations. And the zEnterprise EC12, which shipped in 2012, has up to 50 percent more total system capacity, as well as availability and security enhancements. It uses 5.5 GHz hexa-core chips-hardly old technology. It's scalable to 120 cores with 3 TB of memory. Clearly larger (more capacity) and faster than anything available in the '60s, with a smaller physical footprint and better energy consumption characteristics.

IBM has a corporate directive for every generation of mainframe: each successive model must be more reliable than the previous one. Incremental and breakthrough improvements have been made over 20 generations of mainframes. Fault tolerance, self-healing capabilities, and concurrent maintainability are characteristics of the mainframe that are lacking in many other systems. The integration of mainframe hardware, firmware and the OS enables the highest reliability, availability and serviceability capabilities in the industry.

Mainframes don't run modern applications?

Mainframes have been running Linux workloads since 2000 and those workloads on the mainframe are growing. From IBM's 2012 Annual Report: “The increase in MIPS (i.e. capacity) was driven by the new mainframe shipments, including specialty engines, which increased 44 percent year over year driven by Linux workloads.”

The mainframe also has a specialty processor specifically intended to run Java workloads. How about Hoplon Infotainment running their TaikoDom game hosted on System z?

You say green screens are ugly? There are graphical interfaces and even iPhone and Android apps that put a pretty face on the green screens for those who are trying to use business applications. More and more, interfaces that the general public is familiar with and comfortable with are being utilized, even in business contexts, to make access to the mainframe easier and more transparent. (How many people are accessing a mainframe on a regular basis today and don't know it? Most of them!)

Those who manage the mainframe often prefer the green screens. These are incredibly fast interfaces that can deliver sub-second response time. When is the last time you clicked your mouse and got sub-second response from a Java application?

What about cloud? The cloud is actually an online computer environment consisting of components (including hardware, networks, storage, services and interfaces) in a virtualized environment that can deliver online services (including data, infrastructure, storage and processes) just in time or based on user demand. By this definition of cloud computing, the System z platform has been an internalized cloud for more than 40 years!

Starting in 2007, IBM embarked on its own server-consolidation project called “Project Big Green.” The company consolidated 3,900 servers onto 16 mainframes, decreasing energy and floor space by more than 80 percent. The electrical power went from $600/day to $32/day and required floor space dropped from 10,000 to 400 square feet. Cooling costs for those mainframes were less than those of distributed servers handling a comparable load as well. In addition, those mainframes required 80 percent less administration/labor, dropping from more than 25 workers vs. less than five.

Mainframes are expensive?

Actual costs depend on what you're looking at. In terms of hardware acquisition costs, certainly, a single mainframe costs more than a single server or even several servers. But, you would need more individual servers to match the computing capability of a mainframe. Add to that the fact software and labor costs for servers grow linearly: The more servers you add, the more software licenses and systems administrators you need. And yet, the mainframe delivers higher utilization, lower overheads and the lowest total cost-per-user of any platform. When all cost factors are considered fairly, the mainframe is usually the lowest cost alternative.

Often when considering the cost of the mainframe, people only look at the initial hardware purchase and overlook the ongoing maintenance costs. With 100 servers, you have 100 times more chances something will break. So you need an army that has to be ready at any time to fix hardware. Each of those servers has an OS on it, and all of them need patches, upgrades and applications deployed to them on a regular basis. So, you need another army for that. Then your applications are spread all over the place, so when the software fails or gets overloaded, it takes an army to monitor the applications and locate the problem. Servers are cheap to buy, but those savings are eaten away by all of the people required to run and monitor them.

Don't forget electrical and air-conditioning costs also increase when you add servers. Then, you need to make sure that you count ALL the servers.

Mainframe skills aren't available or you need more people?

As we've already seen, it takes fewer people to manage a mainframe than a set of servers delivering comparable capability. Do you need specialized skills to manage a mainframe? It depends. If managing Linux on System z, you'll find that Linux is Linux regardless of platform. So if you can manage Linux on Intel, you can manage Linux on the mainframe. This means those students coming out of universities that know Linux can, with very little additional training, manage a Linux on System z environment.

In addition, IBM has been investing in increasing the available skills. The IBM System z Academic Initiative helps to ensure that a shortage of System z and z/OS skills does not happen. Since 2004, the program has worked with more than 1,000 schools to educate more than 50,000 students worldwide! Many people in the mainframe community are using the System z Academic Initiative to assist and enable schools to teach mainframe skills.

Then there is SHARE's zNextGen community that connects more than 900 young mainframe professionals from more than 24 countries. And don't forget the two annual SHARE conferences and year-round webcasts, which offer hundreds of hours of mainframe skills training and numerous opportunities for peer networking.

There's plenty of access to the skills required to manage a mainframe and scores of experts who are happy to share their knowledge and experience. Being well versed in mainframe technologies is a pretty good career choice.

MIPS don't lie

Are companies running from the mainframe? Certainly a few are contemplating or attempting to migrate off the mainframe. But the work being done by the platform is increasing, not decreasing. Just looking IBM's Annual Report, 2010 saw a 22 percent increase in MIPS shipped over the previous year, 2011 had a 16 percent increase, and 2012 saw 19 percent growth. Clearly, the truth about mainframes is out there—especially for those willing to look beyond the myths.[3]

[3] The blog article ends here.

Note: The author of 1.1.1, “Don't Believe the Myths” on page 2, Janet L. Sun, is the immediate past president of SHARE Inc.

You can obtain more information about mainframes at the following website:

http://destinationz.org/Mainframe-Solution/Business-Case/Dispel-Mainframe-Myths.aspx#sthash.rumcf9pN.dpuf

The following sections describe hardware and software options that are available to implement Oracle 12c on IBM System z.

1.2 IBM zEnterprise EC12

The IBM zEnterprise EC12 (zEC12) builds on the strengths of its predecessor, the IBM zEnterprise 196. It is designed to help overcome problems in today's IT infrastructures and provide a foundation for the future. The zEC12 continues the evolution of integrated hybrid systems by introducing the zEnterprise BladeCenter® Extension (zBX) Model 003 and an updated zEnterprise Unified Resource Manager.

The zEC12 has a redesigned zEnterprise chip. It is the first six-core chip in mainframe history, and operates at an industry-leading, high frequency of 5.5 GHz. The zEC12 is a scalable symmetric multiprocessor (SMP) that can be configured with up to 101 processors that run concurrent production tasks with up to 3 TB of memory. Figure 1-1 shows an internal view.

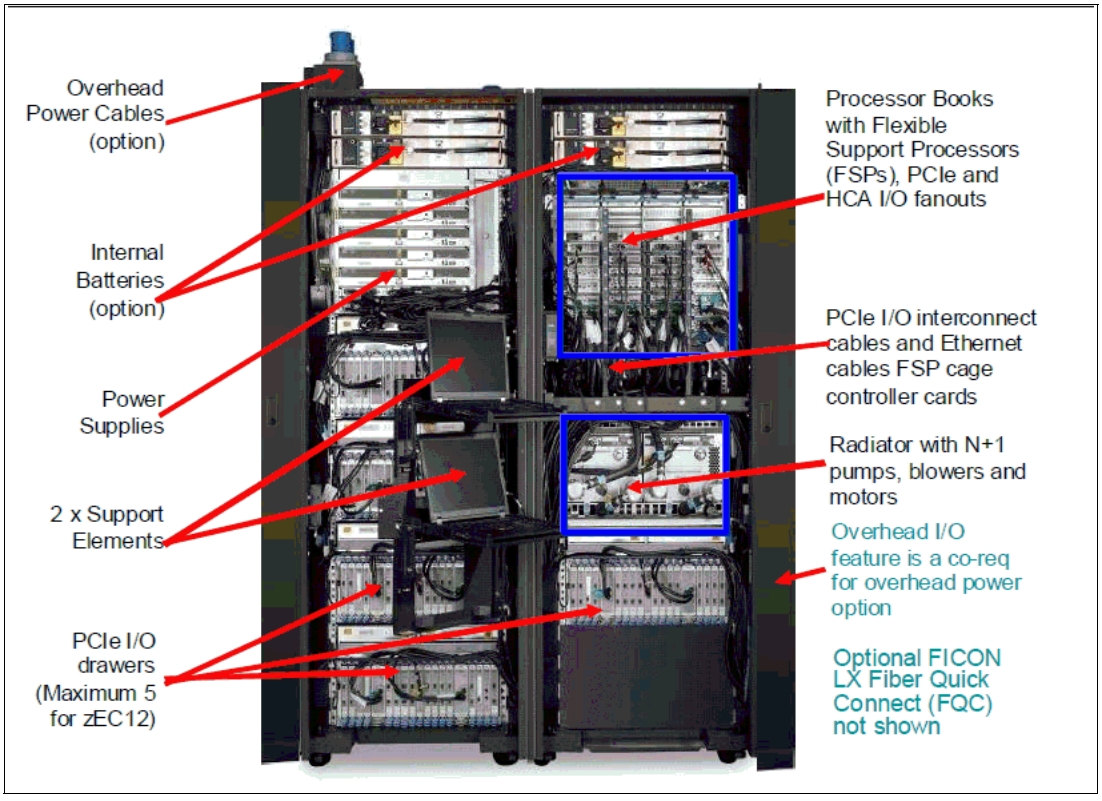


Figure 1-1 zEC12 internal front view - air-cooled CPC

The zEC12 introduces several PCIe I/O features, such as usage of Storage Class Memory through the Flash Express feature. It also introduces technologies such as the IBM System z Advanced Workload Analysis Reporter (IBM zAware). This appliance has cutting edge pattern recognition analytics that use heuristic techniques, and represents the next generation of system health monitoring.

The zEC12 goes beyond previous designs while continuing to enhance the traditional mainframe qualities, delivering unprecedented performance and capacity growth. The zEC12 has a well-balanced general-purpose design that allows it to be equally at ease with compute-intensive and I/O-intensive workloads.

1.3 IBM zEnterprise BC12

The IBM zEnterprise BC12 (zBC12) server is the successor to the IBM zEnterprise 114 and is the fourth member of the zEnterprise CPC family. Similar to the IBM zEnterprise EC12 (zEC12), the zBC12 was designed to help overcome problems in today's IT infrastructure and provide a foundation for the future. Together with the zEC12, it continues the evolution of integrated hybrid systems, including the zEnterprise BladeCenter Extension (zBX) Model 003 and an updated zEnterprise Unified Resource Manager. The zBC12, with up to 13 IFLS, can be used by customers with smaller Oracle workloads. Figure 1-2 shows a zBC12.

Figure 1-2 zBC12

1.4 IBM zEnterprise BladeCenter Extension

The IBM zEnterprise BladeCenter Extension (zBX) is the infrastructure for extending the System z qualities of service and management capabilities across a set of heterogeneous compute elements in an ensemble.

The zBX is available as an optional system to work along with the zEC12 server. It consists of up to four IBM 42U Enterprise racks that can contain POWER® processor-based blade server to run IBM AIX® or IBM BladeCenter® HX5 blades to run Intel-based operating systems such as Linux or Windows.

Using these blades, you can run other certified Oracle products in the same managed environment as the zEC12. An example of this is shown in Figure 1-3 on page 8, where we ran Oracle Enterprise Manager Cloud Control on a blade to manage the Oracle Database 12c Release1 on the zEC12.

Users can run solutions such as Oracle e-Business Suite, PeopleSoft, or Siebel. The applications run on a zBX Power Blade while the database is either IBM DB2® on System z or Oracle on Linux on System z, gaining the advantages of System z for the entire solution. All are certified and supported by IBM and Oracle.

The zBX is configured with redundant hardware infrastructure to provide qualities of service similar to those of System z, such as the capability for concurrent upgrades and repairs.

1.5 z/VM

IBM z/VM V6 extends the mainframe virtualization platform to help you reshape and derive more value from your experiences. The new features of z/VM V6.3, such as support for 1 TB of real memory and better performance for larger virtual machines, benefits those businesses running Oracle on the mainframe.

For more information about the zEC12, zBC12, zBX, and z/VM V6, see Appendix A, “Details about the new IBM System z” on page 201.

1.5.1 Summary of the IBM hardware for Oracle Solutions

The zEC12/zBC12 models, along with the zBX, provide an ideal platform for running Oracle Solutions. An example system is shown in Figure 1-3.

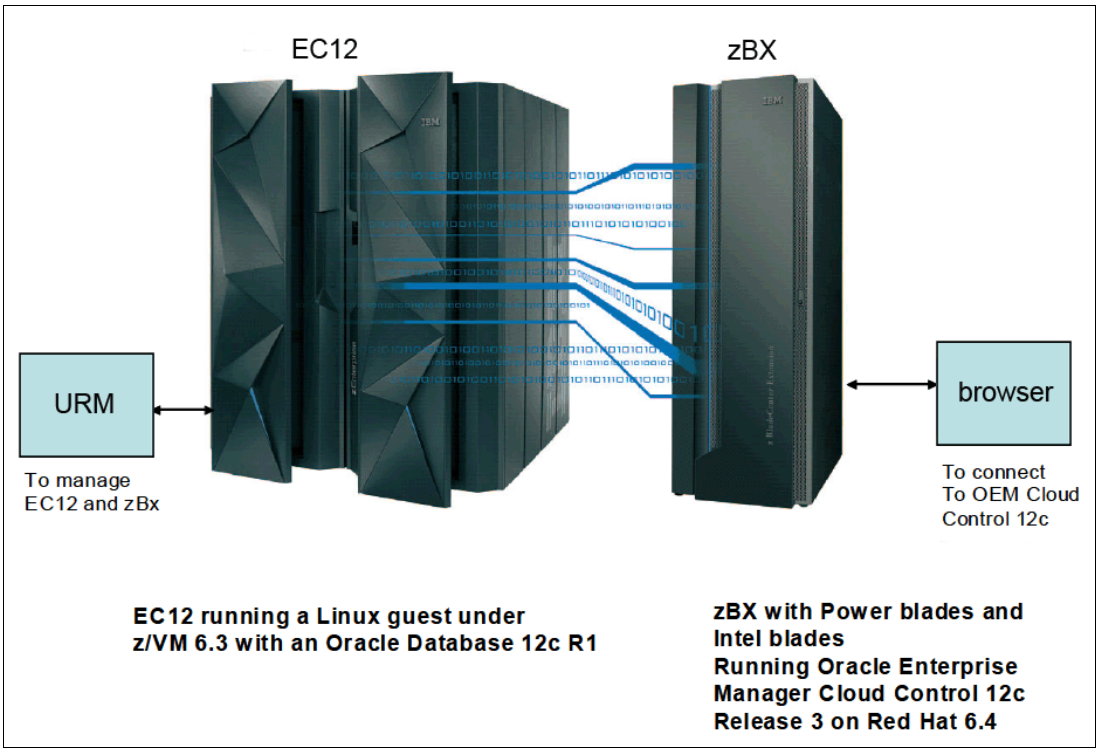


Figure 1-3 Example of an Oracle solution running on zEC12 and zBX

For more information, see Chapter 5, “Using Oracle Enterprise Manager Cloud Control Agent to manage Oracle Database 12c Release 1” on page 75. Oracle Database 12c Release 1 is run on a Linux guest on Red Hat 6.4 on the zEC12. The Oracle Enterprise Manager Cloud Control 12c application is run on Red Hat 6.4 on an Intel blade in the zBX.

This same configuration can be used to run a split-tier implementation of Oracle e-Business Suite, BIEE, or Oracle PeopleSoft applications.

1.6 Linux distribution: New versions

Oracle 12c Database is certified to run on Red Hat Enterprise Linux 5.8 and later, RHEL 6.3 and later, and SLES 11 SP2 and later. Use the most current version that is supported by Oracle. At the time of writing, the suggested versions for Oracle Database 12c Release 1 are RHEL 6.4 and SLES 11 SP3. *The Virtualization Cookbook for IBM z/VM 6.3, RHEL 6.4, and SLES 11 SP3*, SG24-8147 provides more information, as does *Oracle Database 12cR1 available on IBM System z running Linux*.[4]

[4] Document ID:FLASH10832. http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/FLASH10832

1.6.1 Red Hat Enterprise Linux 6.4 and later

Red Hat Enterprise Linux fully supports instances running stand-alone and in virtualized guests over z/VM. Running Red Hat Enterprise Linux on top of z/VM allows the creation of virtual environments that can dynamically allocate computing resources as needed to new or fluctuating workloads. In our examples, our tests were run on Red Hat 6.4 on Linux on System z.

Red Hat Enterprise Linux 6.4 is optimized for performance, stability, and flexibility, and designed to help organizations manage their workloads across physical, virtual, and cloud environments. Red Hat Enterprise Linux introduces several new that help enterprises meet these core business objectives.

Red Hat Enterprise Linux 6.4 delivers scale-out data access through parallel NFS (pNFS), focus on security through Enhanced Identity Management, updated resource management capabilities and new tools, and improved productivity support.

Specifically for the System z, Red Hat Enterprise 6.4 delivers Fibre Channel protocol, end-to-end data consistency checking, Flash Express support, support of the Transactional Execution Facility and Runtime Instrumentation Facility, **`kdump`** and **`kexec`** kernel dumping mechanisms, new modes of operation for libica, and optimization of and support for the zlib compression library for System z and the **`lscpu`** and **`chcpu`** utilities.

The key benefits for organizations deploying Red Hat Enterprise Linux 6.4 are greater efficiency through resource management and performance optimization, enhanced business agility through additional security enhancements, and more flexibility for virtualized and clustered environments.

1.6.2 SLES 11 SP3 and later

Faster performance, tighter security, better resource usage, and reduced administration are just a few of the benefits of server consolidation with SUSE Linux Enterprise Server for System z. Enhancements in SUSE Linux Enterprise Server for System z 11 Service Pack 3 include advanced exploitation of the latest System z hardware releases, improved RAS features, and increased performance.

1.7 Oracle new solutions

Oracle recently made available a group of Oracle Technology products to run on Linux on IBM System z. Supported IBM systems include zEC12, zBC12, z196, z114, z10™ EC, and z10 BC.

1.7.1 Oracle Database 12c R1

Oracle Database 12c Release 1 introduces a new multitenant architecture that makes it easy to deploy and manage database clouds. Innovations such as Oracle Multitenant, for consolidating multiple databases quickly, and Automatic Data Optimization with Heat Map, for compressing and tiering data at a higher density, maximize resource efficiency and flexibility. The IBM System z is an ideal platform for private and public cloud deployments.

1.7.2 Oracle WebLogic Server 12c

Oracle WebLogic Server 12c is available on Linux on IBM System z. It is an application server for building and deploying enterprise Java EE applications with support for new features for lowering cost of operations, improving performance, enhancing scalability, and supporting the Oracle Applications portfolio.

1.7.3 Oracle Agent 12c on Linux on z for Oracle Grid Control

The Oracle Enterprise Manager Agent 12c is available to run on Linux on IBM System z so you can monitor your Oracle 11gR2 and 12c databases with Oracle Enterprise Grid Control server. The server can run on an AIX LPAR in a zBX.

1.8 Summary

The rest of this book concentrates on our experiences installing Oracle Database 12c Release 1, Oracle Enterprise Manager Cloud Control Agent, and Oracle WebLogic Server on Linux on IBM System z. It is designed to show you examples of the installation process. It does not replace Oracle documentation. It should be helpful as an example to those installing these products for the first time.

2

Setting up Linux guests to install Oracle Database 12c

This chapter describes the following topics:

- Documentation available
- RHEL 6 setup
- SLES 11 setup
- Network considerations for Oracle Real Application Clusters (RACs)
- Disk storage considerations for RAC

The details are kept up-to-date in My Oracle Support (MOS) notes, so they are not covered here. It is critical for a successful installation that you review the current version of the MOS notes that are referenced here.

The sections about network and disk storage are detailed to provide you with the current information. The disk and network requirements are covered in detail in *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104.

2.1 Obtaining Oracle documentation, Oracle code, and My Oracle Support notes

The first step is to acquire and review the Oracle documentation by the Note:605251.1 - *Where To Locate The Oracle RDBMS Installation Guides, Upgrade Guides, and Release Notes* MOS note as a guide.

The following Oracle Installation Guides are at http://docs.oracle.com:

- *Oracle Grid Infrastructure Installation Guide 12c Release 1 (12.1) for Linux*, E17888
- *Oracle Database Installation Guide 12c Release 1 (12.1) for Linux,* E17720
- *Oracle Database Release Notes 12c Release 1 (12.1) for Linux*, E17734
- *Oracle Database Quick Installation Guide 12c Release 1 (12.1) for IBM: Linux on System z,* E18443

For Oracle Real Application Cluster installation, we used these installation guides as well:

- *Oracle Real Application Clusters Installation Guide 12c Release 1 (12.1) for Linux and UNIX,* E17889
- *Oracle Clusterware Administration and Deployment Guide 12c Release 1 (12.1),* E17886
- *Oracle Real Application Clusters Administration and Deployment Guide 12c Release1(12.1),* E17887
- *Oracle Automatic Storage Management Administrator's Guide 12c Release 1 (12.1),* E17612

Here are the key MOS notes, available at http://support.oracle.com, for Oracle Database 12c:

- *Getting Started - 12c Release 1 Grid Infrastructure, Oracle Database - IBM: Linux on System z (s390x)*, Doc ID 1574412.1
- *Requirements for Installing Oracle Database 12c Release 1 on SLES 11 on IBM: Linux on System z (s390x),* Doc ID 1574414.1
- *Requirements for Installing Oracle Database 12c Release 1 on RHEL 6 on IBM: Linux on System z (s390x)*, Doc ID 1574413.1

For more documents, see “Related publications” on page 211.

The Oracle code can be downloaded from the following websites:

- http://www.oracle.com/us/downloads/index.html
- https://edelivery.oracle.com/

Ensure that you review the Note:I1574412.1 - *Getting Started* for key information.

2.2 Red Hat setup

The minimum version that is supported is Red Hat 5.8. Use Red Hat 6.4 or later if it is available. Remember these key points:

- Ensure that your Linux guest meets the minimum hardware requirement.
- Review the specific MOS notes for Red Hat.

  - Note:1574413.1—*Requirements for Installing Oracle Database 12c Release 1 on RHEL 6 on IBM: Linux on System z (s390x)* (This section is not visible to customers.)
  - Note:1574412.1—*Getting Started - 12c Release 1 Grid Infrastructure, Oracle Database - IBM: Linux on System z (s390x)* (This section is not visible to customers.)
  - Note:1377392.1—*How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z under Red Hat 6*
- Use the RPM checker to ensure that you have the correct RPMs installed.
- Check the kernel parameters and security settings.
- Set up the Group and User accounts for Oracle.
- For Grid Control and RAC:
  - Check the disk multipathing setup for Red Hat.
  - Check the network setting for RAC, and set up the `/etc/hosts` file.
  - Run cluster verify.
- Check the setting for SELinux.

2.2.1 SELinux permissive or disabled

For Oracle 12c with RHEL 5.8+, the SELinux setting should be either disabled or set to permissive. Issues can occur with sqlplus if SELinux is set to “enforcing”.

If “enforcing” is a requirement for your organization, then see *2013 - Deploying Oracle Database 11g R2 on Red Hat Enterprise Linux 6 - Best Practices Guide*, which can be found at https://access.redhat.com/site/articles/395013. It has the required RPMs in the Appendix section.

Example 2-1 shows the update of the RPMs for SELinux “enforcing” with Linux on System z.

Example 2-1 Updating for enforcing

```
# rpm -qa | grep selinux-policy
selinux-policy-3.7.19-195.el6.noarch
selinux-policy-targeted-3.7.19-195.el6.noarch

# ls selinux-policy*
selinux-policy-3.7.19-211.el6.noarch.rpm
selinux-policy-targeted-3.7.19-211.el6.noarch.rpm

# rpm -Uvh selinux-policy-3.7.19-211.el6.noarch.rpm
selinux-policy-targeted-3.7.19-211.el6.noarch.rpm
Preparing...                ########################################### [100%]
   1:selinux-policy         ########################################### [ 50%]
   2:selinux-policy-targeted########################################### [100%]
```

To verify your SELinux setting, check the `/etc/selinux/config` file.

A reboot is required for the change to take effect. To change it dynamically, run the commands that are shown in Example 2-2 as the root user to change the SELinux security mode.

Example 2-2 Changing the SELinux security mode

```
   getenforce     (returns "Enforcing")
   setenforce 0
   getenforce     (returns "Permissive")
#Output:
   # cat /etc/selinux/config
   # This file controls the state of SELinux on the system.
   # SELINUX= can take one of these three values:
   #       enforcing - SELinux security policy is enforced.
   #       permissive - SELinux prints warnings instead of enforcing.
   #       disabled - SELinux is fully disabled.
   SELINUX=disabled
   # SELINUXTYPE= type of policy in use. Possible values are:
   #       targeted - Only targeted network daemons are protected.
   #       strict - Full SELinux protection.
   SELINUXTYPE=targeted
```

Note: SELinux is turned on by default on Red Hat Enterprise Linux to keep current with the highest standards of security. If this security feature is not wanted, Red Hat gives you the option to disable it or to keep it enabled in permissive mode.

For more information about SELinux, go to the following website:

https://access.redhat.com/site/documentation/en-US/Red_Hat_Enterprise_Linux/6/html/Security-Enhanced_Linux/index.html

2.3 SLES setup

The minimum version that is supported is SLES 11 SP2, which is kernel level 3.0.13-0.27 or later. Here are the key points:

- Ensure that your Linux guest meets the minimum hardware requirements.
- Review the specific MOS notes for SLES 11:
  - *Requirements for Installing Oracle Database 12c Release 1 on SLES 11 on IBM: Linux on System z (s390x)*, Doc ID 1574414.1
  - Note:1574412.1 - *Getting Started - 12c Release1 Grid Infrastructure, Oracle Database - IBM: Linux on System z (s390x)*
  - Note 1350008.1 - *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z under SLES*
- Although the SUSE orarun RPM package can be used to configure the user/groups, ulimits, and kernel parms automatically, our experiences are based on manually configuring these settings based on guidance from the *Oracle Database Quick Installation Guide 12c Release 1 (12.1) for IBM: Linux on System z*, E18443. Changes in the recommended Oracle RPMs and kernel parameters can occur between release levels, so review the latest Oracle support Getting Started notes for the latest updates.
- Use the RPM checker to ensure that you have the correct RPMs installed.
- Check the kernel parameters and security settings.

- Check the group and user accounts for Oracle.
- Set up the directory entries.
- For Grid Control and RAC:
  - Check the disk multipathing that is set up for SLES.
  - Check the network setting for RAC.
  - Run cluster verify.

2.4 Network considerations for RAC

This section describes the network configurations options that are available when configuring the Linux network options for running Oracle with Linux on System z.

Chapter 3, “Network connectivity options for Oracle on Linux on IBM System z”, in *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104, focuses primarily on configuring the network on Linux on System z for both performance and high availability when connecting to another System z for Oracle RAC and connectivity to application servers running on machines other than the database server.

To plan for a network Oracle RAC, have at a minimum of two separate network subnets, one for the public interfaces and another for the private network interfaces. These network interfaces should be configured on layer 2 of the IP protocol stack.

Although not mandatory, it is a preferred practice to use a non-routable IP address for the private network, such as 10.x.x.x or 192.168.x.x. It is also a preferred practice to configure the private interconnect switches with jumbo frames and a large MTU size greater than the DB block size of the database. If the network is configured with VLANs, it is a preferred practice to configure the private network switches with VLAN pruning to protect the private network from uplink routers and network spanning tree events.

Although it is possible to install an Oracle Cluster with one scan IP configured in the local `/etc/hosts` file, this is not a preferred high availability configuration. As a preferred practice, configure three SCAN IPs on the same subnet as the public interface in the network DNS for the network.

Example 2-3 is an example of the IP addresses that are required for a RAC cluster. The VIP and the SCAN IPs are on the same network subnet as the public interfaces.

Example 2-3 Typical /etc/hosts network IP configuration for a two -node RAC

```
192.168.36.234  usora1 usora1.dmz              #Node 1 Public IP address
192.168.36.238  usora1-vip usora1-vip.dmz   #Node 1 VIP
192.168.36.235  usora2 usora2.dmz              #Node 2 Public IP address
192.168.36.239  usora2-vip usora2-vip.dmz   #Node 2 VIP
10.0.1.234      usora1-priv usora1-priv.dmz    #Node 1 Private Network
10.0.1.235      usora2-priv usora2-priv.dmz    #Node 2 Private Network
#
#       Oracle SCAN IP's (configured in DNS)
#
#192.168.36.242        usscan1   usscan1.dmz
#192.168.36.243        usscan1   usscan1.dmz
#192.168.36.244        usscan1   usscan1.dmz
```

As with other active/passive high availability solutions, where the applications connect to the database through a virtual IP address (VIP), Oracle RAC requires that the network be configured with Address Resolution Protocol (ARP) enabled.

ARP is required in the event of a cluster node outage. Oracle RAC requires that the network is configured with ARP so that a new MAC address that is associated with a failover network interface and VIP is routable in the network for the applications accessing the database.

Another consideration is that to have ARP enabled, the network interfaces should be configured on layer 2 of the IP protocol stack. IBM HiperSockets™ are certified and supported for the private network. Only a network that is configured with real HiperSockets is possible, as z/VM guest LAN HiperSockets cannot be configured on layer 2, which is required for ARP.

Figure 2-1 shows a typical network configuration, with the Oracle VIP, and two SCAN IP addresses, being “plumbed” to the eth0 interface as eth0:5, eth0:1, and eth0:2, with the interconnect running on interface hsi0. The **`ip`** command replaces the **`ifconfig`** command that is used here.

```
usoral:~ # ifconfig -a
eth0      Link encap:Ethernet  HWaddr 02:00:01:00:00:72
          inet addr:192.168.36.234  Bcast:192.168.36.255  Mask:255.255.255.0
          inet6 addr: fe80::200:100:200:72/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1492  Metric:1
          RX packets:38106924 errors:0 dropped:0 overruns:0 frame:0
          TX packets:35345824 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:29681605462 (28306.5 Mb)  TX bytes:26813763038 (25571.5 Mb)

eth0:1    Link encap:Ethernet  HWaddr 02:00:01:00:00:72
          inet addr:192.168.36.244  Bcast:192.168.36.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1492  Metric:1

eth0:2    Link encap:Ethernet  HWaddr 02:00:01:00:00:72
          inet addr:192.168.36.243  Bcast:192.168.36.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1492  Metric:1

eth0:5    Link encap:Ethernet  HWaddr 02:00:01:00:00:72
          inet addr:192.168.36.238  Bcast:192.168.36.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1492  Metric:1

hsi0      Link encap:Ethernet  HWaddr 06:00:FF:1C:00:08
          inet addr:10.0.1.234  Bcast:10.0.1.255  Mask:255.255.255.0
          inet6 addr: fe80::400:ffff:fe1c:8/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:57344  Metric:1
          RX packets:8585763 errors:0 dropped:0 overruns:0 frame:0
          TX packets:8865047 errors:69524 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:7299095188 (6960.9 Mb)  TX bytes:3198691230 (3050.5 Mb)

hsi0:1    Link encap:Ethernet  HWaddr 06:00:FF:1C:00:08
          inet addr:169.254.252.250  Bcast:169.254.255.255  Mask:255.255.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:57344  Metric:1
```

Figure 2-1 Typical Oracle RAC network configuration

FlexASM is a new feature in Oracle 12c that eliminates the requirement of one ASM instance per Oracle RAC node cluster. With FlexASM, if an unplanned ASM shutdown occurs on a node, the databases running on that node can now reconnect to an ASM instance on another node.

Oracle in 12c allows for the network communication between ASM instances to be configured either on a separate private network or on the same network. Figure 2-2 on page 17 shows the new optional capability to configure a FlexASM network.

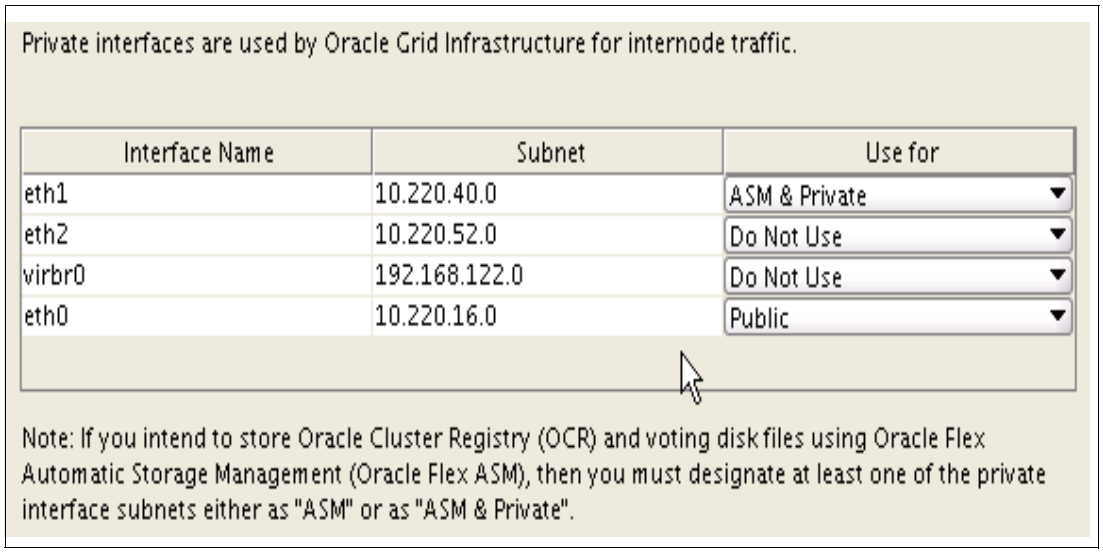


Figure 2-2 Oracle 12c RAC network configuration with FlexASM network

2.5 Disk storage options for Linux on System z

This section describes the disk storage options that are available when configuring Oracle database files on Linux for System z.

Note: Memory sizing is covered in Chapter 2, “Getting started on a proof of concept project for Oracle Database on Linux on System z”, of *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104.

The following section is a supplement to Oracle support notes such as *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z under Red Hat 6*, Doc ID 1377392.1 and *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z under SLES*, Doc ID 1350008.1, and the update note for SLES 11 SP2+, Doc ID 1584934.1.

In general, there are two disk storage configuration options for database files: IBM Extended Count Key Data (ECKD™) DASD with HyperPAV, or Open Storage FCP/SCSI LUNs. ECKD DASD uses less CPU, but does not get the same transactional throughput as FCP/SCSI implementations. Your choice depends on your environment, including your disaster recovery (DR) requirements. For more information about this choice, see 9.5, “Disk I/O performance” on page 196

2.5.1 FCP/SCSI disk configuration

To configure disk storage for Linux on System z, you must first assign the LUNs (with multiple paths) to your Linux system.

The first step is to verify that the LUNs are available to the Linux system. You can run the **lsluns** or **lsscsi** commands to verify connectivity to the SAN. Example 2-4 shows sample LUN listings.

Example 2-4 LUN listings

```
orainst1:~ # lsluns
Scanning for LUNs on adapter 0.0.9e00
        at port 0x500507630338cbbf:
                0x40ef400000000000
                0x40ef400100000000
                0x40ef400200000000
                0x40ef400300000000
Scanning for LUNs on adapter 0.0.9f00
        at port 0x500507630338cbbf:
                0x40ef400000000000
                0x40ef400100000000
                0x40ef400200000000
               0x40ef400300000000

orainst1:~ # lsscsi
[0:0:0:1073758447]disk    IBM      2107900          6.91  /dev/sda
[0:0:0:1073823983]disk    IBM      2107900          6.91  /dev/sdb
[1:0:0:1073758447]disk    IBM      2107900          6.91  /dev/sdc
[1:0:0:1073823983]disk    IBM      2107900          6.91  /dev/sdd
```

If your LUNs are not yet configured, you can use the YaST zfcp LUN configuration tool (if you are using SLES) or the `/etc/zfcp.conf` configuration (if you are using Red Hat) to make the LUNs available to the Linux system. Chapter 24, “Working with disks”, in *The Virtualization Cookbook for IBM z/VM 6.3, RHEL 6.4, and SLES 11 SP3*, SG24-8147 covers these steps in more detail.

You can require up to four separate paths to each LUN in a two-node Oracle RAC configuration when you use FCP/SCSI and multipathing. Multiple separate LUNs can share the same path, but separate paths are required for each multipath path going to the same worldwide LUN ID.

Unlike ECKD/DASD configurations, a partition is not required for FCP/SCSI LUNs. As a preferred practice, configure the disk LUNs with multipathing to ensure high availability and better performance by spreading the I/O workload across more channel paths/host bus adapters (HBAs).

The first step in configuring is ensuring that the multipath daemon is started. It should be configured to start for system restarts. The exact version of multipath varies by the Linux distribution that you are running. Example 2-5 shows the steps to verify that multipath RPMs are installed.

Example 2-5 Verifying multipath RPMs

```
SUSE:
orainst1:/etc # rpm -qa | grep multipath
multipath-tools-0.4.9-0.83.2
```

```
Red Hat 6:
[root@xrorap ~]# rpm -qa | grep multipath
device-mapper-multipath-0.4.9-64.el6.s390x
device-mapper-multipath-libs-0.4.9-64.el6.s390x
```

Next, check that the multipathd service is configured to start on system startup by running the following command and reviewing its output:

```
# chkconfig --list | grep multipathd
multipathd               0:off   1:off   2:on    3:on    4:on    5:on    6:off
```

SLES 11

If you are using SLES 11, you should also ensure `boot.multipath` is started and configured to start on system restart by running the following commands and reviewing their output:

```
# chkconfig multipathd on
# chkconfig boot.multipath on
# chkconfig --list multipathd
boot.multipath           0:off  1:off  2:off  3:off  4:off  5:off  6:off  B:on
```

You can start `boot.multipath` and `boot.multipathd` on SLES 11 systems by running the following commands:

```
# /etc/init.d/boot.multipath start
# /etc/init.d/multipathd start
```

Now that multipath is configured, the next step is to gather the unique worldwide identifier (WWID) for each of the LUNs that you plan to use for your Oracle database files.

Notice in Example 2-6 that the LUN WWIDs `/dev/sda` and `/dev/sdc` have the same WWIDs. These are the same physical disk LUN, but are configured with an alternative path to provide higher availability.

Example 2-6 Gathering LUN WWIDs

```
# /lib/udev/scsi_id --whitelisted --device=/dev/sda
36005076303ffcbbf000000000000ef00
# /lib/udev/scsi_id --whitelisted --device=/dev/sdb
36005076303ffcbbf000000000000ef01
# /lib/udev/scsi_id --whitelisted --device=/dev/sdc
36005076303ffcbbf000000000000ef00
# /lib/udev/scsi_id --whitelisted --device=/dev/sdd
36005076303ffcbbf000000000000ef01
```

After the LUN WWIDs are determined, configure `/etc/multipath.conf` with aliases and define any storage array-specific settings to help improve disk I/O performance. Example 2-7 illustrates a sample `/etc/multipath.conf` setting.

Example 2-7 Sample multipath.conf file

```
# check with your storage vendor as well for any updates
defaults  {
   dev_loss_tmo 90    #zSeries specific, no. of secs wait before marking path bad
   failback "immediate"
#  failback  "manual" #use manual with RAC clusters to prevent ping-pong effect
   fast_io_fail_tmo 5 #zSeries specific, length time to wait before failing I/O
   getuid_callout "/lib/udev/scsi_id --whitelisted --device=/dev/%n"
```

```
#  getuid_callout "/sbin/scsi_id -g -u -s /block/%n" #use with Red Hat 5.x,SLES  10
#  uid_attribute "ID_SERIAL" #use uid_attribute instead of getuid for SLES 11SP3+ & RH 7
   max_fds "max" #Red Hat 6.3+, SLES 11SP3+
#  max_fds 8192  #Use for Older SLES and Red Hat distros
   no_path_retry "queue" #XiV recommendation if no paths available, use fail with RAC
#  no_path_retry "fail"  # use fail if using Oracle RAC
   path_selector "round-robin 0"   #round-robin for SLES 11 SP2 and Red Hat 6.x and older
#  path_selector "service-time 0"  #use service-time for SLES 11 SP3+ and Red Hat 7+
   path_grouping_policy "multibus" # SLES 11 SP1+ and Red Hat 6.x
#  path_grouping_policy "failover" # SLES 10, Red Hat 5.x
   path_checker "tur"  # Determines state of path, XiV, DS8000, verify with vendor
   polling_interval 30 # Time in seconds to check paths
   prio "const"
   queue_without_daemon "yes"
#  rr_min_io 100    #rr_min_io for older Linux distro's (Red Hat 5.x,SLES 11sp1 & older)
#  rr_min_io_rq 1   #RamSan RS-710/810
#  rr_min_io_rq 4   #RamSan RS-720/820
#  rr_min_io_rq 15  #IBM XiV
   rr_min_io_rq 100 #IBM DS8000, rr_min_io_rq for newer Linux distros (SLES 11sp2+ RH 6+)
   rr_weight "uniform"
   user_friendly_names "yes"
}

blacklist  {
   devnode "^(dasd)[0-9]*"
}

multipaths {
   multipath {
      #remember to use /lib/udev/scsi_id --whitelisted --device=/dev/sda to get unique wwid
      wwid   36005076303ffcbbf000000000000ef00
      alias     ASMFCP1
}
```

Note: It is not a preferred practice to use aliases for the system root/boot device.

Note: A multipath YaST module can be installed from the SLE HA Extension that is included with a SLES for System z subscription. The YaST multipath module makes configuring the `multipath.conf` file much easier.

In order for the changes for `multipathd` to take effect for SLES 11, run the commands that are shown in Example 2-8.

Example 2-8 SLES 11 - starting and stopping multipathd

```
# service multipathd stop
Shutting down multipathd done

#  /sbin/multipath -F
#  /sbin/multipath -v2 -l
#  service multipathd start
Starting multipathd done
```

In order for the changes for `multipathd` to take effect for Red Hat 6, run the commands that are shown in Example 2-9 on page 21.

Example 2-9 Red Hat 6 - starting and stopping multipathd

```
# service multipathd stop
Stopping multipathd daemon: [  OK  ]
#  multipath -F
#  /sbin/multipath -v2
#  service multipathd start
Starting multipathd daemon: [  OK  ]
```

It is also a preferred practice to run **zipl** and **mkinitrd** after making changes to /etc/multipath.conf.

The last step is required if you are using Oracle ASM. If you are using ASM, you must set up the file permissions so that the Oracle user has read and write access to the ASM storage volumes.

The /etc/udev/rules.d/12-dm-permissions.rules file is used to map the multipath alias with the Linux user ID that is used to install the Oracle Grid Infrastructure code. Some sites use grid for this user ID, and other sites use the Linux Oracle ID for both the Orace Grid Infrastructure and the Oracle RDBMS binary files.

If you do not have a template copy of the /etc/udev/rules.d/12-dm-permissions.rules file, you can usually find a copy of this file in /usr/share/doc/device-mapper-1.02.77/12-dm-permissions.rules on Red Hat systems and /usr/share/doc/packages/device-mapper/12-dm-permissions.rules on SLES 11 systems.

Configure the /etc/udev/rules.d/12-dm-permissions.rules file as shown in Example 2-10 by assigning the multipath alias with the needed Oracle file permissions. It is a preferred practice to use the DM-NAME that is tied to the multipath.conf alias, but you can also use the mpath-WWID if you are not using the multipath aliases.

Example 2-10 Sample /etc/udev/rules.d/12-dm-permissions.rules file

```
# MULTIPATH DEVICES
#
# Set permissions for all multipath devices
#ENV{DM_UUID}=="mpath-36005076303ffcbbf000000000000ef01", OWNER:="oracle",
GROUP:="dba", MODE:="660"
ENV{DM_NAME}=="ASM*", OWNER:="oracle", GROUP:="dba", MODE:="660"
```

For the follow-on Oracle ASM configuration steps that are typically performed by the Oracle DBA, see 2.5.3, “Oracle ASM configuration” on page 26.

2.5.2 ECKD/DASD disk configuration

If you are configuring your disk storage for Oracle with ECKD/DASD, there are several enhancements in z/VM that allow for increased disk performance for Oracle databases, namely HyperPAV and Live Guest Relocation (LGR).

The scope of this section is configuring the DASD for Oracle database to help use HyperPAV and LGR in your Oracle environments.

If you want to configure HyperPAV or PAV, the first step is to verify and configure that the Hardware Management Console (HMC) IOCP configuration for the DASD aliases is done.

The following guide can assist if you require further assistance in configuring HyperPAV aliases in the IOCP:

http://public.dhe.ibm.com/software/dw/linux390/docu/lk35hp01.pdf

HyperPAV/PAV support is available with RHEL 5.9+ and SLES 10 SP4+.

At the z/VM layer, after the IOCP is defined, the next step is to attach the base DASD volumes and the associated aliases, and then verify that z/VM can see the devices. Here are the steps to temporarily add the base and aliases devices:

1. Attach the base DASD device by running the following command:

   ```
   CP ATTACH 7408 *
   ```

2. Attach the alias by running the following command

   ```
   CP ATTACH 74D0 *
   ```

3. Verify that HyperPAV aliases can be seen by z/VM:

   ```
   q pav all
   HYPERPAV BASE  7408 ON 7408 0X7408 ASSIGNED 7408 POOL 65
   HYPERPAV BASE  7409 ON 7409 0X7409 ASSIGNED 7409 POOL 65
   HYPERPAV ALIAS 74D0 ASSIGNED 74D0 POOL 65
   HYPERPAV ALIAS 74D1 ASSIGNED 74D1 POOL 65
   ```

To be persistent across IPLs of z/VM, the base and aliases devices should be defined in the Linux guest's z/VM `USER` directory.

Aliases are not exclusive to the base device for which they are defined. An alias can be used for any base device in the same logical subsystem on the storage system. In our example, any base device beginning with '75XX' can use any of the '75XX' format aliases. HyperPAV alias definitions should be defined before any DEVICE definitions in the guest's `USER` directory.

Example 2-11 shows a partial user directory entry with HyperPAV alias definitions.

Example 2-11 Sample excerpt of USER DIRECT file showing HyperPAV aliases

```
USER ORARH1 1RV7QL00 64G 256G AG
   INCLUDE CMSUSER
   COMMAND DEFINE HYPERPAVALIAS 74D0 FOR BASE 7408
   COMMAND DEFINE HYPERPAVALIAS 74D1 FOR BASE 7408
```

Activating DASD and aliases with SLES 11

The YaST DASD module (YaST | Hardware | DASD) or the **`dasd_configure`** command that is shown in Example 2-12 can be used to bring online a base device and the aliases. These commands are run to make the DASD and aliases persistent across reboots by creating a corresponding UDEV rule in the `/etc/udev/rules.d` directory.

Example 2-12 SLES 11 dasd_configure example

```
dasd_configure 0.0.7408 1 0
dasd_configure 0.0.7409 1 0
dasd_configure 0.0.74d0 1 0
dasd_configure 0.0.74d1 1 0
```

You should then test and verify that HyperPAV is set up correctly from the Linux system by running **lsdasd -u**. If you see no aliases, then HyperPAV is not configured properly.

Activating DASD and aliases with Red Hat 6

With Red Hat 6, you can use the `/etc/dasd.conf` file to automatically bring online a DASD base device and the corresponding aliases can be enabled through this file as well. Each line pertains to the device (base or alias) to bring online (see Example 2-13).

Example 2-13 Red Hat 6 /etc/dasd.conf example

```
0.0.7408
0.0.7409
0.0.74d0
0.0.74d1
```

As a final test of whether HyperPAV is configured correctly for a Linux guest, as shown in Example 2-14, you should run **lsdasd -u** to confirm that your base devices have all the aliases that you have defined.

Example 2-14 lsdasd -u

```
Bus-ID    Name      UID
============================================================================
0.0.7408  dasdt     IBM.750000000NA461.1554.08.00000000000027200000000000000000
0.0.7409  dasdce    IBM.750000000NA461.1554.09.00000000000027200000000000000000
0.0.74d0  alias     IBM.750000000NA461.1554.xx.00000000000000000000000000000000
0.0.74d1  alias     IBM.750000000NA461.1554.xx.00000000000000000000000000000000
```

After the DASD volumes are presented to Linux, the next step is to format and partition the ECKD/DASD devices. It is mandatory to partition all physical DASD disk volumes.

Example 2-15 shows the commands that you can use to format and partition the DASD base volumes.

Note: Formatting can result in loss of data. Make sure that you have the correct device names.

Example 2-15 Formatting a DASD volume

```
# /sbin/dasdfmt -f /dev/dasdt   -b 4096 -p -y
# /sbin/dasdfmt -f /dev/dasdce -b 4096 -p -y
```

The **-f** parameter specifies the DASD volume to format, the **-b** flag specifies the block size, which should be 4096, the -p flag shows a progress bar, and the **-y** flag specifies start formatting without user confirmation.

It is mandatory to partition ECKD/DASD devices for use with Oracle 11.2 ASM. Example 2-16 illustrates the partitioning commands that can be used to create a single partition on your base DASD volumes.

Example 2-16 Creating a partition on a DASD volume

```
#  fdasd -a /dev/dasdt
#  fdasd -a /dev/dasdce
```

After you partition ECKD/DASD devices, then you must remember to reread the partition tables on each of the remaining nodes in the cluster. For Red Hat, you can use `/sbin/partprobe devicename`, and for SLES 11, you can use `/usr/sbin/partprobe devicename` to update your remaining cluster nodes with the partition tables.

Oracle ASM typically spreads I/O out evenly, so it is a preferred practice to have at least one alias for each base device being used. For example, with a pool of 16 base devices, a pool of 16 aliases that are shared among all the base devices provides a good logical subsystem starting point for avoiding any device queuing.

HyperPAV can improve performance when device queuing is occurring. However, having too many aliases can reduce these performance gains. Juergen Doelle's “Oracle Database on Linux on System z - Disk I/O Connectivity Study” white paper[1] provides further analysis on determining the correct number of aliases to use.

You can use the DASD Statistics in the FCX108 performance toolkit report (shown in Example 2-17) or any similar performance analysis report to look for devices where “Req. Queued” is > 1. “Req. Qued is the average length of the wait queue for the real device. This is the average number of I/Os waiting in line to use the volume.”[2] Additional HyperPAV aliases can be defined if the Req Qued value is consistently >1.

Example 2-17 Sample performance toolkit report

```
FCX108  Run 2007/06/05 11:01:14         DEVICE
                                        General I/O Device Load and Performance
From 2007/02/04 13:28:34
To   2007/02/04 13:38:35
For    600 Secs 00:10:00                Result of Y032180H Run

_____________________________________________________________________________

 .    .                    .      ___     .    .    .    .    .    .    .    .
 <-- Device Descr. -->  MDisk Pa- <-Rate/s-> <------- Time (msec) -------> Req.
 Addr Type   Label/ID   Links ths  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued
 522A 3390   BWPVS0         0   4  711    .0   .2   .2   .9  1.3  3.9   .0  1.8
 522B 3390   BWPVS1         0   4  745    .0   .2   .2   .9  1.3  3.8   .0  1.8
 522C 3390   BWPVS2         0   4  744    .0   .2   .2   .9  1.3  3.8   .0  1.8
 522D 3390   BWPVS3         0   4  745    .0   .2   .2   .9  1.3  3.8   .0  1.8
 522E 3390   BWPVT0         0   4  769    .0   .2   .2   .8  1.2  3.6   .0  1.8
 522F 3390   BWPVT1         0   4  740    .0   .2   .2   .9  1.3  3.7   .0  1.8
 5230 3390   BWPVT2         0   4  716    .0   .2   .2   .9  1.3  3.9   .0  1.8
 5231 3390   BWPVT3         0   4  719    .0   .2   .2   .9  1.3  3.9   .0  1.8
```

[1] http://pic.dhe.ibm.com/infocenter/lnxinfo/v3r0m0/topic/liaag/l0orac00.pdf
[2] Source: http://www.vm.ibm.com/perf/reports/zvm/html/530hpav.html

If you are configuring your HyperPAV base volumes to use Oracle ASM, then you must configure a UDEV rule to ensure device persistence and to set the correct file permissions for Oracle.

Example 2-18 shows a `/etc/udev/rules.d/99-udev-oracle.rules` file that assigns permissions and device-persistent soft link aliases for the DASD device. If you are using Oracle RAC, the devices should be the same across each node in the cluster.

Example 2-18 /etc/udev/rules.d/99-udev-oracle.rules file

```
=======================================================
# Oracle ASM dasd disk
KERNEL=="dasd*1",ID=="0.0.7408",OWNER="oracle",GROUP="dba",MODE="0660",SYMLINK+="A
SM7408"
KERNEL=="dasd*1",ID=="0.0.7409",OWNER="oracle",GROUP="dba",MODE="0660",SYMLINK+="A
SM7409"
=======================================================
```

The OWNER and GROUP values are based on the Linux user ID that is used to install the Oracle grid ASM binary files. Some sites use two IDs (for example, grid for ASM and Oracle for the database), and other sites use the Oracle ID for both ASM and database.

After you modify the udev rules, it is then necessary to stop and start udev, as shown in Example 2-19 and Example 2-20, to test the changes.

Example 2-19 SLES 11 - reloading UDEV rules

```
# /etc/init.d/boot.udev stop
# /etc/init.d/boot.udev start
```

Example 2-20 Red Hat 6 - reloading UDEV fules

```
# udevadm control --reload-rules
# start_udev
```

Verify that the permissions are correct for the devices for which the udev rules are in effect, as shown in Example 2-21.

Example 2-21 Verifying UDEV file permissions

```
# ls -la /dev/dasdt1 /dev/dasdce1
brw-rw---- 1 oracle oinstall 94, 329 Nov 27 18:00 /dev/dasdce1
brw-rw---- 1 oracle oinstall 94,  77 Nov 27 22:51 /dev/dasdt1

# ls -latr /dev/dasdt1 /dev/dasdce1
brw-rw---- 1 oracle oinstall 94, 329 Nov 27 18:00 /dev/dasdce1
brw-rw---- 1 oracle oinstall 94,  77  Nov 27 22:54 /dev/dasdt1
```

If you must set up Oracle RAC with shared DASD volumes across multiple Linux guests, see Chapter 3, “Network connectivity options for Oracle on Linux on IBM System z”, in *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104.

2.5.3 Oracle ASM configuration

If you are using Oracle ASM for storing your Oracle database files, there are several steps to consider. The first step is to ensure that ASM can see either DASD or FCP disk devices that are created by configuring the ASM disk string.

Figure 2-3 shows that you can change the ASM diskstring from ASMCA. You can change the ASM search string from ASMCA or with the ASM Instance's spfile.

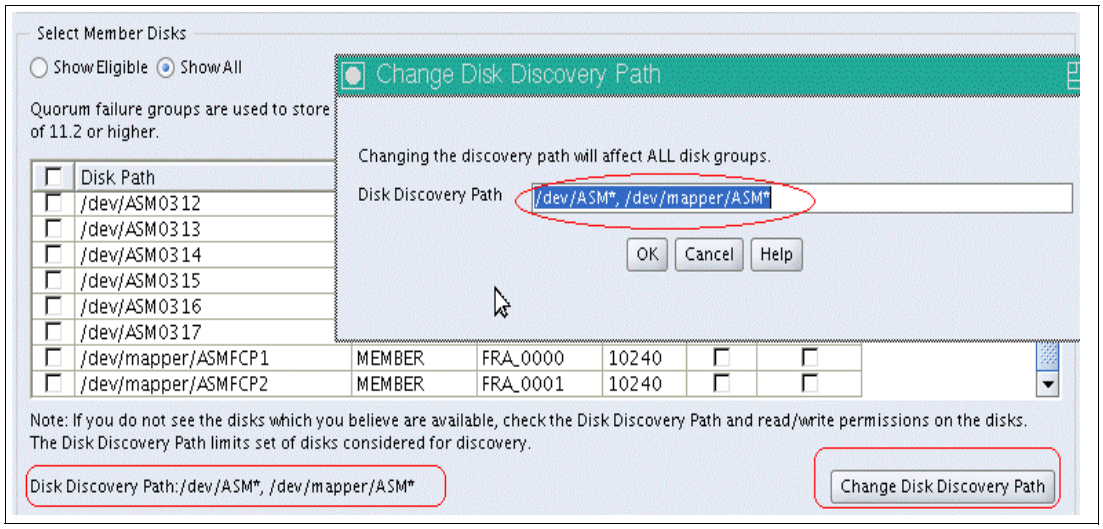


Figure 2-3 Configuring the ASM Search String

Oracle 12c ASM can modify the default ASM Stripe size for the disk group. Factors such as the size of the database and the type (transactional or Decision Support sequential) of workload can help with the I/O performance of the database. Figure 2-4 shows how to configure the AU_SIZE of the ASM disk, which can be configured only at disk group creation. Oracle recommends 4 MB, but this size should be increased for larger or more sequential-oriented databases.

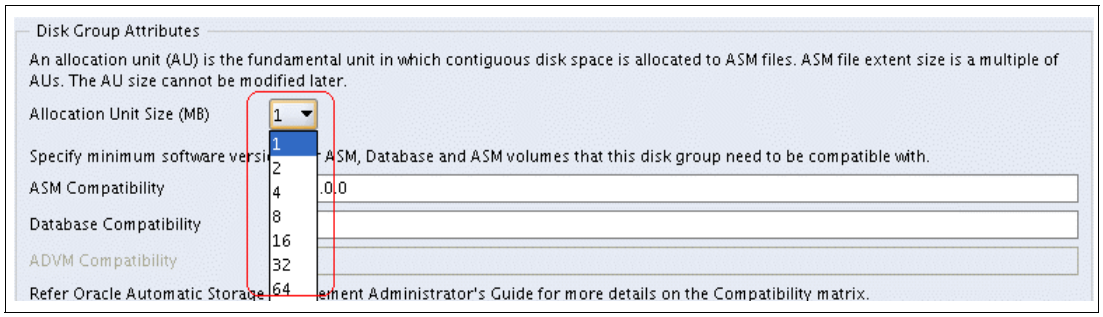


Figure 2-4 ASM Disk Group Attributes

2.5.4 LVM file system configuration

If you are not planning to use Oracle ASM for your database files, then a Logical Volume Manager file system can be used. Example 2-22 on page 27 shows the steps to create a volume group, logical volume, update `fstab`, assign disk permissions, and then disable Linux read-ahead for an Oracle database file system.

Example 2-22 Configuring an LVM file system for Oracle

```
# pvcreate  /dev/dasdce1
  Physical volume "/dev/dasdce1" successfully created
# pvcreate  /dev/dasdt1
  Physical volume "/dev/dasdt1" successfully created

# vgcreate vgoradata /dev/dasdce1 /dev/dasdt1
  Volume group "vgoradata" successfully created
# lvcreate -l 100%FREE --stripes 2 --name lvoradata vgoradata
  Using default stripesize 64.00 KiB
  Logical volume "lvoradata" created
```

In Example 2-22, the **-l 100%FREE** option creates the LVM with all the available cylinders. It is a preferred practice to stripe any file systems that are being used for Oracle data files, particularly with DASD storage. This is similar to our experience that aliases having more base devices with aliases usually provide better I/O throughput, particularly with DASD storage devices.

A general rule of thumb is a stripe size of 64 (default) -128 KB for transactional systems, and 128 - 256 KB for more sequential DSS workloads.

In general for Red Hat systems, ext4 is suggested for Red Hat 6 systems, and for SLES 11 systems, ext3 is suggested for the file system step. Example 2-23 shows an ext3 SLES system and Example 2-24 illustrates an ext4 Red Hat 6 system.

Example 2-23 Configuring an ext3 file system on SLES 11

```
#   mkfs.ext3 /dev/vgoradata/lvoradata
```

Example 2-24 Configuring an ext4 file system on Red Hat 6

```
#   mkfs.ext4  /dev/vgoradata/lvoradata
```

After the file systems are created, it is a good idea to make a backup of your `/etc/fstab` file and then add the new file system entries to the `/etc/fstab` file, as shown in Example 2-25. You should also make sure that the Oracle Linux user ID has read/write access to the directories that are needed for Oracle.

Example 2-25 Sample SLES 11 fstab entry

```
#  cp /etc/fstab /etc/fstab.bkup
#  cat /etc/fstab
/dev/disk/by-path/ccw-0.0.0200-part1 /                    ext3
acl,user_xattr        1 1
/dev/orvg/orlv                       /u01                           ext3
acl,user_xattr        1 2
/dev/vgoradata/lvoradata       /oradata                              ext3
acl,user_xattr        1 2
```

After the `fstab` entry is created, you can mount the Oracle database file system, as shown in Example 2-26. It is now ready for the Oracle database installation.

Example 2-26 Mounting and checking the file system

```
# mkdir  /oradata
# mount /oradata
# chown oracle:dba /oradata

# df -h
Filesystem                      Size  Used Avail Use% Mounted on
/dev/dasda1                     2.3G  1.2G  1.1G  52% /
/dev/dasdc1                     2.3G  1.4G  800M  64% /usr
/dev/mapper/vgoradata-lvoradata 4.6G  138M  4.2G   4% /oradata
```

If you are using file systems for Oracle database files, it is suggested for most workloads to set the Oracle parameter **`filesystemio_options='setall'`** from the default of `NONE` to do both asynchronous and direct I/O for Oracle database files.

Finally, for Linux on System z workloads, use the SLES 11 or Red Hat 6 default I/O Scheduler of **`deadline`** or **`noop`** based on your storage configuration. In our internal testing, both have performed well, compared to the **`CFQ`** (completely fair queuing) I/O scheduler for Oracle workloads.

For SLES systems with Linux on System z, the default I/O scheduler for a storage device is set by the device driver. You can determine what I/O scheduler is in use by running **`cat`** for the LUN's scheduler value, as shown in Example 2-27. The parameter in square brackets [] indicates the current I/O scheduler setting.

Example 2-27 Verifying the I/O scheduler for SAN disk LUN

```
#  cat /sys/block/sda/queue/scheduler
noop [deadline] cfq
```

You can change the I/O scheduler default value for all LUNs by updating the `/etc/zipl.conf` file and adding `elevator=deadline` (or `noop`) to the end of the parameters line.

2.5.5 Unit testing your I/O configuration

Oracle RDBMS 11gR2 and 12c have a new function that you can use to run the run Oracle Orion disk I/O utility before any new database is migrated or created. Orion simulates an Oracle I/O workload, and is a good indicator of how your I/O subsystem will perform. As a preferred practice, run Oracle Orion when a new storage subsystem is configured to test and verify various I/O configurations.

To run Oracle Orion, the first step is to create a file that is called `orion.lun` with the storage devices that you want to test. `orion.lun` is the default file name. Other file names can be used if you specify **`-testname XXX`**“. In that case, *`XXX`*`.lun` (XXX is the specified test name) is the configuration file that Orion uses. Example 2-28 on page 29 illustrates a typical configuration of `orion.lun` using the multipath LUN names and an Orion oltp IOPS test.

Example 2-28 Oracle Orion test

```
cat orion.lun
/dev/mapper/ASMFCP01
/dev/mapper/ASMFCP02
/dev/mapper/ASMFCP03
/dev/mapper/ASMFCP04

./orion -run oltp -duration 20
ORION: ORacle IO Numbers -- Version 11.2.0.3.0
orion_20131129_1316
Calibration will take approximately 18 minutes.
Using a large value for -cache_size may take longer.

Maximum Small IOPS=22652 @ Small=576 and Large=0
Small Read Latency: avg=25384 us, min=171 us, max=401820 us, std dev=39517 us @
Small=576 and Large=0

Minimum Small Latency=5705 usecs @ Small=32 and Large=0
Small Read Latency: avg=5705 us, min=172 us, max=153864 us, std dev=3516 us @
Small=32 and Large=0
Small Read / Write Latency Histogram @ Small=576 and Large=0
        Latency:               # of IOs (read)          # of IOs (write)
        0 - 1           us:            0                       0
        2 - 4           us:            0                       0
        4 - 8           us:            0                       0
        8 - 16          us:            0                       0
       16 - 32          us:            0                       0
       32 - 64          us:            0                       0
       64 - 128         us:            0                       0
      128 - 256         us:            1111                    0
      256 - 512         us:            43                      0
      512 - 1024        us:            1                       0
     1024 - 2048        us:            1270                    0
     2048 - 4096        us:            28063                   0
     4096 - 8192        us:            68046                   0
     8192 - 16384       us:            12508                   0
    16384 - 32768       us:            894                     0
    32768 - 65536       us:            38                      0
    65536 - 131072      us:            54                      0
   131072 - 262144      us:            5                       0
   262144 - 524288      us:            0                       0
   524288 - 1048576     us:            0                       0
  1048576 - 2097152     us:            0                       0
```

Note: Do not specify active database LUNs or LVM file systems, especially when using the **-write** parameter, or else your database / LVM file system can be corrupted and become unoperational.

Another handy tool in Oracle 11gR2 and 12c is the Oracle I/O Calibrate routine (Example 2-29). I/O Calibrate can be used from the script that is provided in the *Oracle Database PL/SQL Packages and Types Reference 12c Release 1 (12.1) Guide*, found at:

http://docs.oracle.com/cd/E16655_01/appdev.121/e17602/d_resmgr.htm#ARPLS67598

Example 2-29 Oracle I/O Calibrate test script

```
SET SERVEROUTPUT ON
DECLARE
  lat  INTEGER;
  iops INTEGER;
  mbps INTEGER;
BEGIN
-- DBMS_RESOURCE_MANAGER.CALIBRATE_IO (<DISKS>, <MAX_LATENCY>, iops, mbps, lat);
   DBMS_RESOURCE_MANAGER.CALIBRATE_IO (32, 15, iops, mbps, lat);

  DBMS_OUTPUT.PUT_LINE ('max_iops = ' || iops);
  DBMS_OUTPUT.PUT_LINE ('latency  = ' || lat);
  dbms_output.put_line('max_mbps = ' || mbps);
end;
/
```

The Oracle /IO Calibrate routine is database-friendly and does not harm the database or the underlying data files. I/O calibrate does require a database to be created. Example 2-30 shows the Max IOPS, the latency, and max Mbps for a sample I/O calibration test.

Example 2-30 I/O Calibrate test run

```
   max_iops = 42313
   latency  = 0
   max_mbps = 4505

   PL/SQL procedure successfully completed.
```

After you configure your disk storage and test your I/O performance, your system is ready to migrate or to create a database on Linux for System z.

2.6 Summary

Paying detailed attention to the Linux environment is key to a successful installation. Do not skip any preparation steps before starting the Oracle installation steps. Follow the Oracle installation manuals for detailed instructions.

3

Installing an Oracle Grid Infrastructure

This chapter covers the setup of network and disk devices and the installation of an Oracle Grid Infrastructure, including CRS and ASM. Chapter 4, “Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database” on page 47 covers the installation of Oracle Real Application Clusters.

For a successful installation, you must take the time to prepare the Linux guest and to run the Oracle cluster verify utility.

The following Oracle documents were used in our demonstration:

- *Oracle Grid Infrastructure Installation Guide 12c Release 1 (12.1) for Linux* E17888-16 October 2013
- *Oracle Real Application Clusters Installation Guide 12c Release 1 (12.1) for Linux and UNIX* E17889-11 June 2013
- *Oracle Database installation Guide 12c Release 1 (12.1) for Linux* E17720-17 November 2013
- *Oracle Clusterware Administration and Deployment Guide 12c Release 1 (12.1)* E17886-13 June 2013
- *Oracle Real Application Clusters Administration and Deployment Guide 12c Release1(12.1)* E17887-12 June 2013
- *Oracle Automatic Storage Management Administrator's Guide 12c Release 1 (12.1)* E17612-15 June 2013

3.1 Getting started

This chapter describes the steps to install a two-node 12c Oracle Grid Infrastructure. Chapter 4, “Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database” on page 47 describes installing RAC and creating a database on the infrastructure. The Linux system is Red Hat 6.3 at kernel level - 2.6.32-279.9.1.el6.s390x. Linux is running in a virtual machine under z/VM 5.4.0. The processors are on an IBM System z9® with 8 GB memory and two IFLs.

The documents that are referenced at the beginning of this chapter contain information about prerequisites for the installation; that information is not repeated here for the most part. However, our network and ASM disk configurations are described in the following sections.

3.2 Network considerations

The public network names are in a domain name server (DNS). Running **nslookup** shows the following information:

```
Name:   pazxxt20.us.oracle.com   Name:   pazxxt21.us.oracle.com
Address: 130.35.53.125                Address: 130.35.53.175
```

For this installation, the private interconnect uses a single network on subnet 10.10.9.0. The /etc/hosts entries on both nodes contain the following settings for the private network:

```
10.10.9.20     pazxxt20-pr.us.oracle.com pazxxt20-pr
10.10.9.21     pazxxt21-pr.us.oracle.com pazxxt21-pr
```

The VIPs are in a DNS and are in the same subnet as the public IPs above:

```
Name:   pazxxt20-vip.us.oracle.com   Name:   pazxxt21-vip.us.oracle.com
Address: 130.35.53.131                       Address: 130.35.53.132
```

The Single Client Access Name (SCAN) name is pazxxt2021-r with the following three IPs in DNS and in the same subnet as the public IPs and VIPs:

```
nslookup pazxxt2021-r

Name:   pazxxt2021-r.us.oracle.com
Address: 130.35.52.42
Name:   pazxxt2021-r.us.oracle.com
Address: 130.35.52.52
Name:   pazxxt2021-r.us.oracle.com
Address: 130.35.52.74
```

The public IPs, VIPs, and SCAN IPs must be in the same network subnet. The subnet mask that is used in our example is 255.255.252.0, which means all the IPs are in the same subnet.

3.3 Automatic Storage Management shared disks

This installation uses Automatic Storage Management (ASM) for all disk storage, including the OCR files, voting files, and database files. The ASM disk storage is on two 5 GB multipath SCSI LUNs with the aliases lun01 and lun02:

```
[root@pazxxt20 ~]# multipath -ll
lun02 (36005076306ffc1150000000000001066) dm-2 IBM,2107900
size=5.0G features='1 queue_if_no_path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 1:0:2:1080442896 sdd   8:48  active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 0:0:1:1080442896 sdb   8:16  active ready running
lun01 (36005076306ffc1150000000000001065) dm-1 IBM,2107900
size=5.0G features='1 queue_if_no_path' hwhandler='0' wp=rw
|-+- policy='round-robin 0' prio=1 status=active
| `- 1:0:2:1080377360 sdc   8:32  active ready running
`-+- policy='round-robin 0' prio=1 status=enabled
  `- 0:0:1:1080377360 sda   8:0   active ready running
```

Here is the `multipath.conf` file (RHAT 6.3) that is used on both nodes:

```
# multipath.conf file
defaults {
        user_friendly_names yes
        find_multipaths yes
        path_grouping_policy failover
        rr_min_io 1
        dev_loss_tmo 90
        fast_io_fail_tmo 5
}
multipaths {
multipath {
wwid 36005076306ffc1150000000000001065
alias lun01
path_grouping_policy failover
}
 multipath {
 wwid 36005076306ffc1150000000000001066
 alias lun02
 path_grouping_policy failover
  }
 }

blacklist {devnode "^(dasd)[a-z]*[0-9]*"
}
```

The UID, GID, and MODE (Red Hat 6.3) for the multipath devices are set in the udev rules for the multipath devices. Here is the udev rule that is used on both nodes in the installation.

```
# Set permissions for multipath devices
ENV{DM_NAME}=="lun0*",OWNER:="oracle",GROUP:="oinstall",MODE:="660"
```

3.4 CRS/ASM installation

The first seven sections in the *Oracle Grid Infrastructure Installation Guide* have details about the hardware and software prerequisites for installing Oracle Grid Infrastructure and ASM. It is available at the following website:

http://docs.oracle.com/cd/E16655_01/install.121/e17888/toc.htm

Before you install the Oracle Grid Infrastructure, run cluster verify to ensure that all the CRS installation prerequisites are met, as shown in Example 3-1.

Example 3-1 Verification of the cluster

```
runcluvfy.sh stage -pre crsinst -n pazxxt20,pazxxt21
Performing pre-checks for cluster services setup
Checking node reachability...
Node reachability check passed from node "pazxxt20"
Checking user equivalence...
User equivalence check passed for user "oracle"
Checking node connectivity...
Checking hosts config file...
Verification of the hosts config file successful
Check: Node connectivity using interfaces on subnet "10.10.9.0"
Node connectivity passed for subnet "10.10.9.0" with node(s) pazxxt20,pazxxt21
TCP connectivity check passed for subnet "10.10.9.0"
Check: Node connectivity using interfaces on subnet "130.35.52.0"
Node connectivity passed for subnet "130.35.52.0" with node(s) pazxxt20,pazxxt21
TCP connectivity check passed for subnet "130.35.52.0"
Checking subnet mask consistency...
Subnet mask consistency check passed for subnet "130.35.52.0".
Subnet mask consistency check passed for subnet "10.10.9.0".
Subnet mask consistency check passed.
Node connectivity check passed
Checking multicast communication...
Checking subnet "10.10.9.0" for multicast communication with multicast group
"224.0.0.251"...
Check of subnet "10.10.9.0" for multicast communication with multicast group
"224.0.0.251" passed.
Check of multicast communication passed.
Total memory check passed
Available memory check passed
Swap space check passed
Free disk space check passed for
"pazxxt21:/usr,pazxxt21:/var,pazxxt21:/etc,pazxxt21:/sbin,pazxxt21:/tmp"
Free disk space check passed for
"pazxxt20:/usr,pazxxt20:/var,pazxxt20:/etc,pazxxt20:/sbin,pazxxt20:/tmp"
Free disk space check passed for "pazxxt21:/oracle/crs"
Free disk space check passed for "pazxxt20:/oracle/crs"
Check for multiple users with UID value 500 passed
User existence check passed for "oracle"
Group existence check passed for "oinstall"
Group existence check passed for "dba"
Membership check for user "oracle" in group "oinstall" [as Primary] passed
Membership check for user "oracle" in group "dba" passed
Run level check passed
Hard limits check passed for "maximum open file descriptors"
```

```
Soft limits check passed for "maximum open file descriptors"
Hard limits check passed for "maximum user processes"
Soft limits check passed for "maximum user processes"
System architecture check passed
Kernel version check passed
Kernel parameter check passed for "semmsl"
Kernel parameter check passed for "semmns"
Kernel parameter check passed for "semopm"
Kernel parameter check passed for "semmni"
Kernel parameter check passed for "shmmax"
Kernel parameter check passed for "file-max"
Kernel parameter check passed for "ip_local_port_range"
Kernel parameter check passed for "rmem_default"
Kernel parameter check passed for "rmem_max"
Kernel parameter check passed for "wmem_default"
Kernel parameter check passed for "wmem_max"
Kernel parameter check passed for "aio-max-nr"
Package existence check passed for "binutils"
Package existence check passed for "compat-libstdc++-33(s390x)"
Package existence check passed for "libgcc(s390x)"
Package existence check passed for "libstdc++(s390x)"
Package existence check passed for "libstdc++-devel(s390x)"
Package existence check passed for "sysstat"
Package existence check passed for "gcc"
Package existence check passed for "gcc-c++"
Package existence check passed for "ksh"
Package existence check passed for "make"
Package existence check passed for "glibc(s390x)"
Package existence check passed for "glibc-devel(s390x)"
Package existence check passed for "libaio(s390x)"
Package existence check passed for "libaio-devel(s390x)"
Check for multiple users with UID value 0 passed
Current group ID check passed
Starting check for consistency of primary group of root user
Check for consistency of root user's primary group passed
Starting Clock synchronization checks using Network Time Protocol(NTP)...
NTP Configuration file check started...
NTP Configuration file check passed
Checking daemon liveness...
Liveness check passed for "ntpd"
Check for NTP daemon or service alive passed on all nodes
NTP common Time Server Check started...
Check of common NTP Time Server passed
Clock time offset check from NTP Time Server started...
Clock time offset check passed
Clock synchronization check using Network Time Protocol(NTP) passed
Core file name pattern consistency check passed.
User "oracle" is not part of "root" group. Check passed
Default user file creation mask check passed
Checking integrity of file "/etc/resolv.conf" across nodes
"domain" and "search" entries do not coexist in any  "/etc/resolv.conf" file
All nodes have same "search" order defined in file "/etc/resolv.conf"
The DNS response time for an unreachable node is within acceptable limit on all
nodes
Check for integrity of file "/etc/resolv.conf" passed
```

```
Time zone consistency check passed
Checking integrity of name service switch configuration file "/etc/nsswitch.conf"
...
All nodes have same "hosts" entry defined in file "/etc/nsswitch.conf"
Check for integrity of name service switch configuration file "/etc/nsswitch.conf"
passed
Checking daemon "avahi-daemon" is not configured and running
Daemon not configured check passed for process "avahi-daemon"
Daemon not running check passed for process "avahi-daemon"
Starting check for /dev/shm mounted as temporary file system ...
Check for /dev/shm mounted as temporary file system passed
Pre-check for cluster services setup was successful.
```

3.5 Running the Oracle Grid Infrastructure installer

To run the Oracle Grid Infrastructure installer, complete the following steps:

1. Run the **runInstaller** command from the VNC viewer. Figure 3-1 shows the start of the Oracle Grid Infrastructure installation. The option to download software updates was not selected.

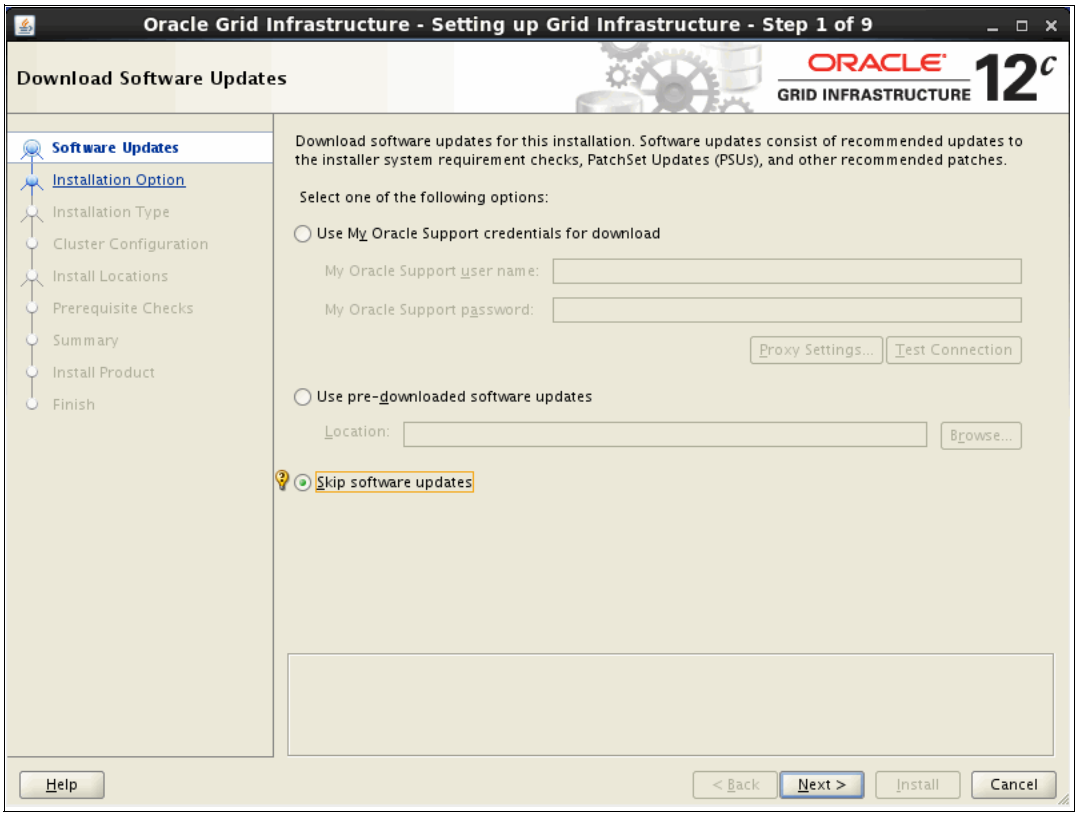


Figure 3-1 Skip the software updates

2. Select **Skip Software updates** and click **Next**. The window that is shown in Figure 3-2 on page 37 opens.

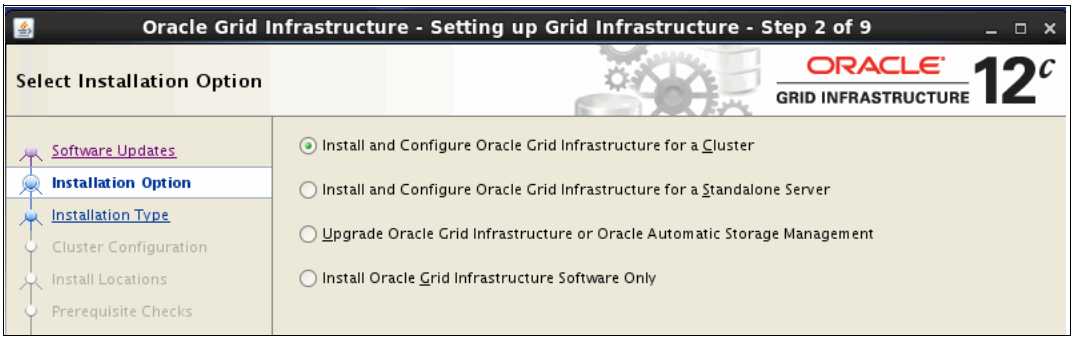


Figure 3-2 Select Installation Option

3. Select **Install and Configure Oracle Grid Infrastructure for a Cluster**. For our example installation, we install a two-node cluster. Select the installation type, as shown in Figure 3-3.

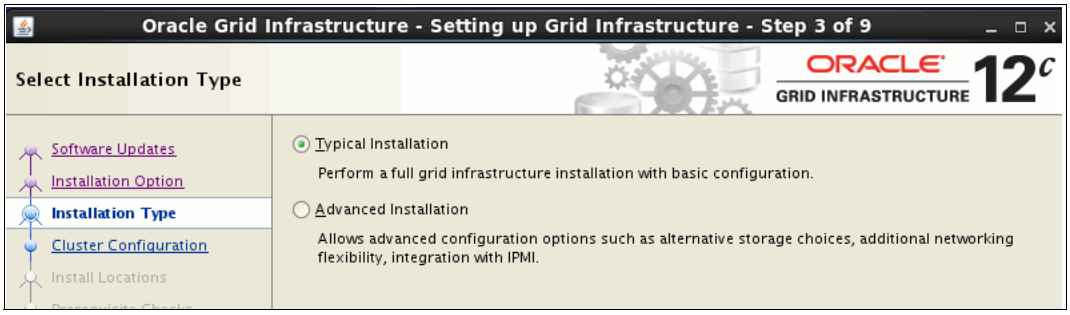


Figure 3-3 Select Installation Type

4. Select **Typical Installation**, which results in many default options being automatically selected. Select **Cluster Configuration**, which opens the window that is shown in Figure 3-4.

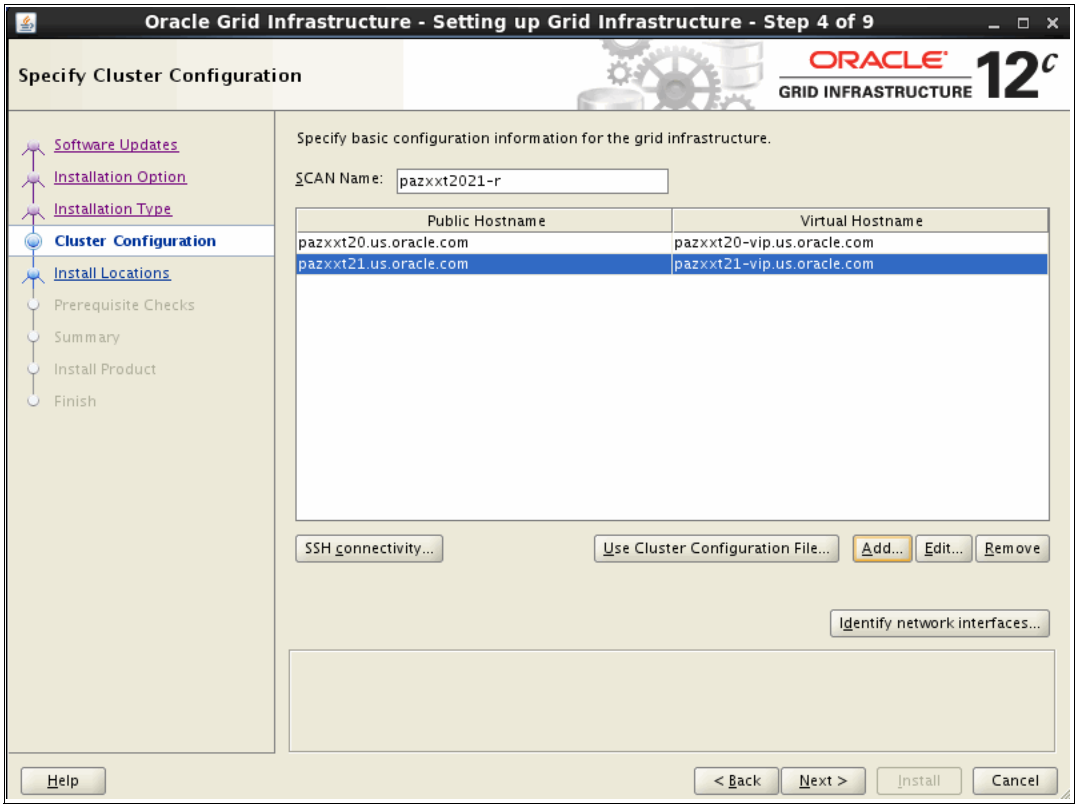


Figure 3-4 Specify Cluster Configuration

5. Edit the information in Figure 3-4 to add the SCAN name and the Public IP and the VIP for the second node, pazxxt21, in the cluster. The first node, pazxxt20, was set by default. Figure 3-5 on page 39 shows how to display the network interfaces.

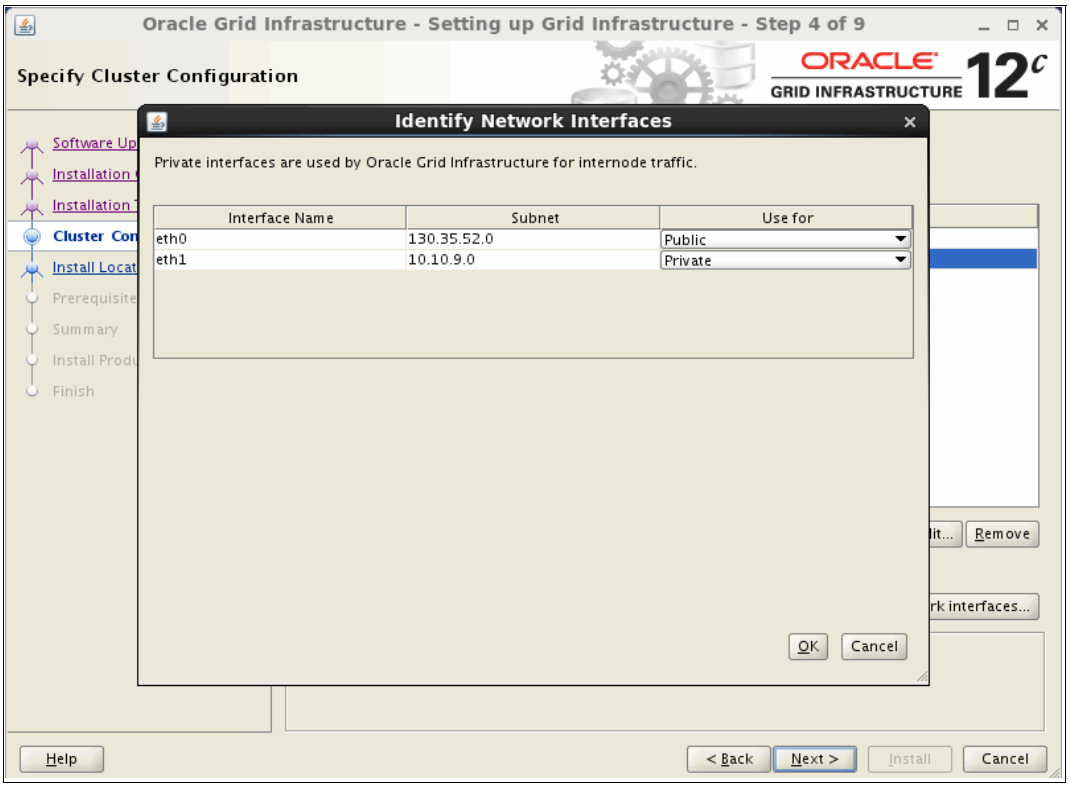


Figure 3-5 Show the network interfaces

6. Select **Identify Network Interfaces**, which opens the window that is shown in Figure 3-5, which shows the interface names and the subnets for the public and private interconnect networks. Specify the installation locations, as shown in Figure 3-6.

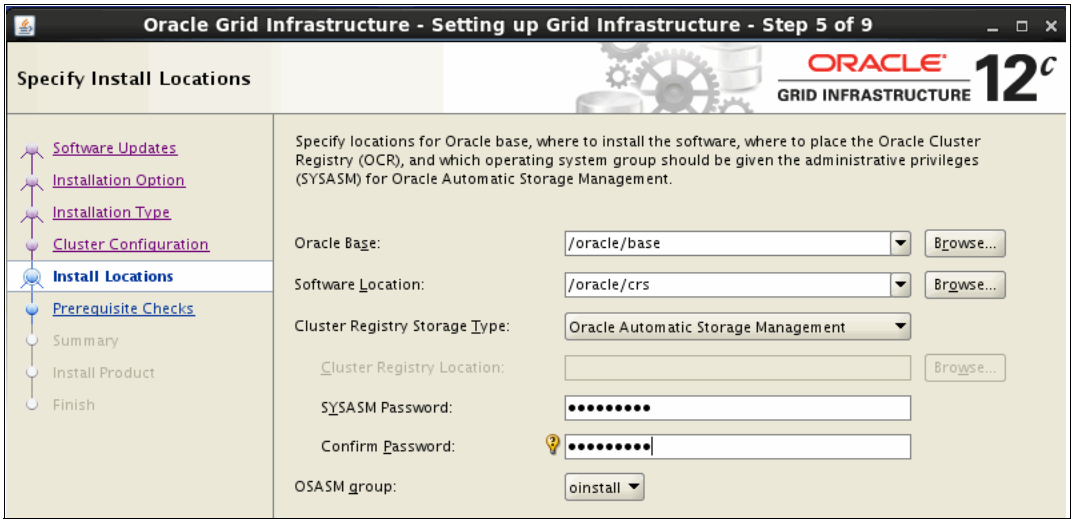


Figure 3-6 Specify Install Locations

ORACLE_BASE and ORACLE_HOME for the Oracle Grid Infrastructure are specified in Figure 3-6. Because ASM is selected for cluster storage, the ASM instance SYSASM password is supplied.

7. Create an ASM disk group, as shown in Figure 3-7 and Figure 3-8.

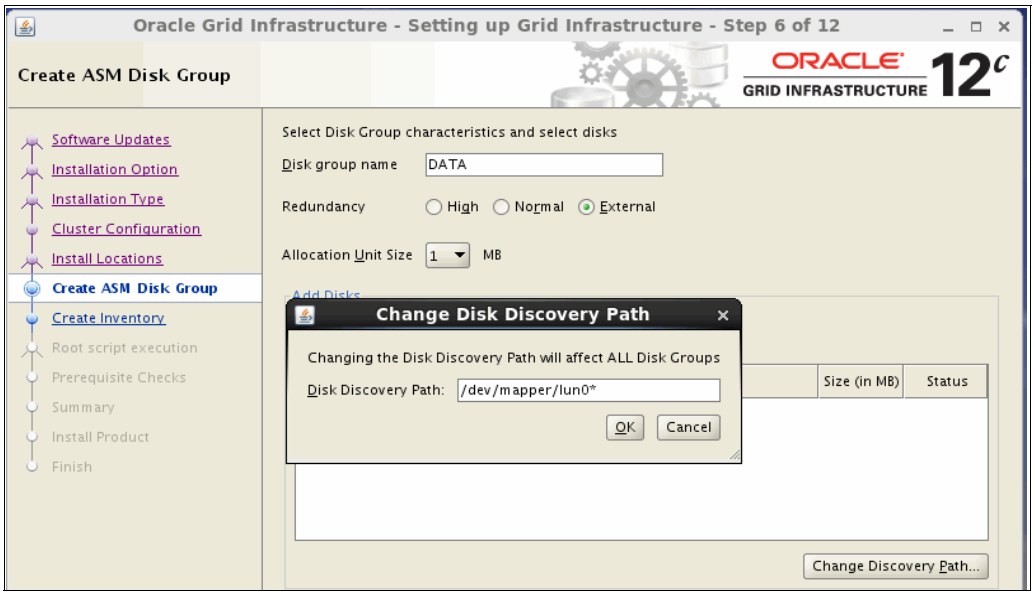


Figure 3-7 Create ASM Disk Group - part 1

The ASM disk discovery string is specified after you click **Change Discovery Path**.

Note: The number of steps increases based on the choices that you make in step 7.

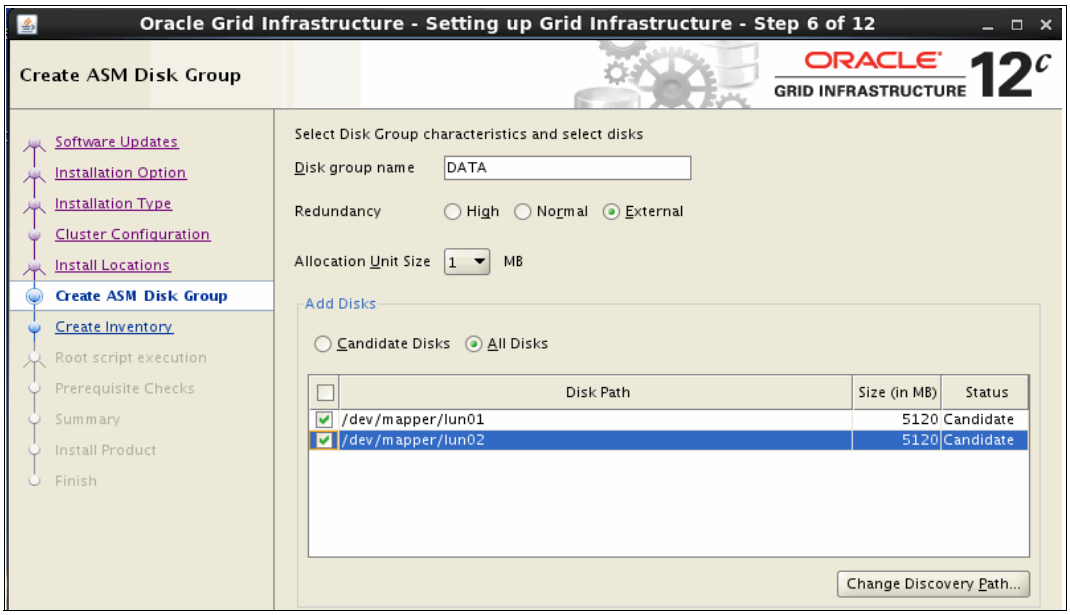


Figure 3-8 Create ASM Disk Group - part 2

8. Select both of the multipath LUNs for the +DATA disk group. Because this is a new installation on this system, the location of the Oracle inventory must be specified, as shown in Figure 3-9 on page 41.

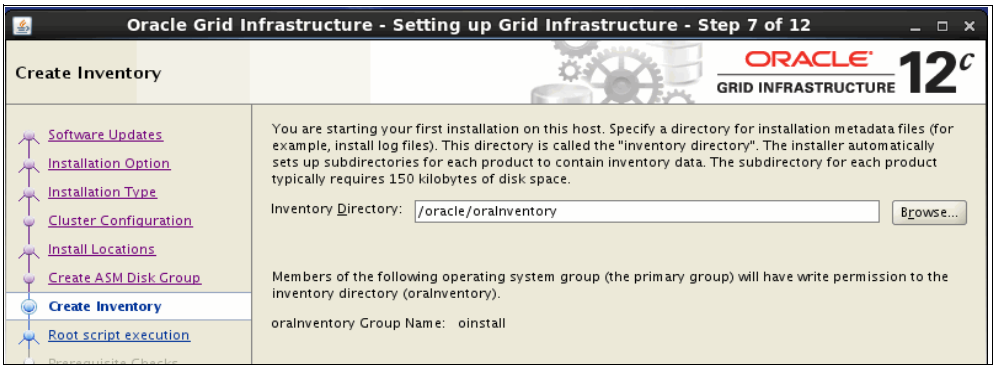


Figure 3-9 Create the Oracle Inventory

9. For this installation, do not select **Automatically run configuration scripts** (Figure 3-10), which enables the automatic execution of the root.sh scripts; run the scripts manually.

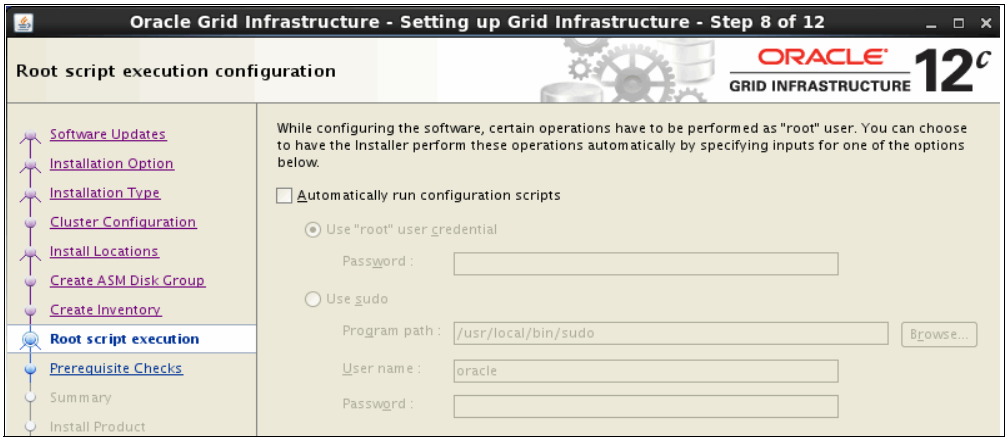


Figure 3-10 Root script execution

Because the prerequisites for the infrastructure installation are all met, Figure 3-11 normally is not shown. In our example, we clicked **Back** to open this window for demonstration purposes.

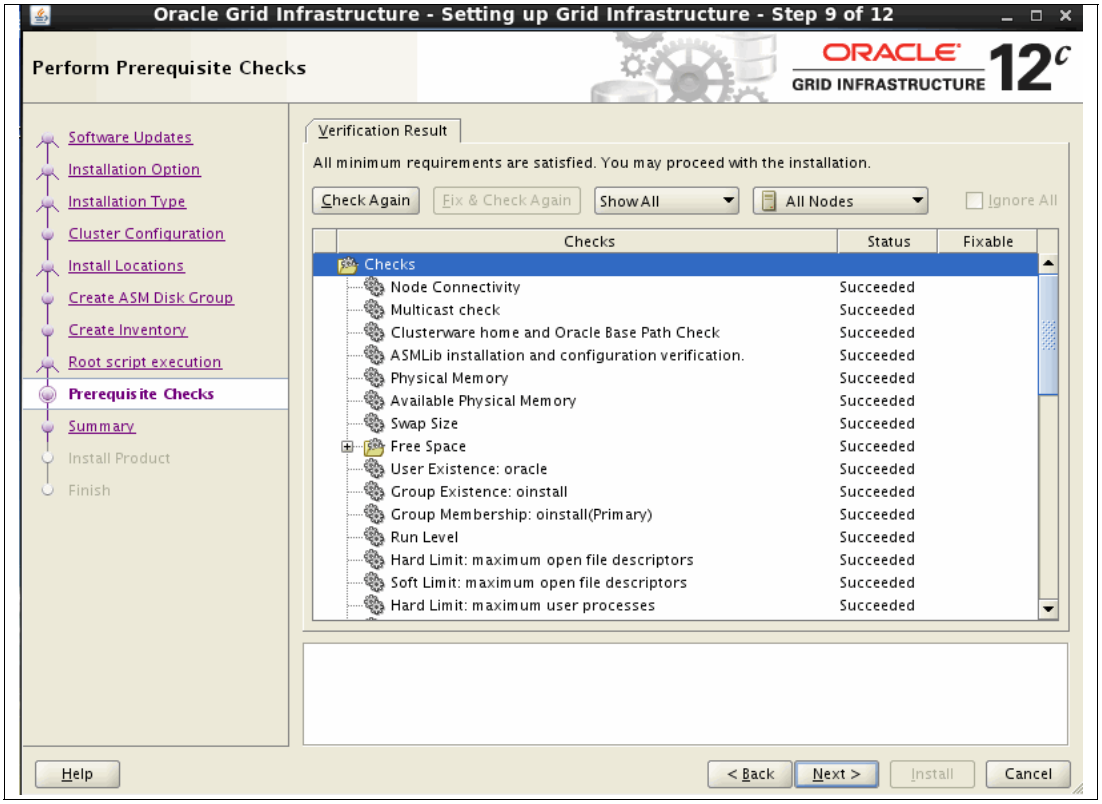


Figure 3-11 All the prerequisites are met

Figure 3-12 shows the Summary window.

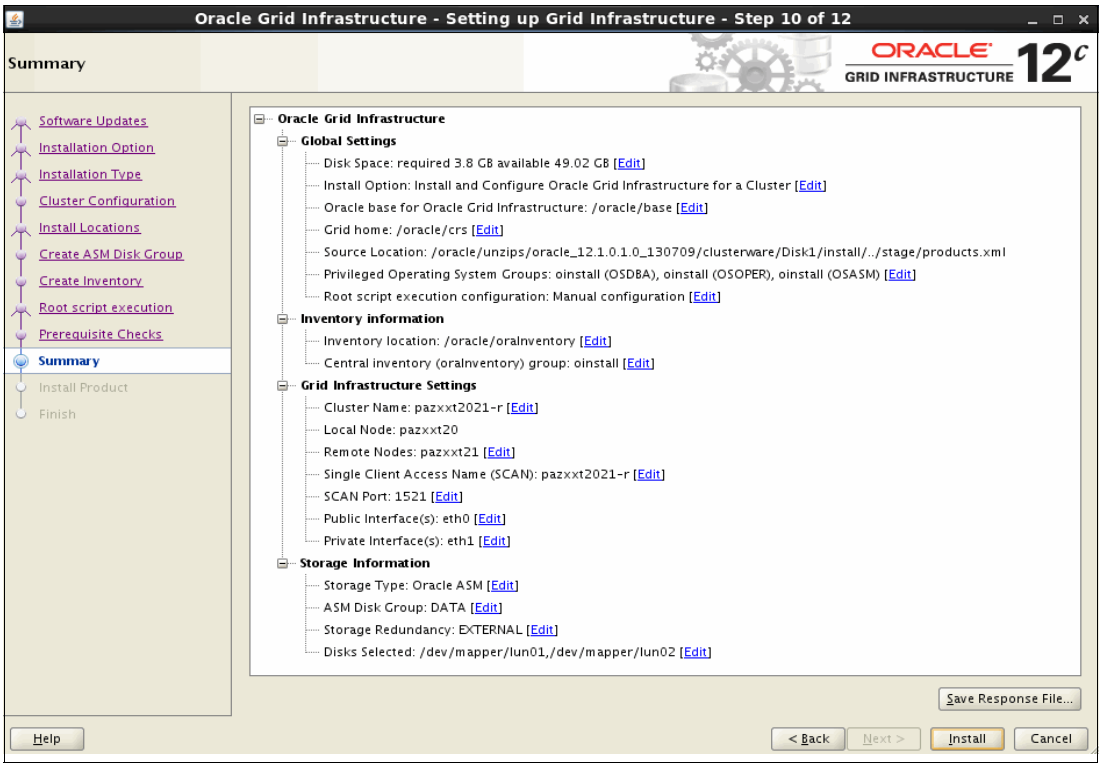


Figure 3-12 Summary

10. Because you did not select **Automatically run configuration scripts** in Figure 3-10 on page 41, you now run the scripts manually now, as shown in Figure 3-13.

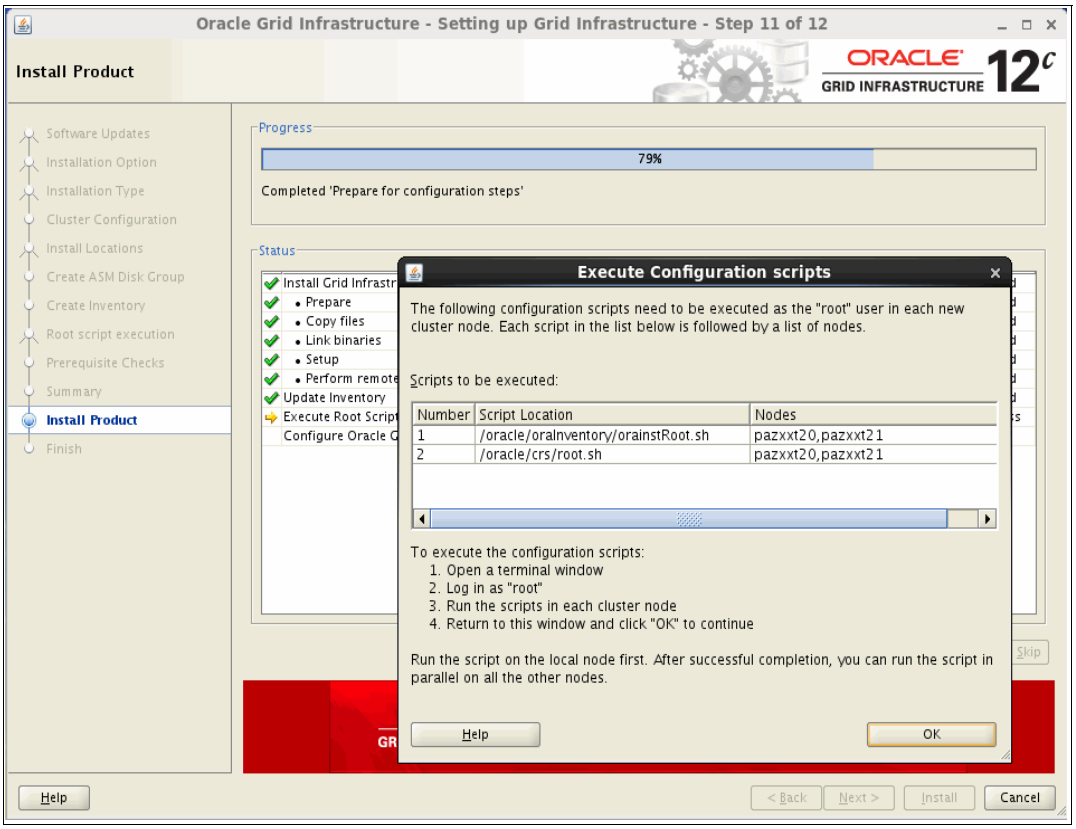


Figure 3-13 Run the root.sh scripts manually

After you run the scripts, the window that is shown in Figure 3-14 opens.

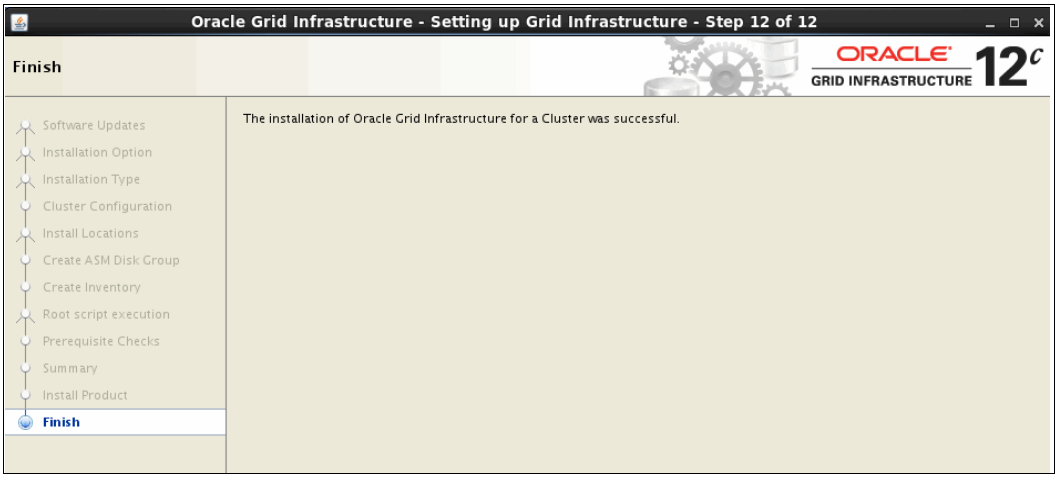


Figure 3-14 Oracle Grid Infrastructure installation is complete

11. After Oracle Grid Infrastructure with ASM is installed, run **crsctl** to check the status of the CRS daemons on both nodes. Run **srvctl** to check the status of ASM. The following command output shows that CRS and ASM are running:

```
[root@pazxxt20 oracle]# /oracle/crs/bin/crsctl check crs
CRS-4638: Oracle High Availability Services is online
CRS-4537: Cluster Ready Services is online
CRS-4529: Cluster Synchronization Services is online
CRS-4533: Event Manager is online

[root@pazxxt21 oracle]# /oracle/crs/bin/crsctl check crs
CRS-4638: Oracle High Availability Services is online
CRS-4537: Cluster Ready Services is online
CRS-4529: Cluster Synchronization Services is online
CRS-4533: Event Manager is online

[root@pazxxt20 oracle]# /oracle/crs/bin/srvctl status asm
```

ASM is now running on pazxxt20,pazxxt21.

The Oracle Grid Infrastructure is now ready for RAC installation, which is described in Chapter 4, “Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database” on page 47.

4

Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database

This chapter covers the steps to install the Oracle binary files for Oracle Real Application Clusters (RACs) and then to use Database Configuration Assistant (DBCA) to create three flavors of databases that are available in Oracle Database 12c. The Oracle 12c CRS/ASM system that was installed in Chapter 3, “Installing an Oracle Grid Infrastructure” on page 31 is used as the starting point for everything that is done in this chapter.

Oracle Database 12c Release 1 introduces a new type of database that is called the multitenant container database (CDB). A database before Oracle Database 12c is referred to as a non-CDB and is still available in Oracle Database 12c. The Oracle Database 12c CDB can contain zero, one, or more user databases called pluggable databases (PDBs). This chapter uses DBCA to create both a non-CDB and a CDB.

This chapter describes the following topics:

- Run cluster verify
- Install Oracle Database code
- Create a non-CDB RAC database
- Create an empty CDB RAC database
- Create a PDB in the CDB

4.1 Installing the RAC binary files

To install the RAC binary files, complete the following steps:

1. The cluster verify utility is used to verify that the prerequisites to install the RAC binary files are met. Example 4-1 shows the output that is generated by the cluster verify utility. There is a verbose option that can be used if more detail is needed, in case there are errors and warnings in the output.

Example 4-1 Running the cluster verify command

```
runcluvfy.sh stage -pre dbinst -n pazxxt20,pazxxt21
Performing pre-checks for database installation
Checking node reachability...
Node reachability check passed from node "pazxxt20"
Checking user equivalence...
User equivalence check passed for user "oracle"
Checking node connectivity...
Checking hosts config file...
Verification of the hosts config file successful
Check: Node connectivity using interfaces on subnet "10.10.9.0"
Node connectivity passed for subnet "10.10.9.0" with node(s) pazxxt21,pazxxt20
TCP connectivity check passed for subnet "10.10.9.0"
Check: Node connectivity using interfaces on subnet "130.35.52.0"
Node connectivity passed for subnet "130.35.52.0" with node(s) pazxxt21,pazxxt20
TCP connectivity check passed for subnet "130.35.52.0"
Checking subnet mask consistency...
Subnet mask consistency check passed for subnet "130.35.52.0".
Subnet mask consistency check passed for subnet "10.10.9.0".
Subnet mask consistency check passed.
Node connectivity check passed
Checking multicast communication...
Checking subnet "10.10.9.0" for multicast communication with multicast group
"224.0.0.251"...
Check of subnet "10.10.9.0" for multicast communication with multicast group
"224.0.0.251" passed.
Check of multicast communication passed.
Total memory check passed
Available memory check passed
Swap space check passed
Free disk space check passed for "pazxxt21:/oracle/crs"
Free disk space check passed for "pazxxt20:/oracle/crs"
Free disk space check passed for "pazxxt21:/tmp"
Free disk space check passed for "pazxxt20:/tmp"
Check for multiple users with UID value 500 passed
User existence check passed for "oracle"
Group existence check passed for "oinstall"
Group existence check passed for "dba"
Membership check for user "oracle" in group "oinstall" [as Primary] passed
Membership check for user "oracle" in group "dba" passed
Run level check passed
Hard limits check passed for "maximum open file descriptors"
Soft limits check passed for "maximum open file descriptors"
Hard limits check passed for "maximum user processes"
Soft limits check passed for "maximum user processes"
System architecture check passed
```

```
Kernel version check passed
Kernel parameter check passed for "semmsl"
Kernel parameter check passed for "semmns"
Kernel parameter check passed for "semopm"
Kernel parameter check passed for "semmni"
Kernel parameter check passed for "shmmax"
Kernel parameter check passed for "file-max"
Kernel parameter check passed for "ip_local_port_range"
Kernel parameter check passed for "rmem_default"
Kernel parameter check passed for "rmem_max"
Kernel parameter check passed for "wmem_default"
Kernel parameter check passed for "wmem_max"
Kernel parameter check passed for "aio-max-nr"
Package existence check passed for "binutils"
Package existence check passed for "compat-libstdc++-33(s390x)"
Package existence check passed for "libgcc(s390x)"
Package existence check passed for "libstdc++(s390x)"
Package existence check passed for "libstdc++-devel(s390x)"
Package existence check passed for "sysstat"
Package existence check passed for "gcc"
Package existence check passed for "gcc-c++"
Package existence check passed for "ksh"
Package existence check passed for "make"
Package existence check passed for "glibc(s390x)"
Package existence check passed for "glibc-devel(s390x)"
Package existence check passed for "libaio(s390x)"
Package existence check passed for "libaio-devel(s390x)"
Check for multiple users with UID value 0 passed
Current group ID check passed
Starting check for consistency of primary group of root user
Check for consistency of root user's primary group passed
Default user file creation mask check passed
Checking CRS integrity...
Clusterware version consistency passed.
CRS integrity check passed
Checking Cluster manager integrity...
Checking CSS daemon...
Oracle Cluster Synchronization Services appear to be online.
Cluster manager integrity check passed
Checking node application existence...
Checking existence of VIP node application (required)
VIP node application check passed
Checking existence of NETWORK node application (required)
NETWORK node application check passed
Checking existence of ONS node application (optional)
ONS node application check passed
Checking if Clusterware is installed on all nodes...
Check of Clusterware install passed
Checking if CTSS Resource is running on all nodes...
CTSS resource check passed
Querying CTSS for time offset on all nodes...
Query of CTSS for time offset passed
Check CTSS state started...
CTSS is in Observer state. Switching over to clock synchronization checks using
NTP
```

```
Starting Clock synchronization checks using Network Time Protocol(NTP)...
NTP Configuration file check started...
NTP Configuration file check passed
Checking daemon liveness...
Liveness check passed for "ntpd"
Check for NTP daemon or service alive passed on all nodes
NTP common Time Server Check started...
Check of common NTP Time Server passed
Clock time offset check from NTP Time Server started...
Clock time offset check passed
Clock synchronization check using Network Time Protocol(NTP) passed
Oracle Cluster Time Synchronization Services check passed
Checking integrity of file "/etc/resolv.conf" across nodes
"domain" and "search" entries do not coexist in any  "/etc/resolv.conf" file
All nodes have same "search" order defined in file "/etc/resolv.conf"
The DNS response time for an unreachable node is within acceptable limit on all
nodes
Check for integrity of file "/etc/resolv.conf" passed
Time zone consistency check passed
Checking Single Client Access Name (SCAN)...
Checking TCP connectivity to SCAN Listeners...
TCP connectivity to SCAN Listeners exists on all cluster nodes
Checking name resolution setup for "pazxxt2021-r"...
Checking integrity of name service switch configuration file "/etc/nsswitch.conf"
...
All nodes have same "hosts" entry defined in file "/etc/nsswitch.conf"
Check for integrity of name service switch configuration file "/etc/nsswitch.conf"
passed
Checking SCAN IP addresses...
Check of SCAN IP addresses passed
Verification of SCAN VIP and Listener setup passed
Checking VIP configuration.
Checking VIP Subnet configuration.
Check for VIP Subnet configuration passed.
Checking VIP reachability
Check for VIP reachability passed.
ASM and CRS versions are compatible
Database Clusterware version compatibility passed.
Starting check for /dev/shm mounted as temporary file system ...
Check for /dev/shm mounted as temporary file system passed
Pre-check for database installation was successful.
```

2. The database installation prerequisites are verified, so you can begin the RAC installation by running **runInstaller**, as shown in Figure 4-1.

```
[oracle@pazxxt20 Disk1]$ ./runInstaller
Starting Oracle Universal Installer...

Checking Temp space: must be greater than 80 MB.   Actual 1764 MB    Passed
Checking swap space: must be greater than 150 MB.   Actual 2047 MB    Passed
Checking monitor: must be configured to display at least 256 colors.    Actual 1
6777216    Passed
Preparing to launch Oracle Universal Installer from /tmp/OraInstall2013-07-29_08
-15-10AM. Please wait ...[oracle@pazxxt20 Disk1]$ You can find the log of this i
nstall session at:
 /oracle/oraInventory/logs/installActions2013-07-29_08-15-10AM.log
[oracle@pazxxt20 Disk1]$
```

Figure 4-1 Running the runInstaller command from VNC

The window that is shown in Figure 4-2 opens.

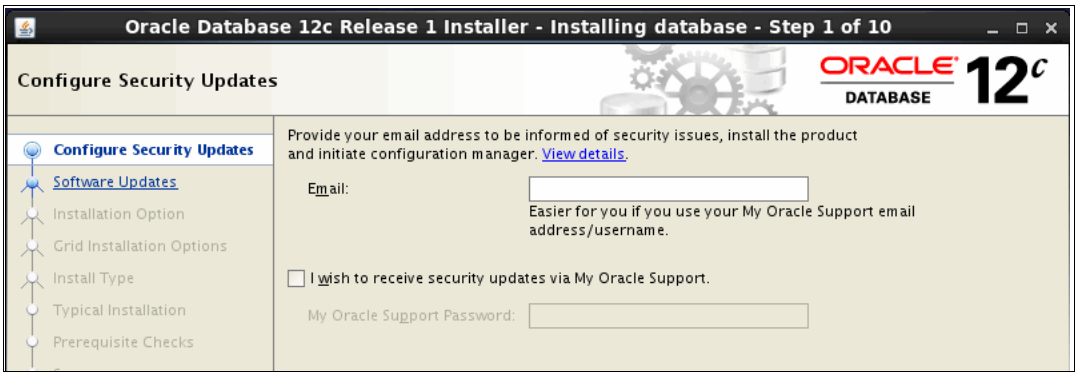


Figure 4-2 Security updates

3. For this installation example, skip the security updates from Oracle Support. A dialog box open and asks if you want to remain uninformed, as shown in Figure 4-3.

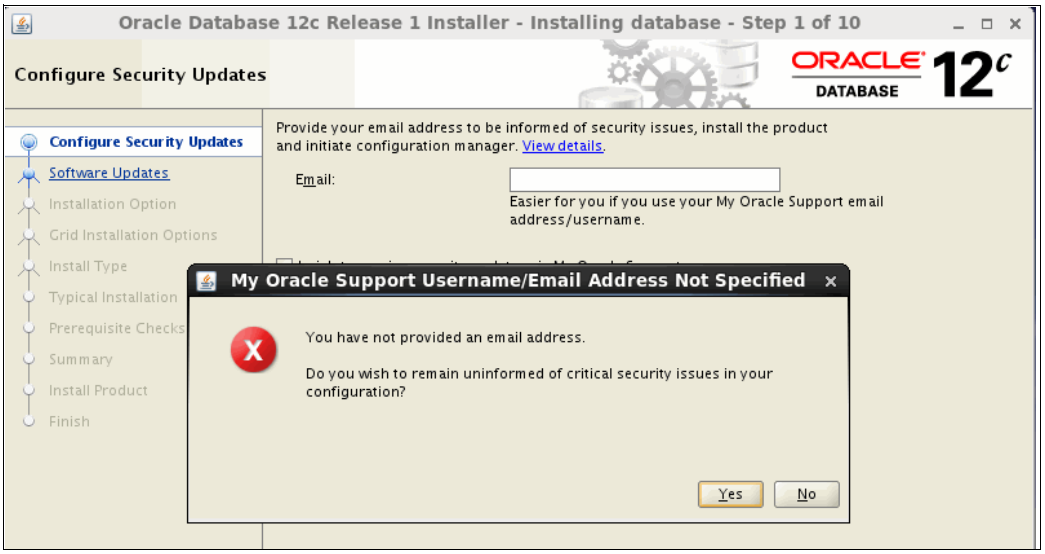


Figure 4-3 Dialog box asking for confirmation for not supplying an email address

4. In this installation, skip the Download Software Updates step, as shown in Figure 4-4.

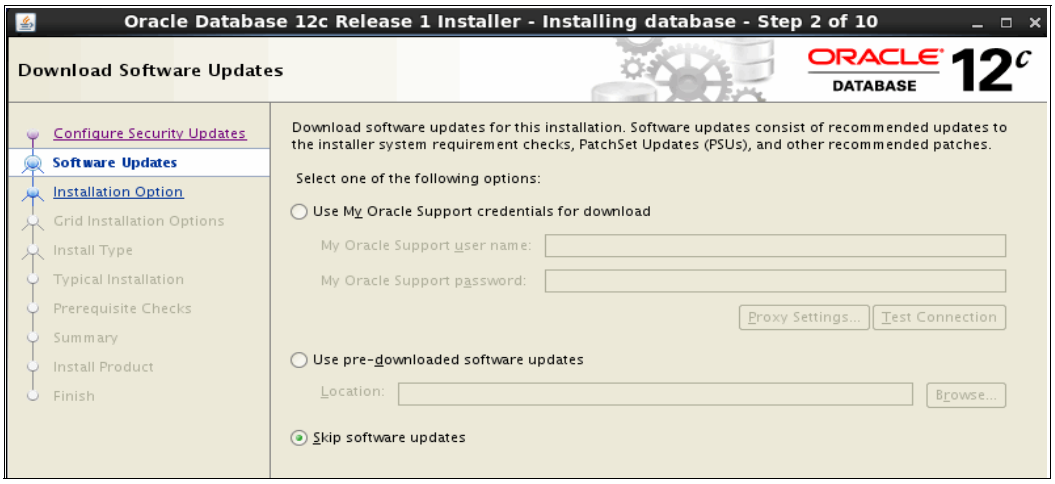


Figure 4-4 Software Updates

5. Select **Install database software only**, as shown in Figure 4-5.

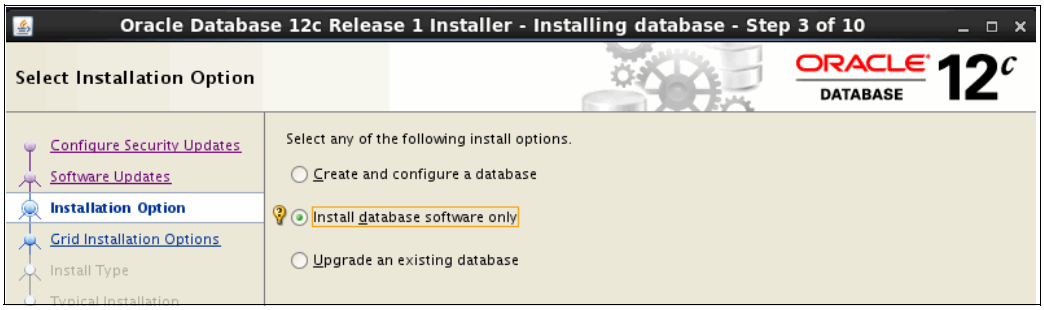


Figure 4-5 Installation Options

6. Select **Oracle Real Application Clusters database installation**, which installs the RAC software code only, as shown in Figure 4-6.

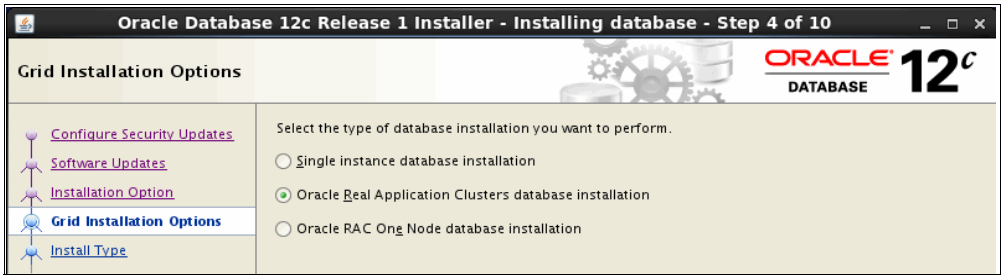


Figure 4-6 RAC cluster installation

7. Figure 4-7 on page 53 shows the two nodes where CRS and ASM were installed, as described in Chapter 3, “Installing an Oracle Grid Infrastructure” on page 31. Use both nodes for the RAC cluster installation.

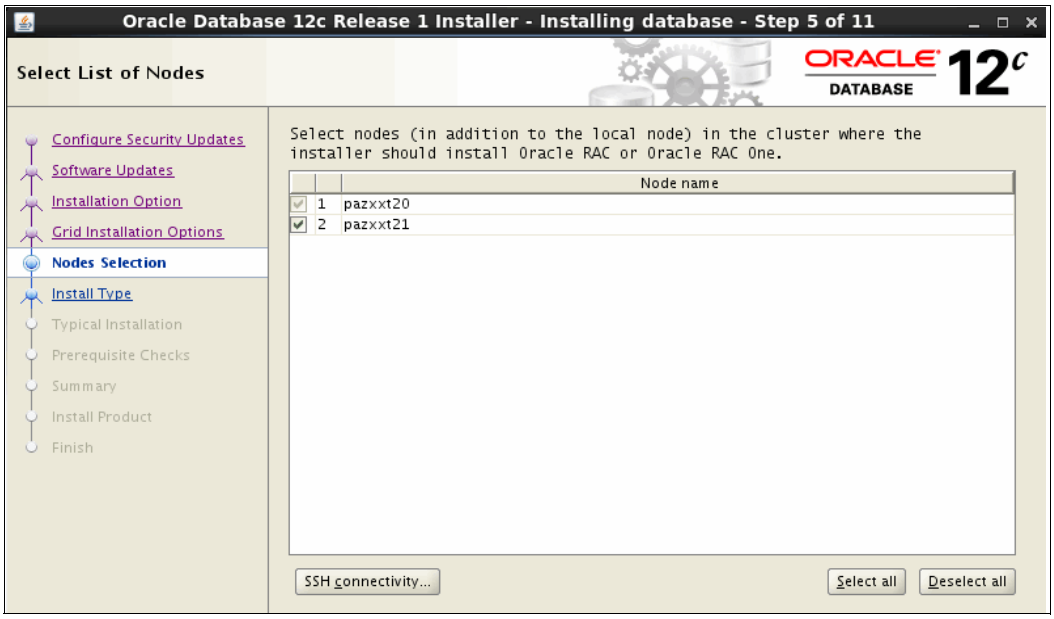


Figure 4-7 List of nodes

8. In the Available languages: field, select **English** and click the right arrow to move it to the Selected languages: field, as shown in Figure 4-8.

Figure 4-8 Language option

9. Select **Enterprise Edition (5.5.GB)**, as shown in Figure 4-9.

Figure 4-9 Database Edition choice

10. Specify the locations for the components, as shown in Figure 4-10. Use the same ORACLE_BASE that is used in Chapter 3, “Installing an Oracle Grid Infrastructure” on page 31; RAC ORACLE_HOME is under this base.

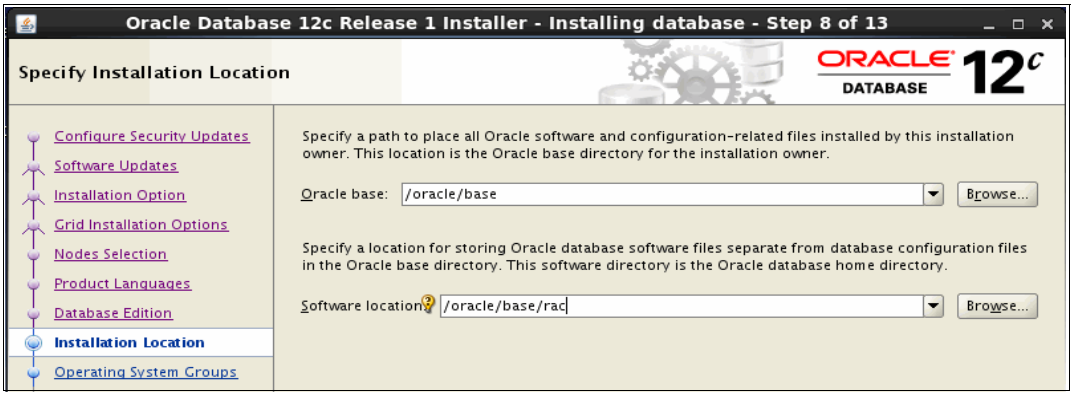


Figure 4-10 Installation location

11. Specify the access privileges, as shown in Figure 4-11.

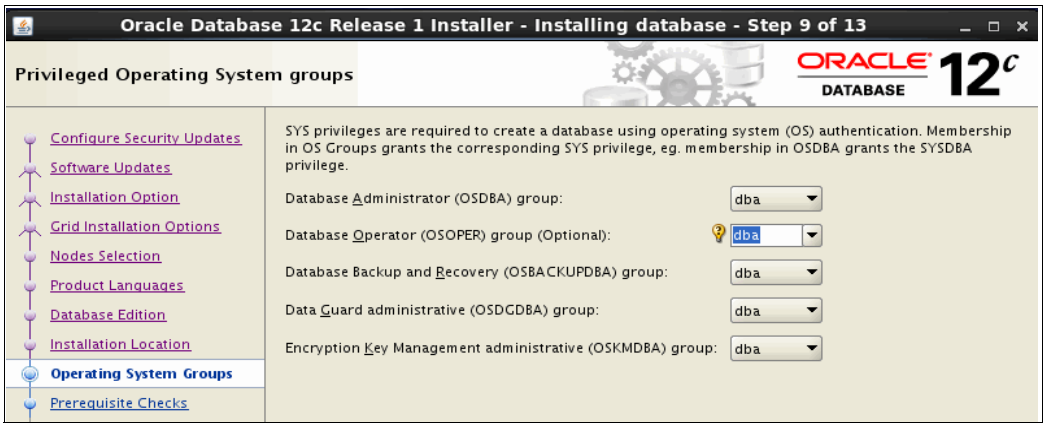


Figure 4-11 Privileged groups

Because all the prerequisites are met, Figure 4-12 normally is not presented. In this example, we clicked **Back** in the Summary window to show the window in Figure 4-12.

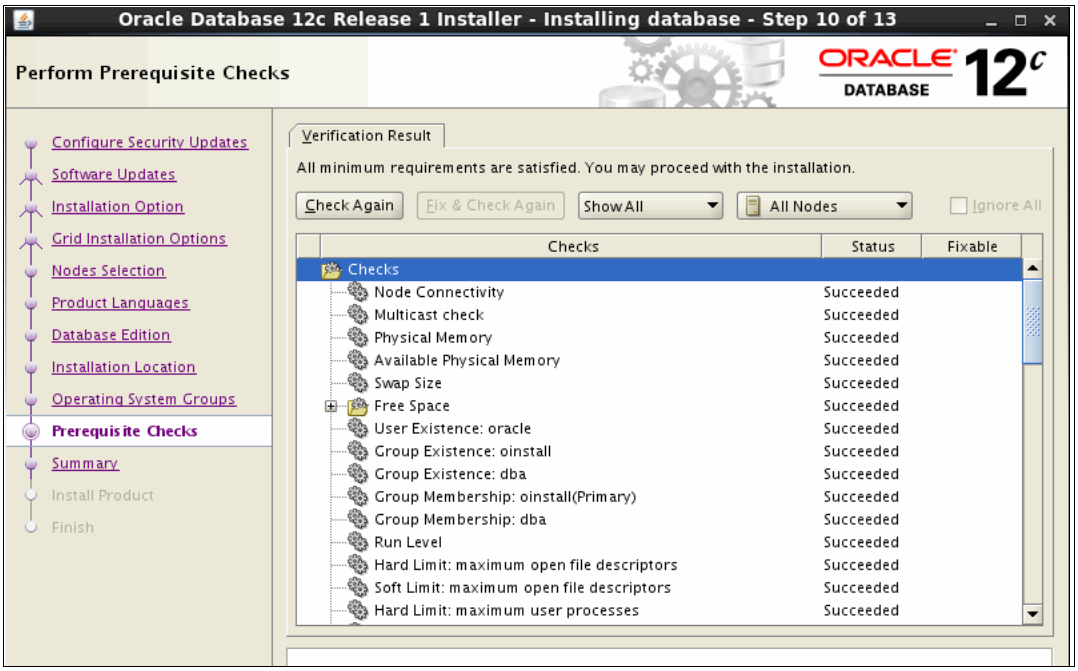


Figure 4-12 All the prerequisite checks are met for the RAC installation

Figure 4-13 shows the summary window.

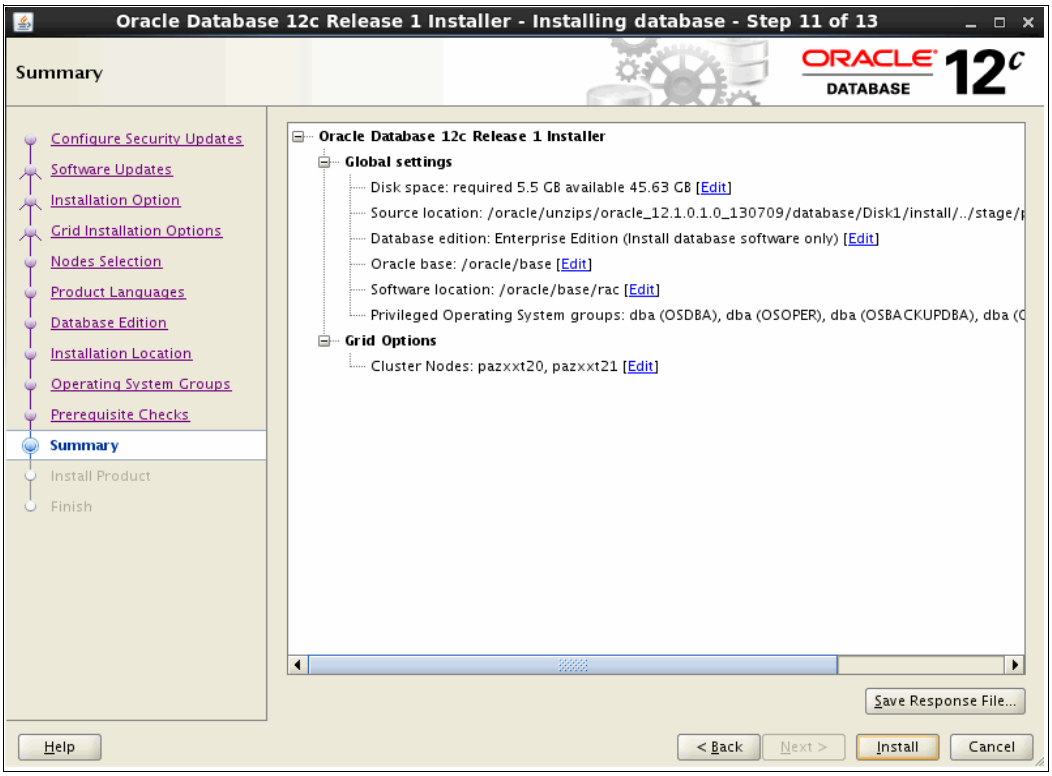


Figure 4-13 Summary

Figure 4-14 shows the window for running the root scripts for each node.

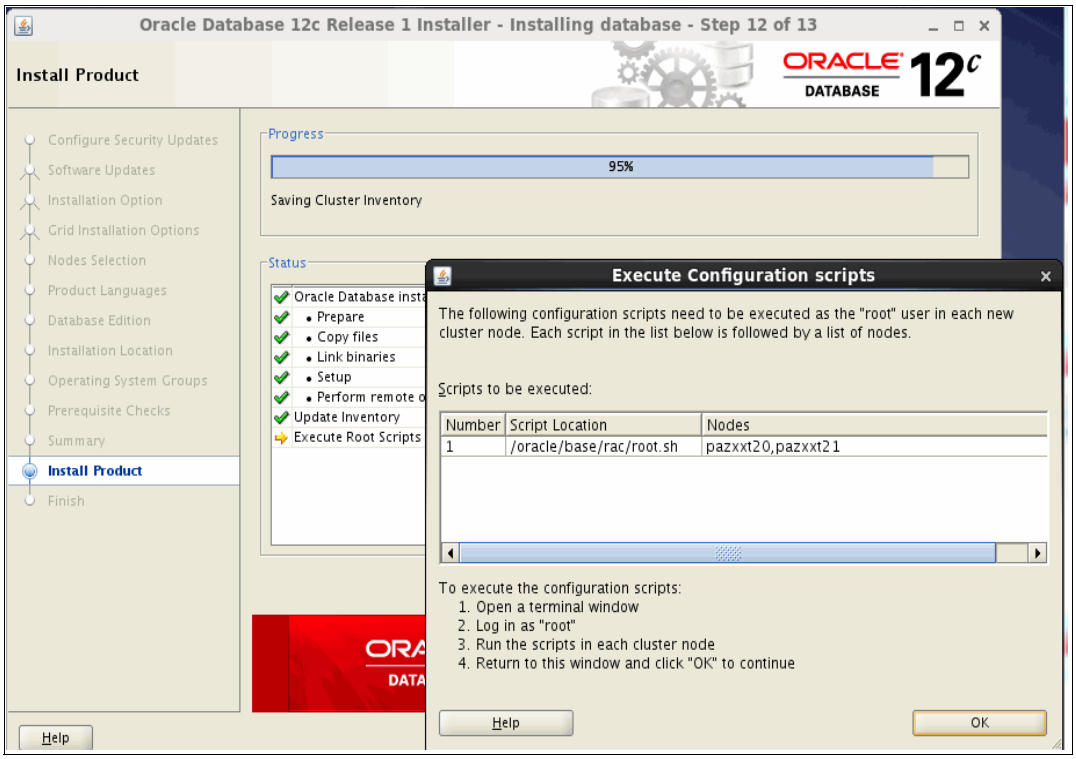


Figure 4-14 Run the root scripts on each node

Example 4-2 shows the results of running the scripts on one node. You must run the scripts on each node.

Example 4-2 Run the root.sh script on the pazxxt21node

```
root@pazxxt21   ]# /oracle/base/rac/root.sh
Performing root user operation  for Oracle 12c

The following environment variables are set as:
       ORACLE_OWNER= oracle
       ORACLE_HOME- /oracle/base/rac

Enter the full pathname of the local bin directory:   [/usr/local/bin]
The contents of "dbhome" have not been changed. No need to overwrite.
The contents of "oraenv" have not been changed. No need to overwrite.
The contents of "coraenv" have not been changed. No need to overwrite.

Entries will be added to the /etc/oratab file as needed by
Database Configuation Assistant when a database is created
Finished running generic part of root script.
Now product-specific root actions will be performed.
root@pazxxt21   ~ ]#
```

Note: If you are attempting a new installation of Oracle RAC with SLES 11 SP2+, comment out the `h1` line in the `/etc/inittab` file before you run the `root.sh` script on each node. For more information, see Oracle Note 1476511.1 - *OHASD fails to start on SuSE 11 SP2 on IBM: Linux on System z*.

Figure 4-15 shows the successful message.

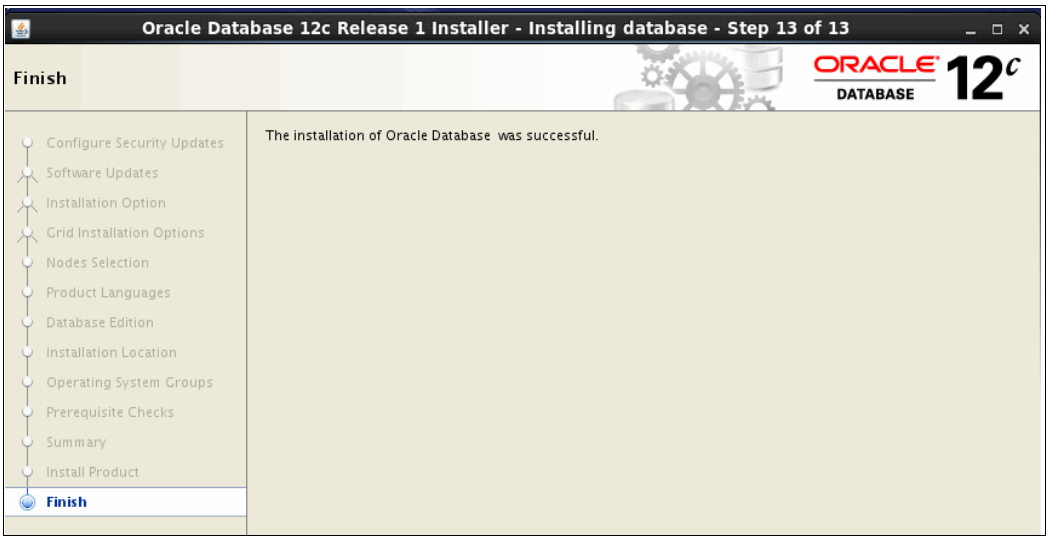


Figure 4-15 The Oracle Database 12c code is successfully installed

4.2 Creating a non-CDB RAC database with DBCA

Now that the RAC binary files are installed, use the Database Configuration Assistant (DBCA) to create a non-CDB RAC database. This procedure is the same as it was for databases before the introduction of the multitenant database in Oracle Database 12c.

Complete the following steps:

1. In the Database Operation window, which is shown in Figure 4-16, select **Create Database**.

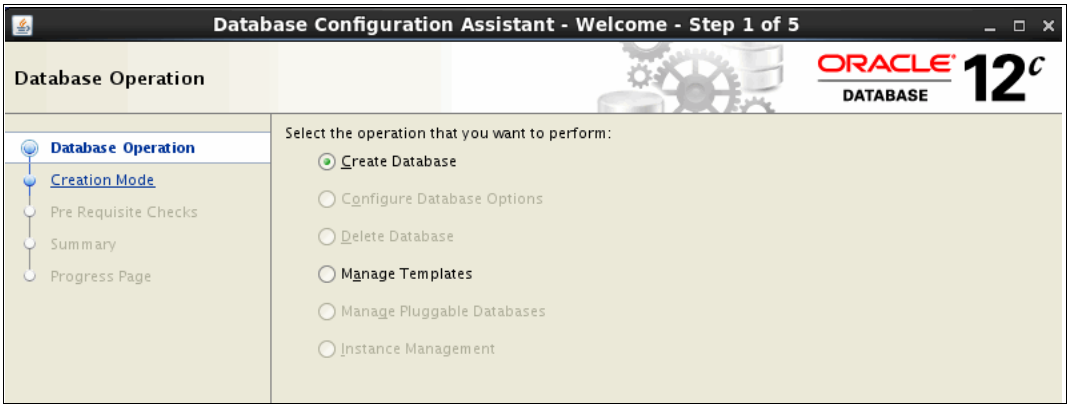


Figure 4-16 Create Database

2. In the Creation Mode window, which is shown in Figure 4-17, select **Create a database with default configuration** and enter the non-CDB parameters.

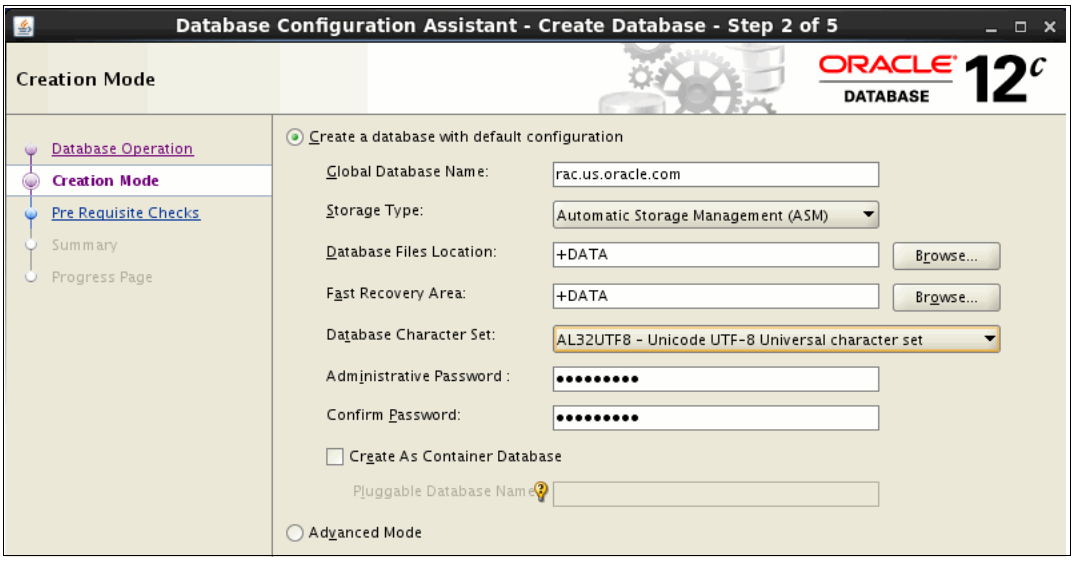


Figure 4-17 Non-CDB database parameters

Figure 4-18 shows the window with all the prerequisite checks met.

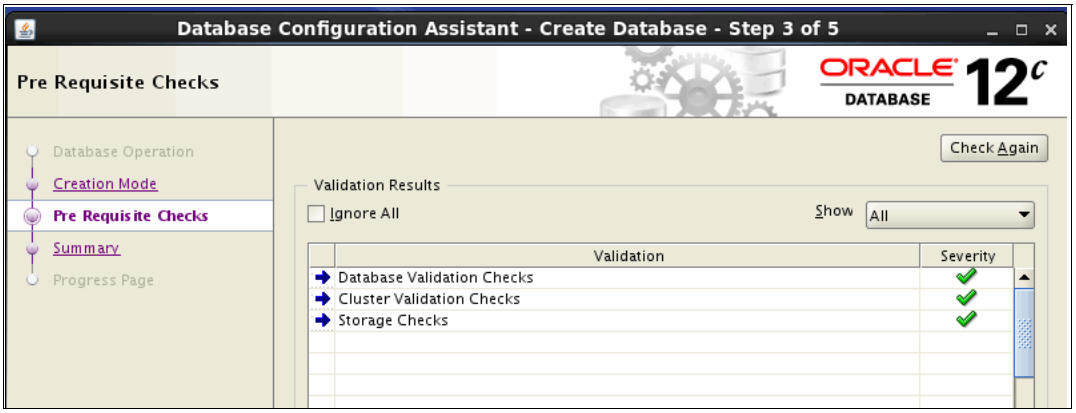


Figure 4-18 All prerequisite checks are met

3. Because all the prerequisites are met, Figure 4-18 is normally not presented. In our example, we clicked **Back** in the summary window (Figure 4-19 on page 59) to show the window that is shown in Figure 4-18.

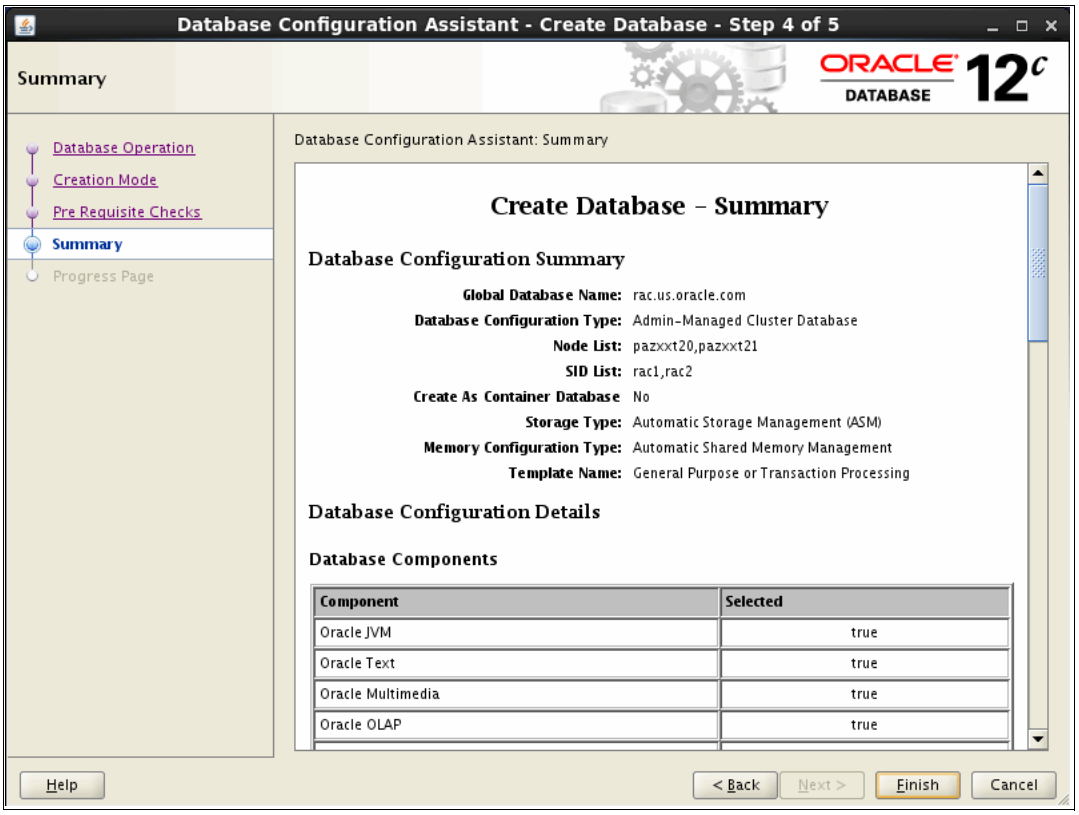


Figure 4-19 Summary window

4. Figure 4-20 shows the Progress Page, which includes the Enterprise Manager Database Express URL in the Database Configuration Assistant dialog box.

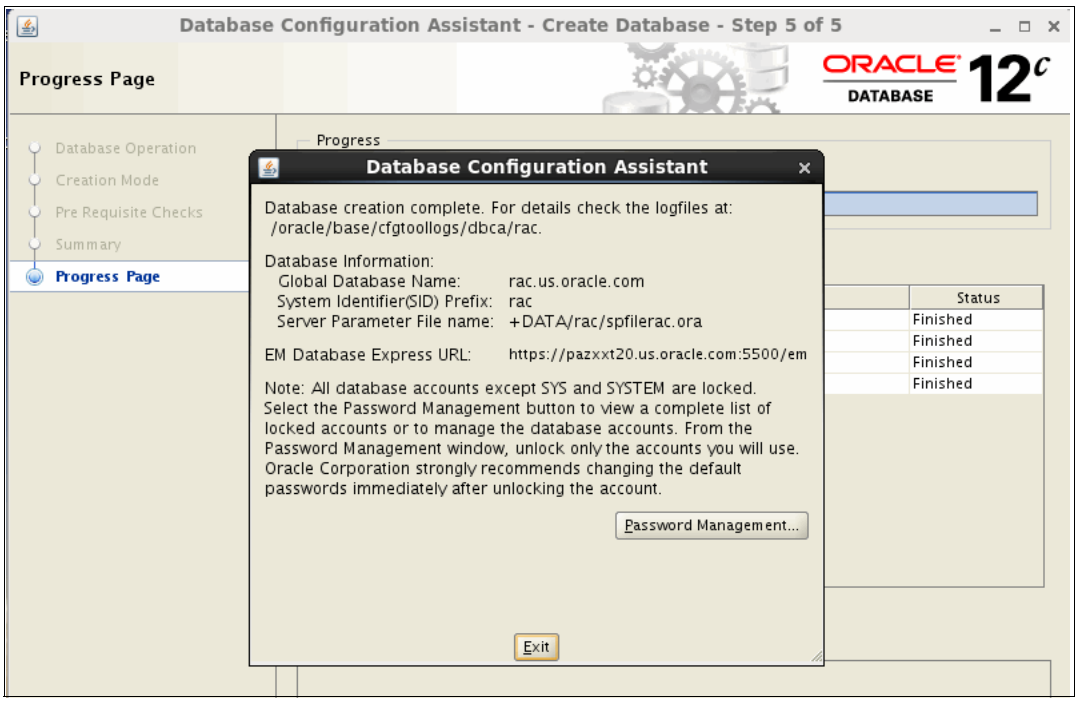


Figure 4-20 Enterprise Manager Database Express URL

The Oracle Enterprise Manager (OEM) DB control function is not in Oracle Database 12cR1, but some of the DB control functions are available with OEM Database Express, which is part of Oracle Database 12cR1. All the functions of DB Control that are available in Oracle Database 11g are available in Oracle Enterprise Manager Cloud Control 12c. An OEM cloud needs an agent that is installed on the target host. For more information, see *Oracle Enterprise Manager Cloud Control Administrator's Guide 12c Release 3 (12.1.0.3)*, found at:

http://docs.oracle.com/cd/E24628_01/index.htm

Figure 4-21 shows the Progress Page.

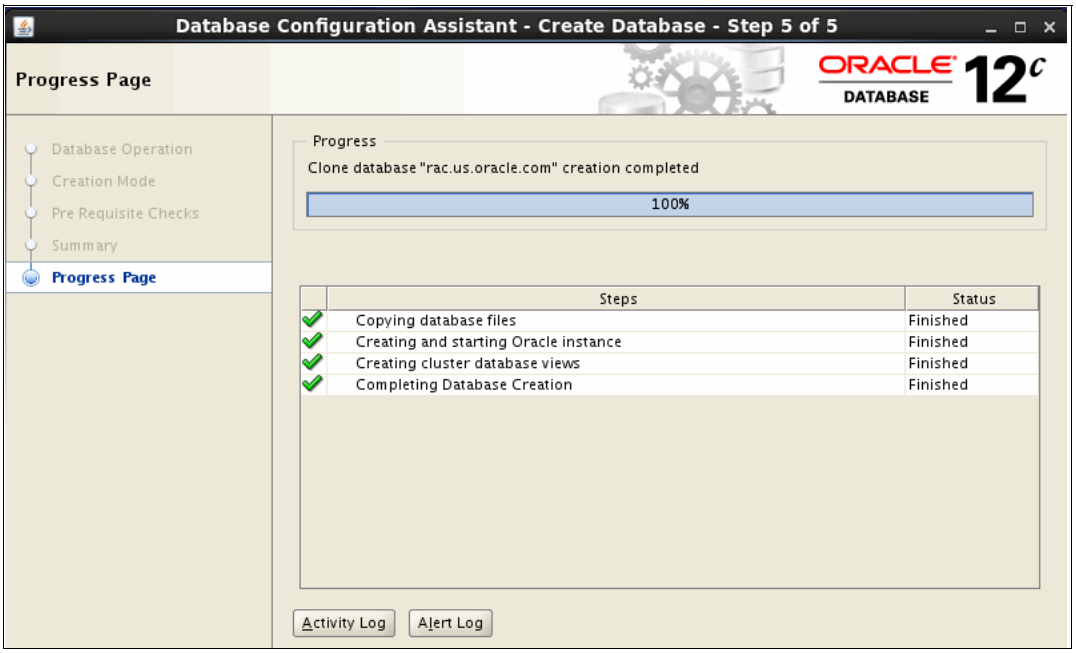


Figure 4-21 Progress Page

Complete the following steps:

1. Now that a RAC database is created, run **srvctl** on the RAC home on node pazxxt20 to check the status of the database:

```
[oracle@pazxxt20 ~]$ export ORACLE_HOME=/oracle/base/rac
[oracle@pazxxt20 ~]$ /oracle/base/rac/bin/srvctl status database -d rac
Instance rac1 is running on node pazxxt20
Instance rac2 is running on node pazxxt21
```

2. Run the same command to check the status of the local listeners:

```
[oracle@pazxxt20 ~]$ /oracle/base/rac/bin/srvctl status listener
Listener LISTENER is enabled
Listener LISTENER is running on node(s): pazxxt20,pazxxt21
```

3. Run **srvctl** to check the status of SCAN and the scan_listeners:

```
[oracle@pazxxt20 ~]$ /oracle/base/rac/bin/srvctl status scan
SCAN VIP scan1 is enabled
SCAN VIP scan1 is running on node pazxxt21
SCAN VIP scan2 is enabled
SCAN VIP scan2 is running on node pazxxt20
SCAN VIP scan3 is enabled
SCAN VIP scan3 is running on node pazxxt20
```

```
[oracle@pazxxt20 ~]$ /oracle/base/rac/bin/srvctl status scan_listener
SCAN Listener LISTENER_SCAN1 is enabled
SCAN listener LISTENER_SCAN1 is running on node pazxxt21
SCAN Listener LISTENER_SCAN2 is enabled
SCAN listener LISTENER_SCAN2 is running on node pazxxt20
SCAN Listener LISTENER_SCAN3 is enabled
SCAN listener LISTENER_SCAN3 is running on node pazxxt20
```

Use the Oracle Enterprise Manager Database Express URL that is shown in Figure 4-20 on page 59 to check the health of the RAC database. To do so, log in by using the window that is shown in Figure 4-22.

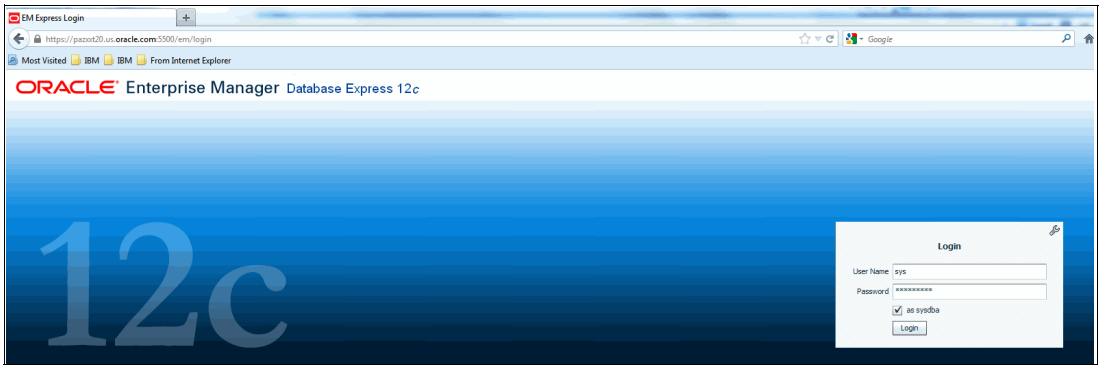


Figure 4-22 Enterprise Manager login

The dashboard is shown in Figure 4-23. Here you can check the health of the RAC database.

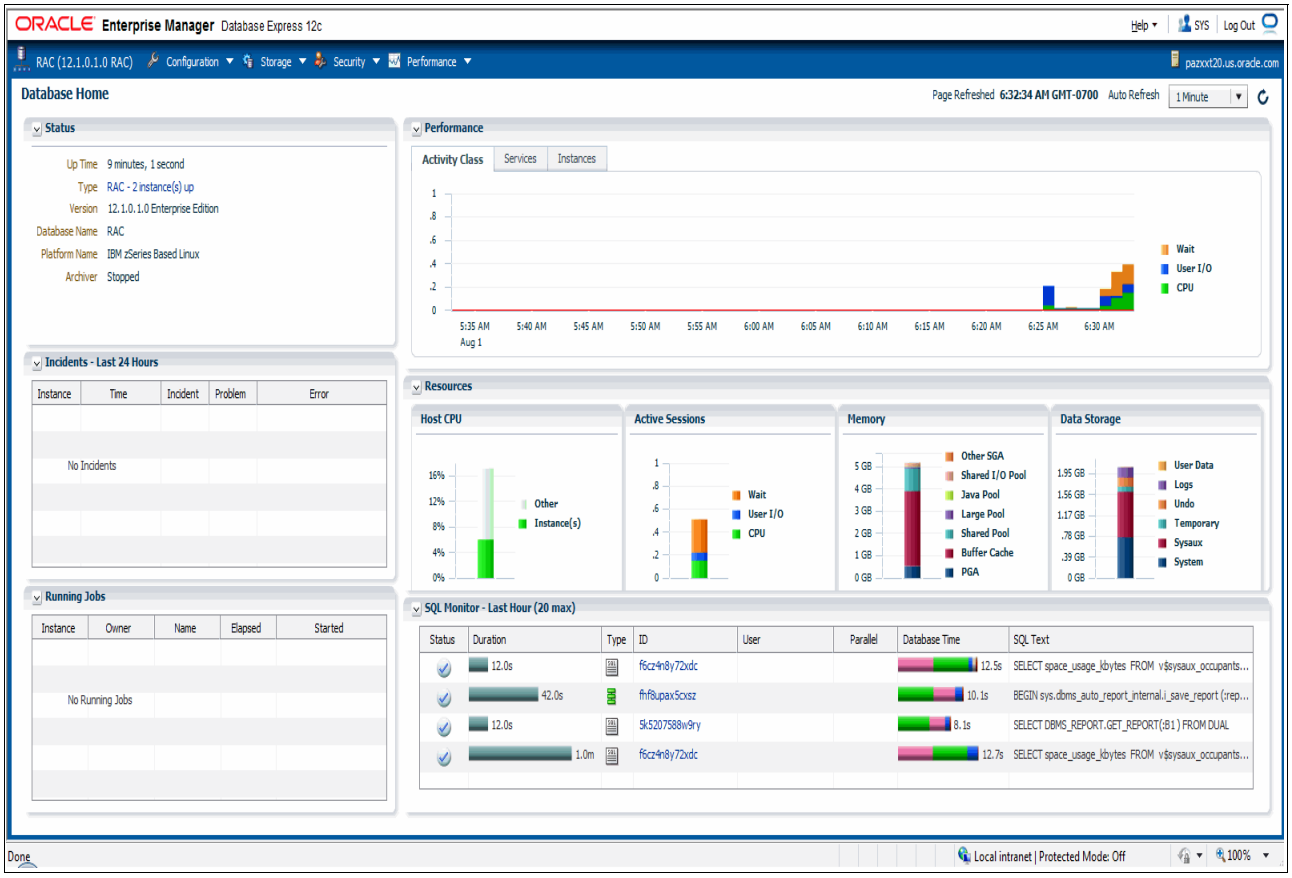


Figure 4-23 OEM DB Express 12c window

4.3 Creating a RAC CDB by using DBCA

The steps to create a RAC Container Database (CDB) are described in this section. The descriptions in this and the next section on multitenant databases do not go into many details. However, there is an Oracle white paper, *Oracle Multitenant*, June 2013 that is an excellent place to start learning details about the new multitenant database feature. Appendix A in the white paper also describes how the Oracle Database Documentation Library treats the new multitenant architecture. It is available at the following website:

`http://www.oracle.com/us/products/database/options/multitenant/overview/index.html`

To create an RAC CDB by using DBCA, complete the following steps:

1. Use DBCA to create a multitenant (CDB) Oracle Database 12c database, as shown in Figure 4-24 on page 63.

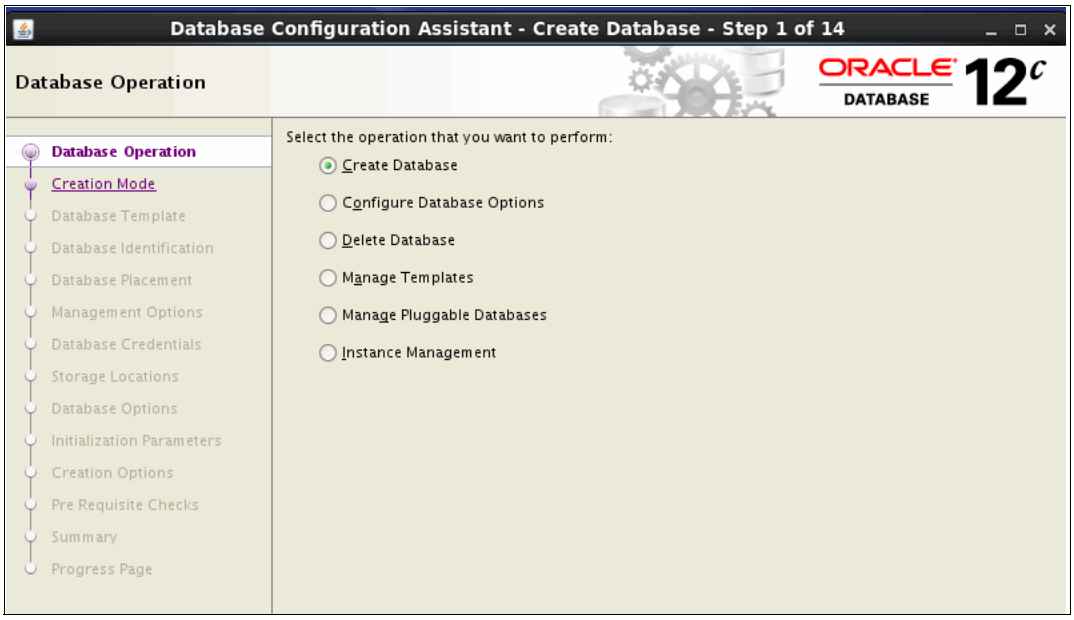


Figure 4-24 DBCA initial window

2. Because this example creates an empty CDB, select **Advanced Mode** to create an empty CDB with DBCA, as shown in Figure 4-25.

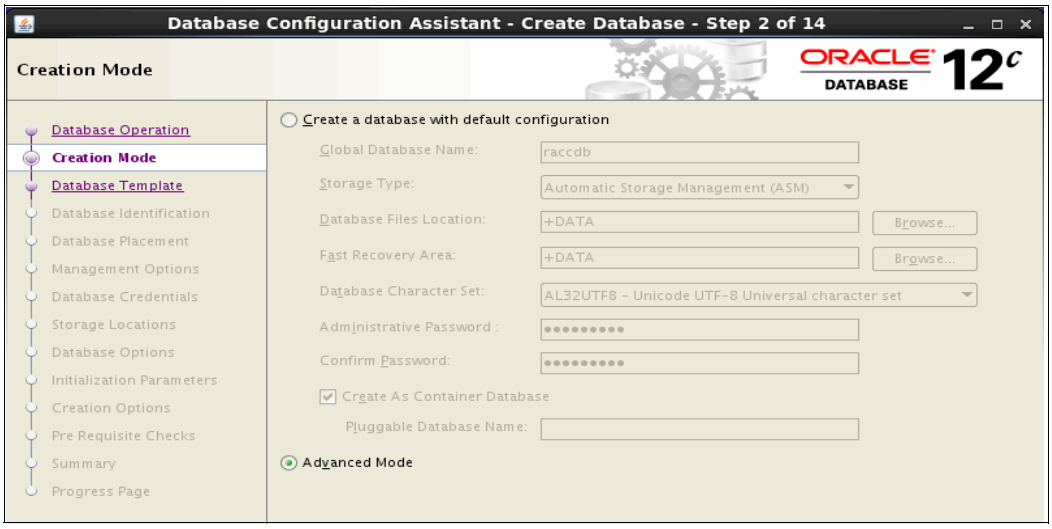


Figure 4-25 Select Advanced Mode

3. Choose a DB template, as shown in Figure 4-26. In this example, we choose the General Purpose or Transaction Processing template.

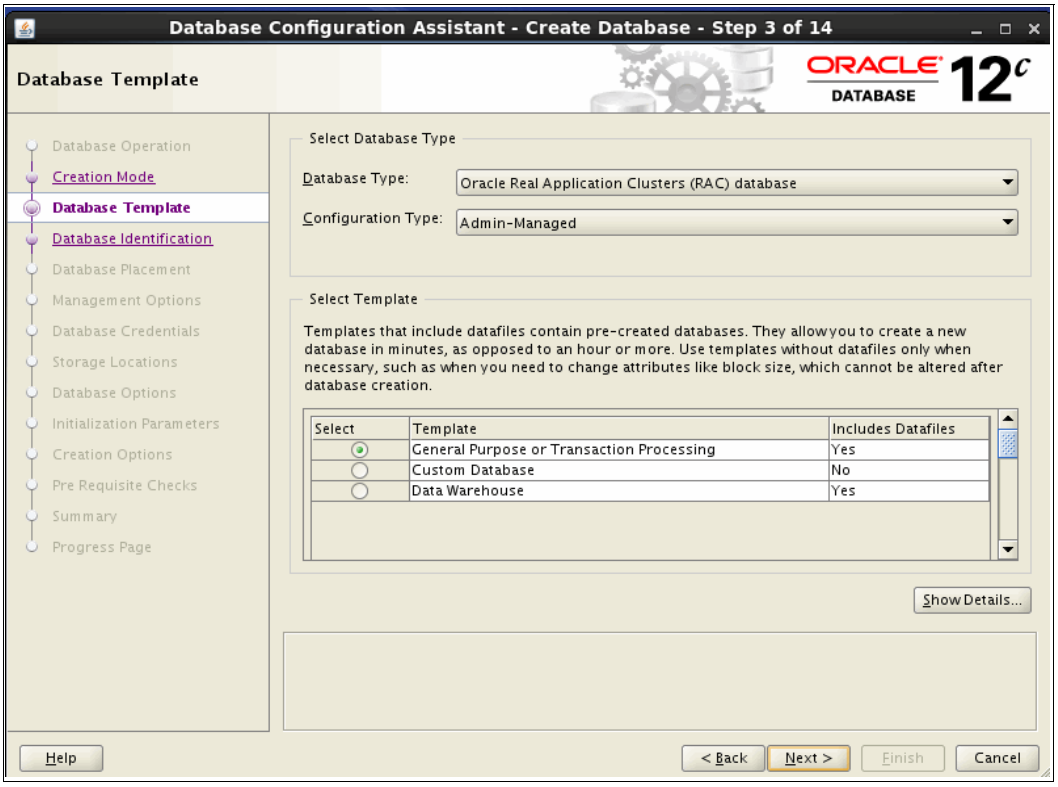


Figure 4-26 Choose a DB template

4. Select **Create an Empty Container Database**, as shown in Figure 4-27. The CDB is created as empty or it does not initially contain any PDBs. A PDB is created in this CDB in 4.4, “Creating a PDB in the CDB by using DBCA” on page 69.

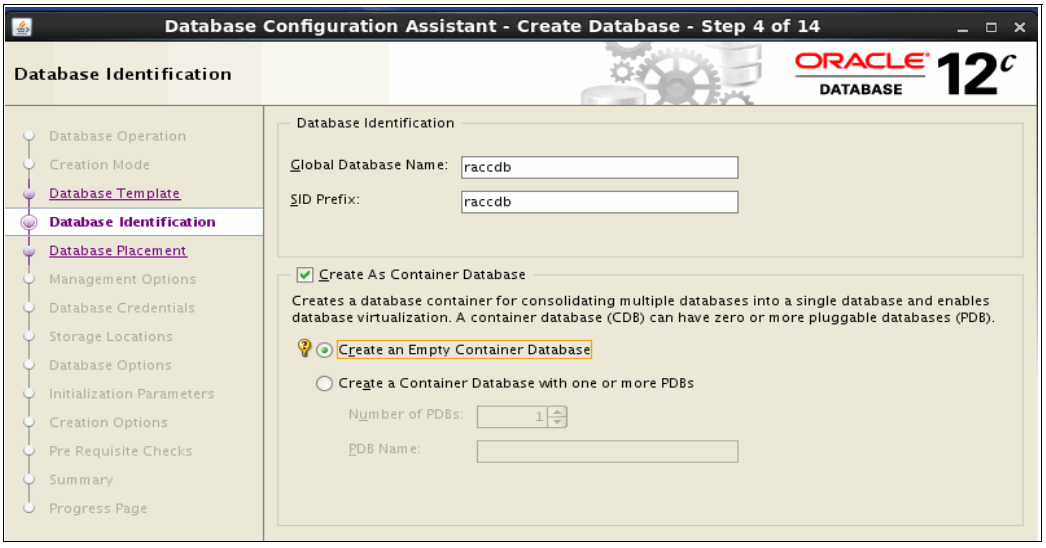


Figure 4-27 Database name for the empty CDB

5. Create an empty CDB for the DBCA path. Figure 4-28 on page 65 shows that the CDB is created as a RAC database.

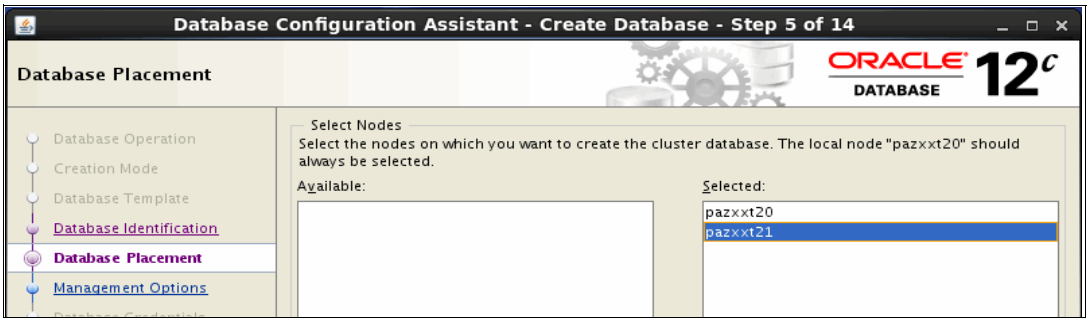


Figure 4-28 Create a database on the RAC cluster

6. For this installation, select **Configure Enterprise Manager (EM) Database Express**, as shown in Figure 4-29.

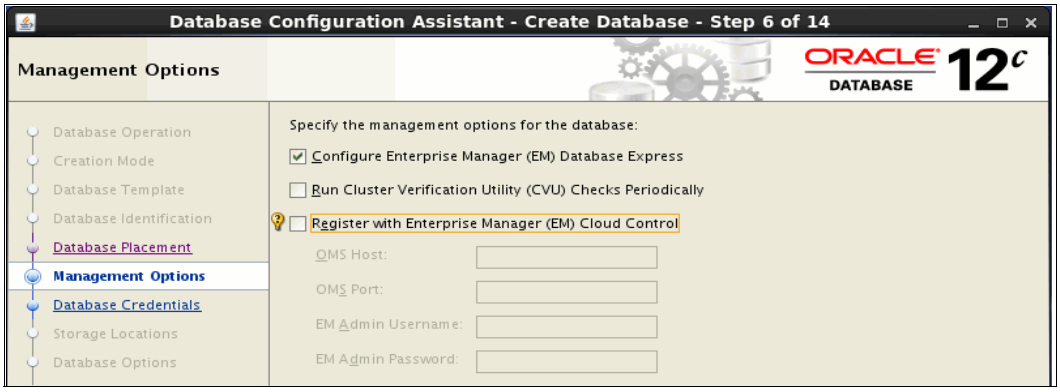


Figure 4-29 Management Options

7. Select **Use the Same Administrative Password for All Accounts** to create the passwords, as shown in Figure 4-30.

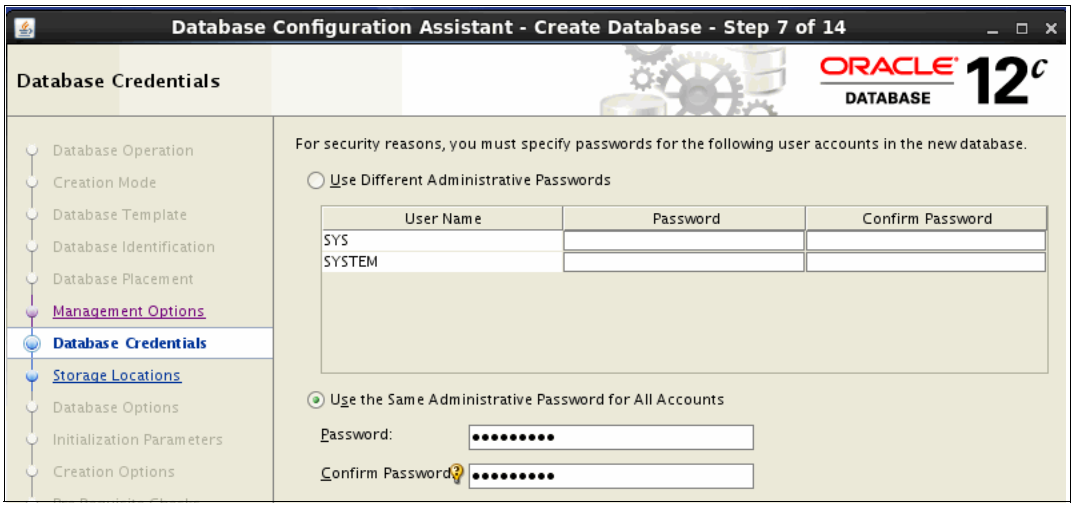


Figure 4-30 Passwords

8. The following five windows define the database. Figure 4-31 shows the usage of Automatic Storage Management (ASM).

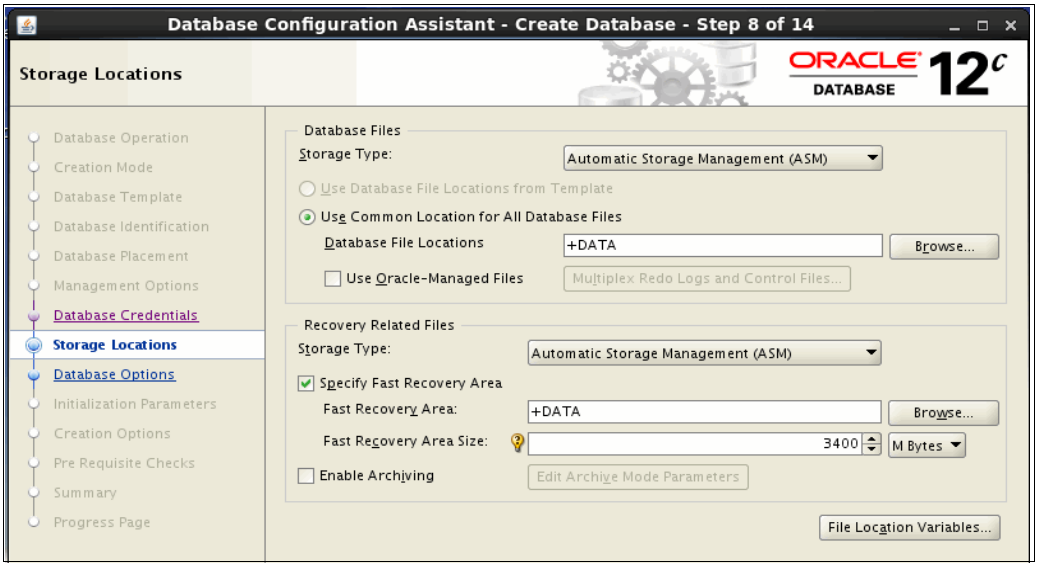


Figure 4-31 Use ASM for the data files

9. Skip Database Vault & Label Security step, which is shown In Figure 4-32.

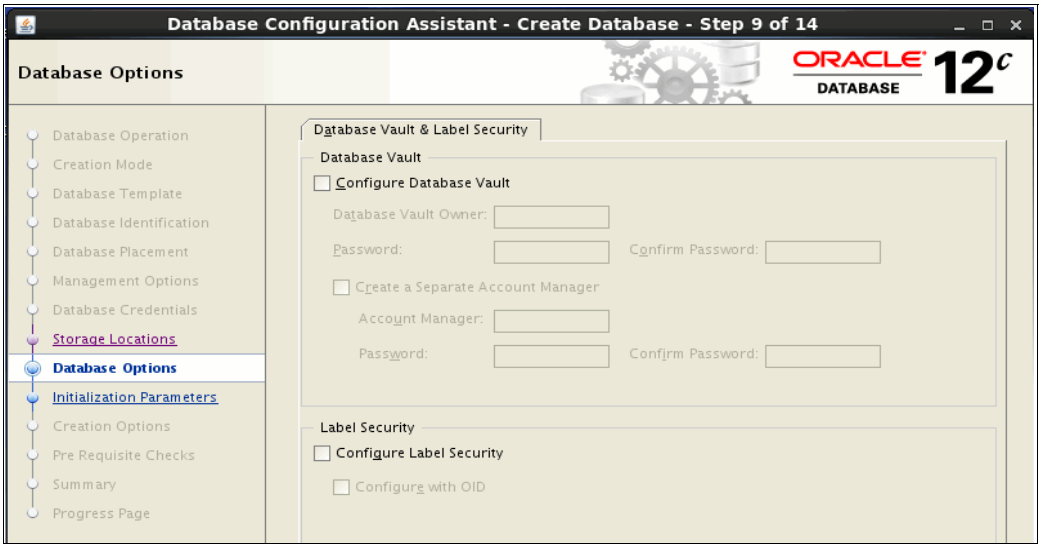


Figure 4-32 Skip additional security

10. Accept the default settings, as shown in Figure 4-33 on page 67.

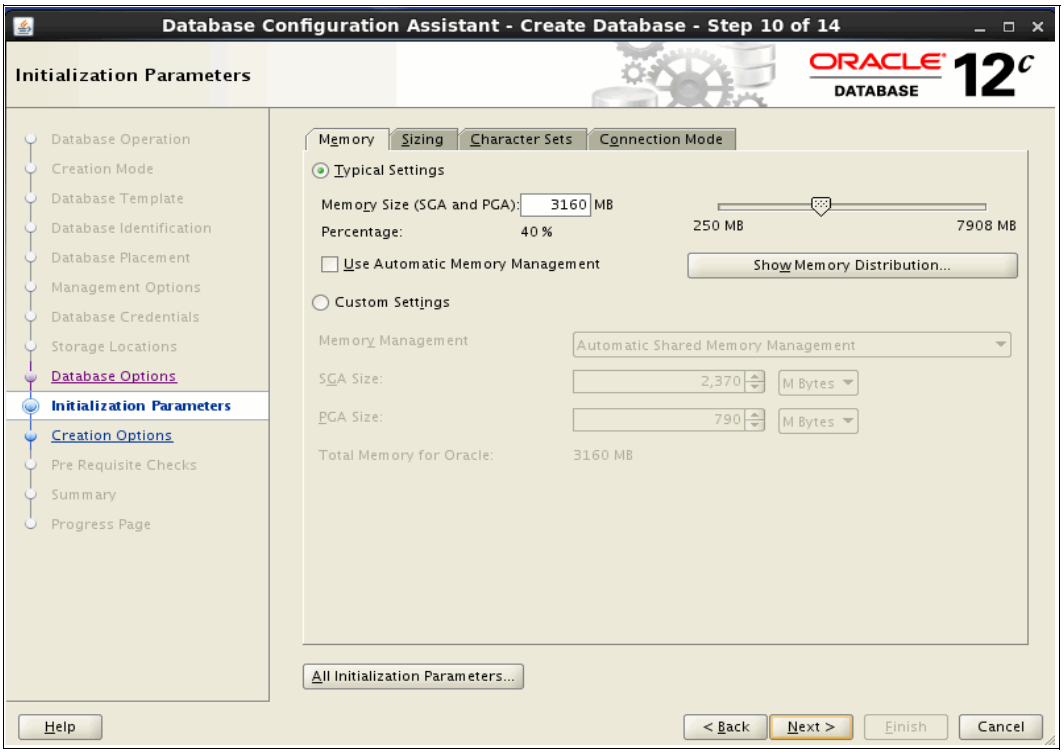


Figure 4-33 Use default settings (except for character settings)

Note: The CDB determines the character set for all the PDBs that it contains, so ensure that the correct character set is selected. To accomplish this task, select the **Character Sets** tab (Figure 4-33).

11. Select **Create Database**, as shown in Figure 4-34.

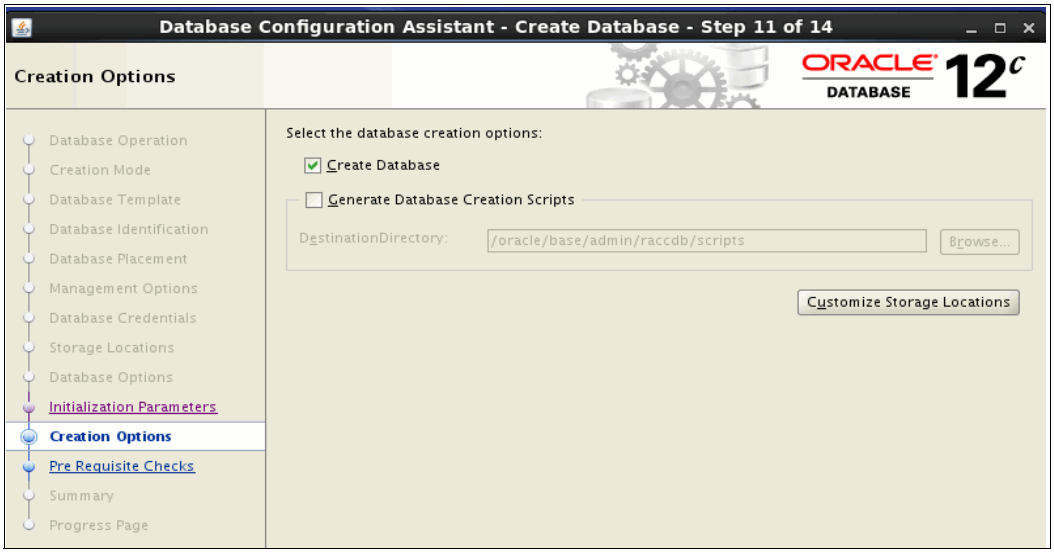


Figure 4-34 Creation options

12. As in the previous examples, all the prerequisite checks are met, so the prerequisite window is bypassed. To view it, select **Back** on the window in Figure 4-35.

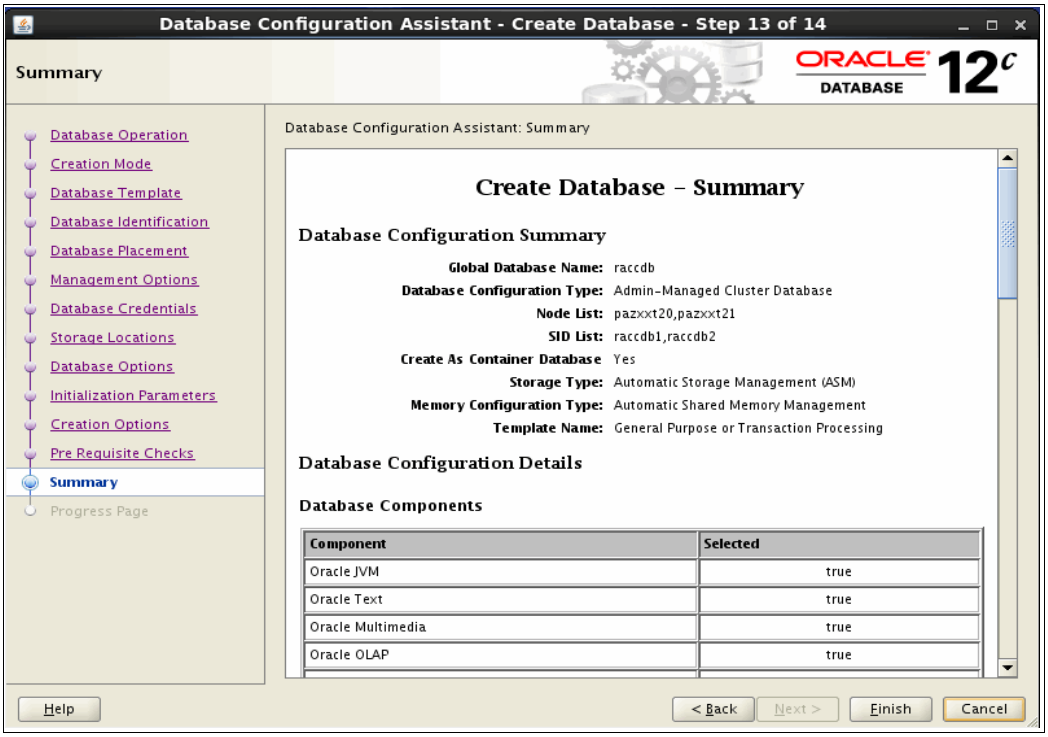


Figure 4-35 Summary to create an empty CDB

Figure 4-36 shows the completion of the activity.

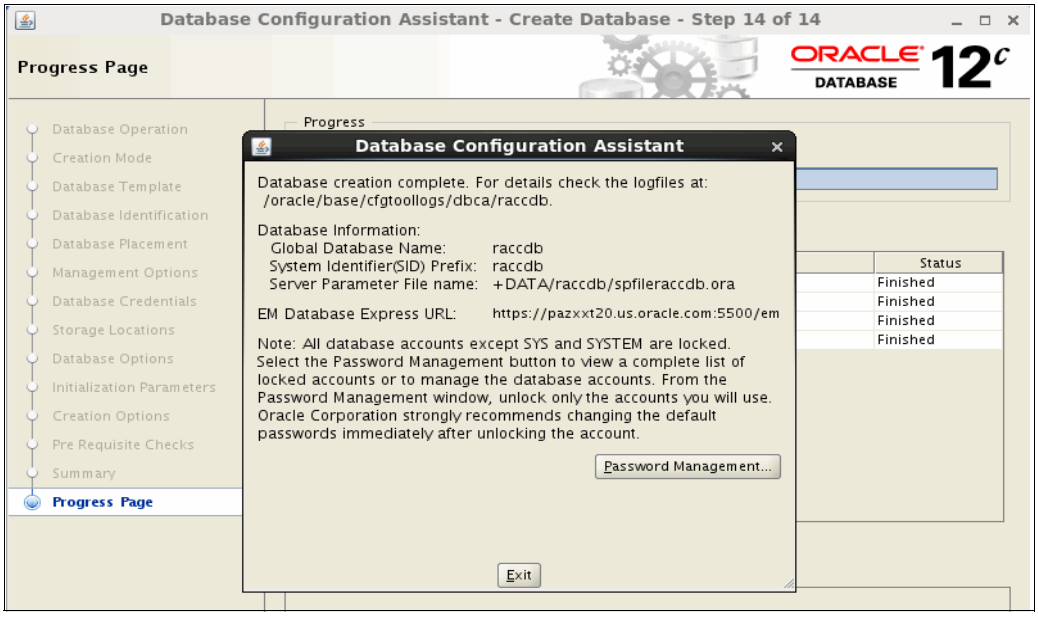


Figure 4-36 Dialog box with Enterprise Manager Database express information

Figure 4-37 on page 69 shows the progress of each step.

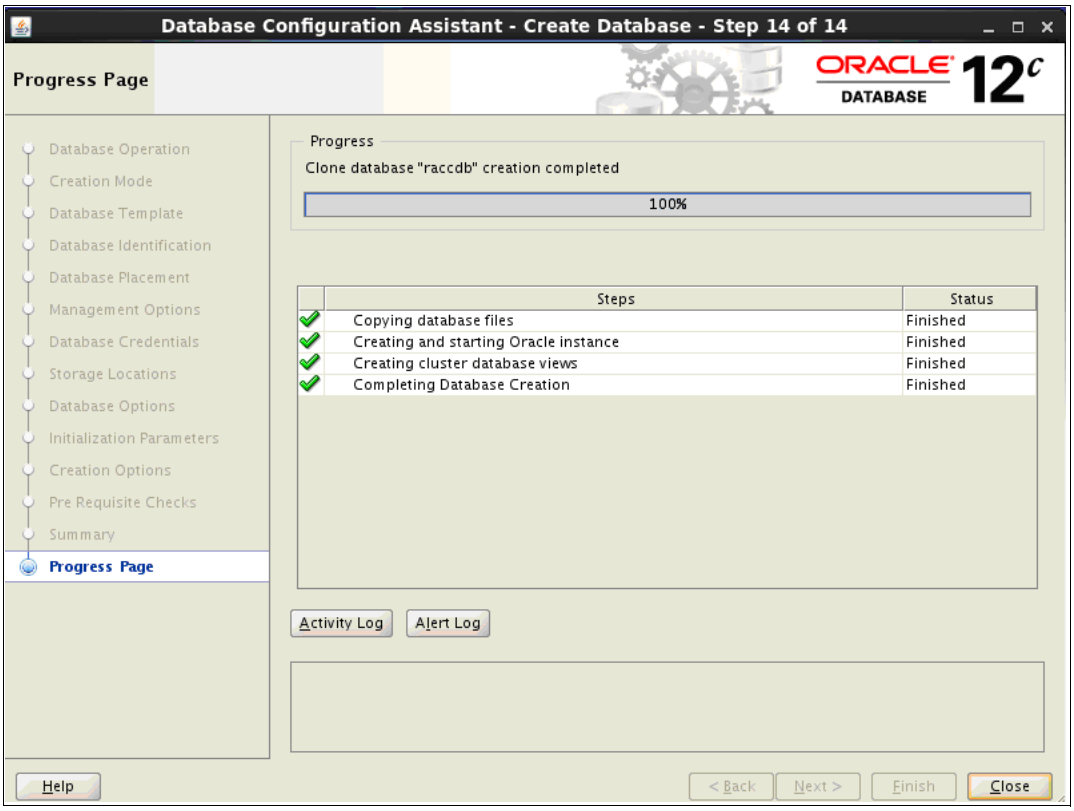


Figure 4-37 Steps in the creation process

You created an RAC with an empty CDB.

4.4 Creating a PDB in the CDB by using DBCA

This section shows the steps to create a pluggable database (PDB) in a RAC Container Database (CDB). The window shows 14 steps at the start, but after the PDB option is selected, there are only seven steps.

To create a PDB in the CDB by using DBCA, complete the following steps:

1. Select **Manage Pluggable Databases**, as shown in Figure 4-38.

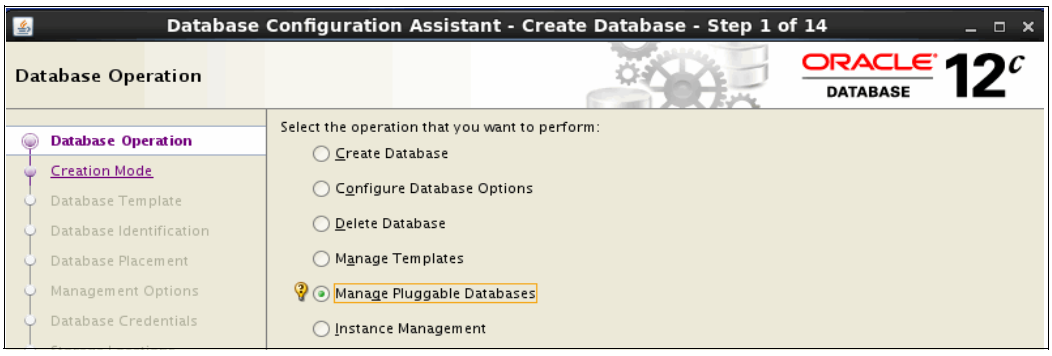


Figure 4-38 Select Manage Pluggable Database

2. Select **Create a Pluggable Database**, as shown in Figure 4-39.

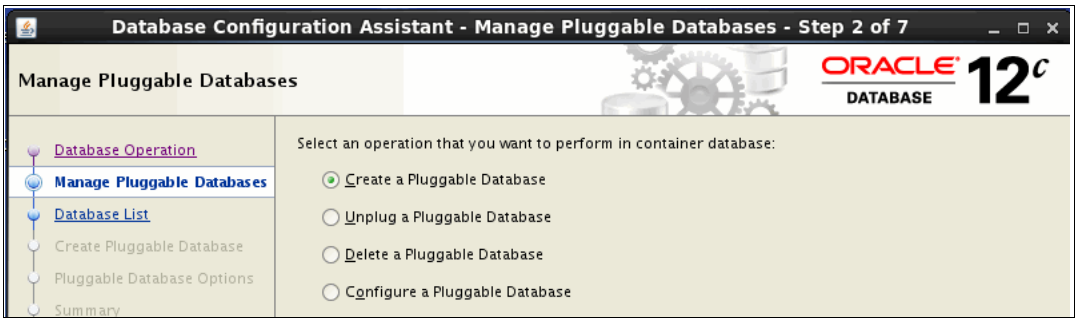


Figure 4-39 Create a Pluggable Database

3. Select a container database, as shown in Figure 4-40.

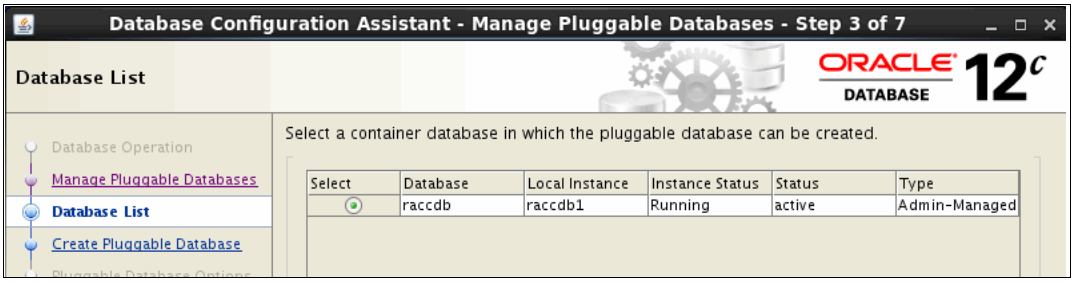


Figure 4-40 Choose the container database

4. Figure 4-41 shows the options that are available when you create a new pluggable database. Select **Create a new Pluggable Database**.

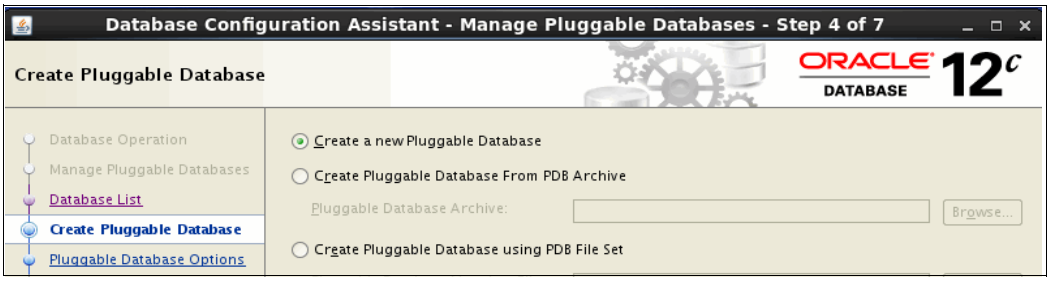


Figure 4-41 Create a new Pluggable Database

5. Create the PDB with pdbadmin as the administrator of this pluggable database only, as shown in Figure 4-42 on page 71. The user pdbadmin is local to the PDB. The same user name can be used as the administrator of another PDB.

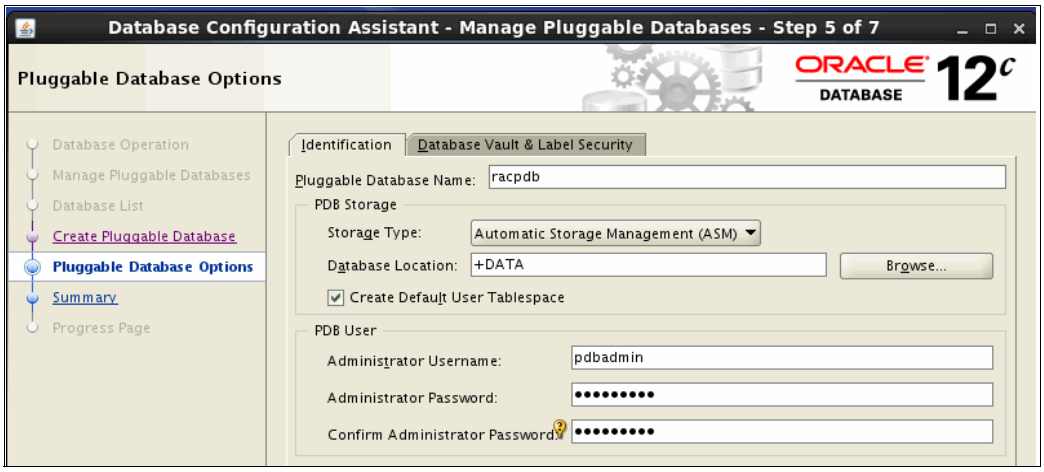


Figure 4-42 Name the pluggable database and select the administrator

6. Optionally, you can create a “user” table space in the PDB. In this example, that option is selected. The window that is shown in Figure 4-43 opens.

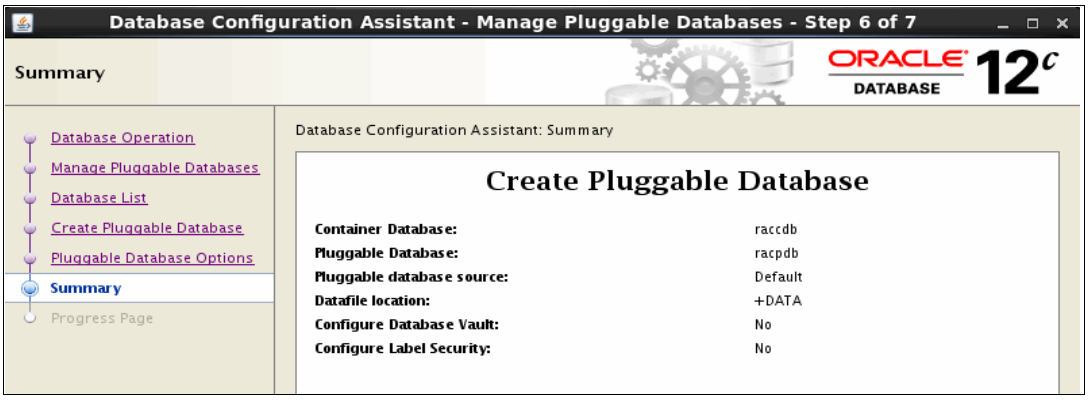


Figure 4-43 Summary of options chosen

Now there is a PDB in the CDB, as shown in Figure 4-44.

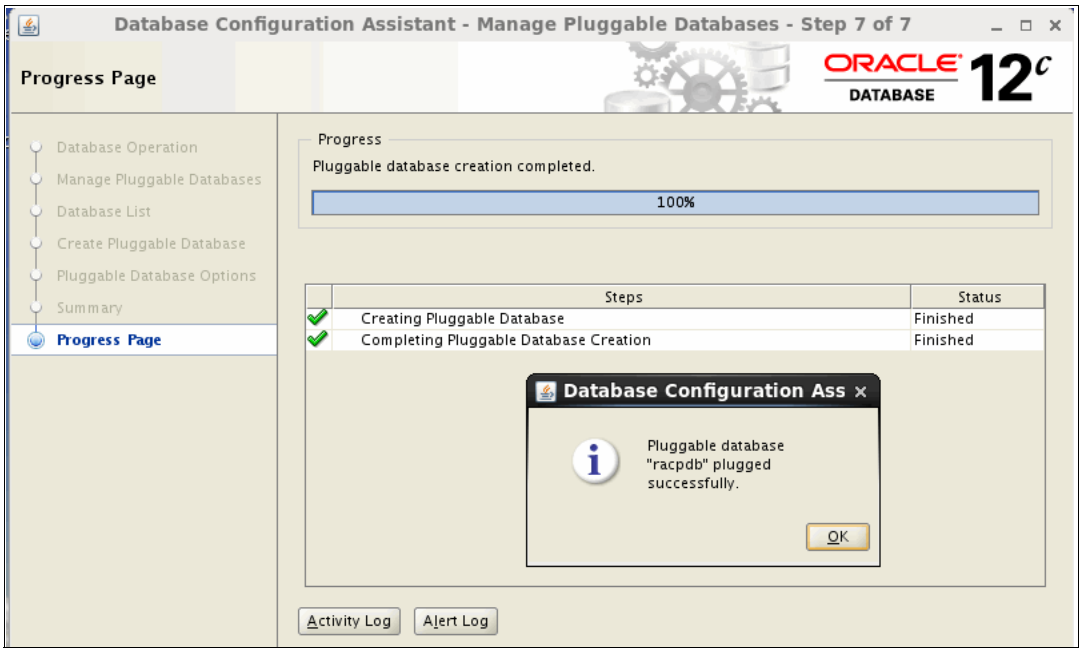


Figure 4-44 PDB creation complete

4.5 Summary

After you create the PDB, when you check the status of the Local Listener on either RAC node, you see that DBCA created a service, racpdb, which is the name of the PDB. Now the PDB is open and a local user can connect to it. Currently, the only local user is pdbadmin. If the instance was restarted, the PDB is in mount status and some method must be used to open it before a local user can connect.

The multitenant database brought several changes to Oracle Database12c. A few of these changes are used in this section. If the instance is restarted, a query of two columns from the new v$containers view shows the following output:

```
SQL> select name,open_mode from v$containers;

NAME                 OPEN_MODE
CDB$ROOT             READ WRITE
PDB$SEED             READ ONLY
RACPDB               MOUNTED
```

The PDB is only MOUNTED, so use the **alter** pluggable database SQL statement to open the PDB:

```
SQL> alter pluggable database racpdb open;
          Pluggable database altered.

SQL> select name,open_mode from v$containers;

NAME                       OPEN_MODE
CDB$ROOT                   READ WRITE
PDB$SEED                   READ ONLY
RACPDB                     READ WRITE
```

In the new multitenant database architecture, users are divided into Common users and Local users. In this example, the SQL that is run is run with a common user SYS. The pdbadmin user that is created with the PDB is local to the PDB.

In this example, a container option, **con_name**, is added to the sql*plus **SHOW** command:

```
SQL> show user
USER is "SYS"

SQL> show con_name
CON_NAME
CDB$ROOT
```

A common user, such as SYS, can use the SQL **alter session** command or SQL*PLUS **connect** command to connect to the PDB, but local users must connect to the PDB through the service name, as shown in this example:

```
SQL> connect pdbadmin/Oracle_01@pazxxt20/racpdb
          Connected.

SQL> show user
USER is "PDBADMIN"

SQL> show con_name
CON_NAME
RACPDB
```

The Local user, PDBADMIN, is restricted to the PDB, as shown in its view of v$containers:

```
SQL> select name,open_mode from v$containers;

NAME                 OPEN_MODE
RACPDB               READ WRITE
```

For more information about the multitenant architecture that is new in Oracle Database 12c, see the Multitenant white paper[1] and Part IV, “Managing a Multitenant Environment”, in the *Oracle Database Administrator's Guide12c Release 1 (12.1)*, E17636.

[1] http://www.oracle.com/us/products/database/options/multitenant/overview/index.html

5

Using Oracle Enterprise Manager Cloud Control Agent to manage Oracle Database 12c Release 1

This chapter provides information about how to deploy Oracle Enterprise Manager Cloud Control 12c Release 2 (12.1.0.3) agents on a Linux on System z environment to manage Oracle databases.

Enterprise Manager Cloud Control can monitor many databases running on multiple environments from a single console. In addition to databases monitoring, other applications, such as Siebel, PeopleSoft, and support for monitoring certain non-Oracle products, for example, IBM WebSphere® Application Server, can be monitored from a single Cloud Control Console. Although the Enterprise Manager Cloud Control does not run on Linux on System z, the agents run on the Linux on System z guests and they communicate with the Enterprise Manager Cloud Control.

In this chapter, we share our experiences on installing Enterprise Manager Cloud Control on an x86 based Linux server and describe how the agents can be deployed from the server to monitor the databases running on Linux on System z. The agents can be deployed from the Enterprise Manager Cloud Control Console or by using the silent agent deployment option at the Linux guests. These procedures are described in this chapter.

This chapter describes the following topics:

- Create Enterprise Manager Cloud Control infrastructures on x86-64 Linux.
- Deploy the Agents from Enterprise Manager Cloud Control Console.
- Deploy the Agents to Linux on System z guests by using silent installation.
- Enable the Enterprise Manager Cloud Control to monitor the Oracle databases

5.1 Basic Enterprise Manager Cloud Control Architecture

The Enterprise Manager Cloud Control Architecture has the following components:

- Oracle Management Services (OMS)

  The OMS is a web-based application that coordinates with the management agents and the plug-ins, stores the collected information in a repository, and renders the user interface for Enterprise Manager Cloud Control. The OMS is deployed to the Oracle Middleware home (Middleware home), and also installs Oracle WebLogic Server if it does not exist in the environment.

- Oracle Management Repository

  At the time of the installation of Enterprise Manager Cloud Control, the Management Repository is configured in an existing Oracle database. The Management Repository is where all the information that is collected by the Management Agent is stored.

- Plug-ins

  Plug-ins are deployed to the OMS and the Management Agent and work with them to monitor all targets in the environment. By default, the plug-ins that are needed for Oracle Databases are installed automatically at the time of the Enterprise Manager Cloud Control installation.

- Oracle Management Agents

  The Management Agent is deployed to the hosts that are monitored by the Enterprise Manager Cloud Control and it works with the plug-ins to monitor the targets running on that managed host.

- Cloud Console

  Cloud Console is the user interface and is the centralized location that is used to monitor and manage the systems and services.

Figure 5-1 on page 77 shows the Enterprise Manager Cloud Control Architecture, which was originally depicted in the *Oracle Enterprise Manager Grid Control Basic Installation Guide*.

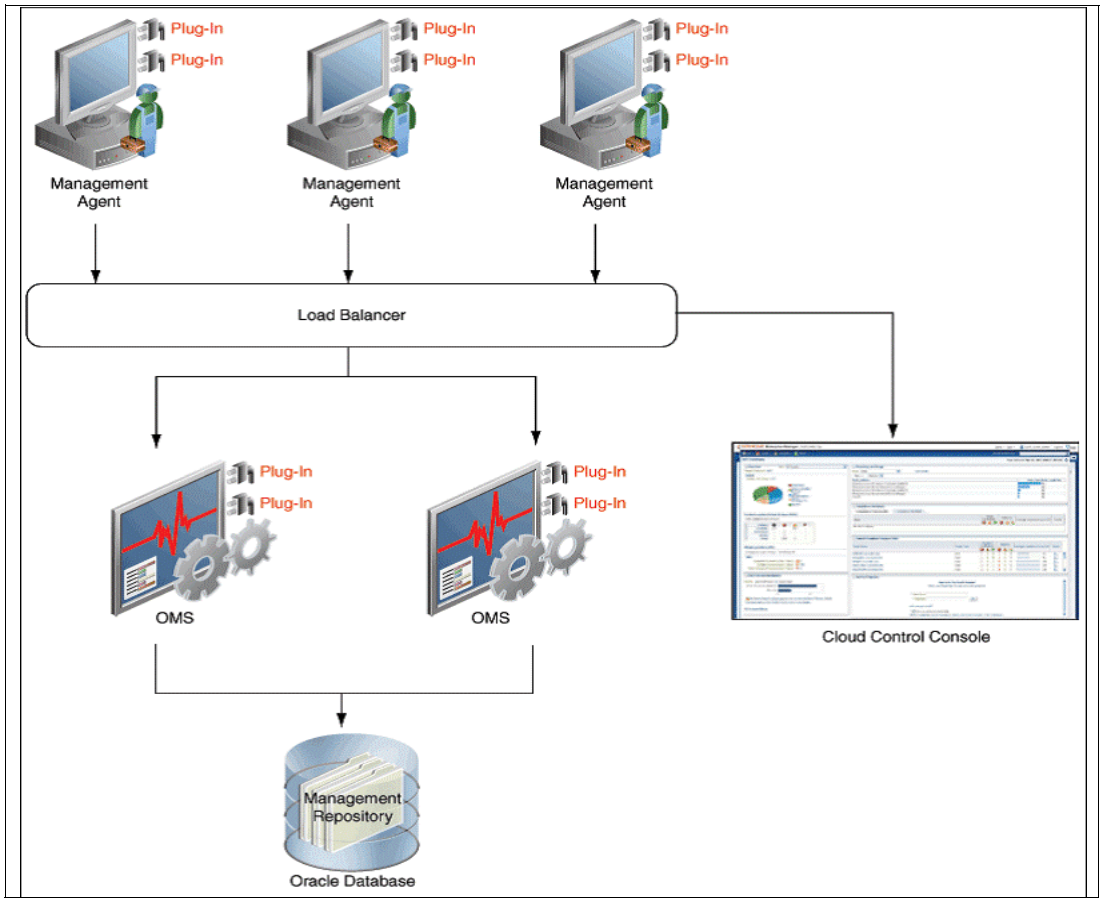


Figure 5-1 Cloud Control Architecture

5.2 Creating Enterprise Manager Cloud Control Architectures on x86 Linux

Before you begin this task, see the following My Oracle support documents:

- *FAQ: Enterprise Manager Cloud Control 12c Availability / Certification / Install / Upgrade Frequently Asked Questions*, Doc. ID 1363863.1.
- *How to Install Enterprise Manager Cloud Control 12c on Linux*, Doc ID 1359176.1

In our example environment, we decided to create Oracle Enterprise Manager Cloud Control on an x86-64 Red Hat Enterprise Linux 6 (RHEL 6.4) Linux server.

For the hardware and software requirements for the server architecture where the Cloud Control is going to be installed, see *Oracle Enterprise Manager Cloud Control Basic Installation Guide, 12c Release 2 (12.1.0.3)*, E22624-25.

Note: At the time of the writing of this document, Oracle Database 12c Release 1 is not yet certified to house Enterprise Manager 12.1.0.3 Plug-in Update 1 Repository, so we used Oracle Database 11.2.0.3. We followed the basic processes to install Oracle Database EE 11.2.0.3 and created a database. The above installation procedure is beyond the scope of this document.

In the Linux server, we created the Oracle Enterprise Manager Cloud Control Architectures by completing the following steps:

1. Download and extract the compressed installation files.
2. Start the installation in a graphical terminal, such as a VNC client.
3. Customize the Enterprise Manager Cloud Control during installation.
4. Customize the Oracle database per the repository configuration requirements.
5. Run **`allrootot.sh`**.
6. Ensure that Enterprise Manager Cloud Control Console is accessible.

5.2.1 Downloading and extracting the compressed installation files

Download the following files from the Oracle OTN network. Ensure that you are authorized to download the software.

Here are the files for Enterprise Manager Cloud Control 12c Release 3 Plug-in Update 1 (12.1.0.3) for Linux x86-64:

- `em12103p1_linux64_disk1.zip` (1,783,676,290 bytes) (cksum - 1243801163)
- `em12103p1_linux64_disk2.zip` (1,689,422,062 bytes) (cksum - 1829098882)
- `em12103p1_linux64_disk3.zip` (2,606,016,969 bytes) (cksum - 3510149507)

Extract the files in to the same directory. The following directory structure is created, as shown in Figure 5-2.

```
drwxrwxr-x  7 oracle oinstall       4096 Jun 22 03:30 install/
drwxrwxr-x  4 oracle oinstall       4096 Jun 22 03:28 jdk/
drwxrwxr-x  4 oracle oinstall       4096 Jun 22 03:31 libskgxn/
drwxrwxr-x  4 oracle oinstall       4096 Jun 22 03:18 oms/
drwxrwxr-x  2 oracle oinstall       4096 Oct 11 20:04 plugins/
-rwxrwxr-x  1 oracle oinstall      77139 Oct 17 18:48 Release_Notes.pdf*
drwxrwxr-x  2 oracle oinstall       4096 Oct  8 12:29 response/
-rwxrwxr-x  1 oracle oinstall       5136 Feb 10  2010 runInstaller*
drwxrwxr-x  9 oracle oinstall       4096 Jun 22 03:31 stage/
drwxrwxr-x  2 oracle oinstall       4096 Jun 22 03:30 wls/
-rwxrwxr-x  1 oracle oinstall 1509685020 Jun 22 03:14 WT.zip*
```

Figure 5-2 Directory listing

5.2.2 Installing and configuring Enterprise Manager Cloud Control 12c

In general, the following operations are carried out by the installation wizard as part of the installation of an Enterprise Manager system:

1. Install the Middleware Components in the Middleware home (in our example, `/u01/app/mw`). The following components are installed in the Middleware home:
   - Java Development Kit (JDK) 1.6.0.43.0
   - Oracle WebLogic Server 11g Release 1 (10.3.6)
   - Oracle Management Service 12c Release 3 (12.1.0.3)
   - Oracle JRF 11g Release (11.1.1.6.0), which includes the `oracle_common` directory
   - Oracle Web Tier 11g Release (11.1.1.6.0), which includes the `oracle_WT` directory

- Oracle plug-ins:
  - Oracle Database plug-in
  - Oracle Fusion middleware plug-in
  - Oracle My Oracle support plug-in
  - Oracle Exadata plug-in

2. Install Oracle Management Agent 12c Release 2 (12.1.0.3) in the agent base directory that is specified during installation (outside the Middleware home; in our case, `/u01/app/oracle/agent`).
3. Create an Oracle WebLogic domain that is called GCDomain, a default user account (weblogic) that is used as the administrative user, and a node manager account.
4. Configure Oracle Management Service in the Instance Base location (`gc_inst`) in the Middleware home for storing all configuration details that are related to Oracle Management Service 12c. (In our case, `/u01/app/mw/gc_inst`).
5. Configures Oracle Management Repository in the existing Oracle Database (In our case, Oracle SID: orcl).
6. Configure the various installed components.

Complete the following steps:

1. Start the installation wizard as the Oracle user in the extracted directory location of the downloaded installation files. The installation starts, as shown Figure 5-3, and you are prompted to specify the Oracle Support Credentials. In our example, we skipped the Software Updates option.

Figure 5-3 My Oracle Support details

2. During the prerequisite checks, the installer verifies the requirements for installation. In our example, we made sure that all the steps are successful, as shown in Figure 5-4.

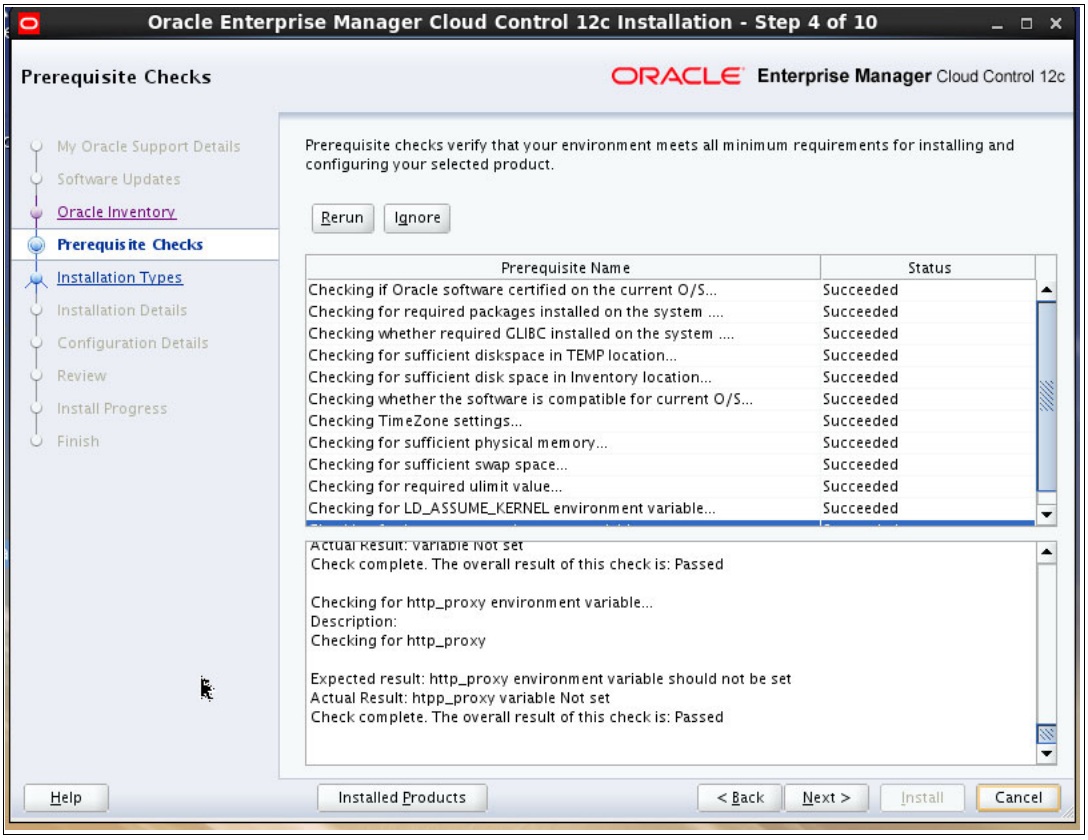


Figure 5-4 Prerequisite Checks

3. In the Installation Types window that is shown in Figure 5-5 on page 81, select **Create a new Enterprise System Manager System** and the **Advanced** option.

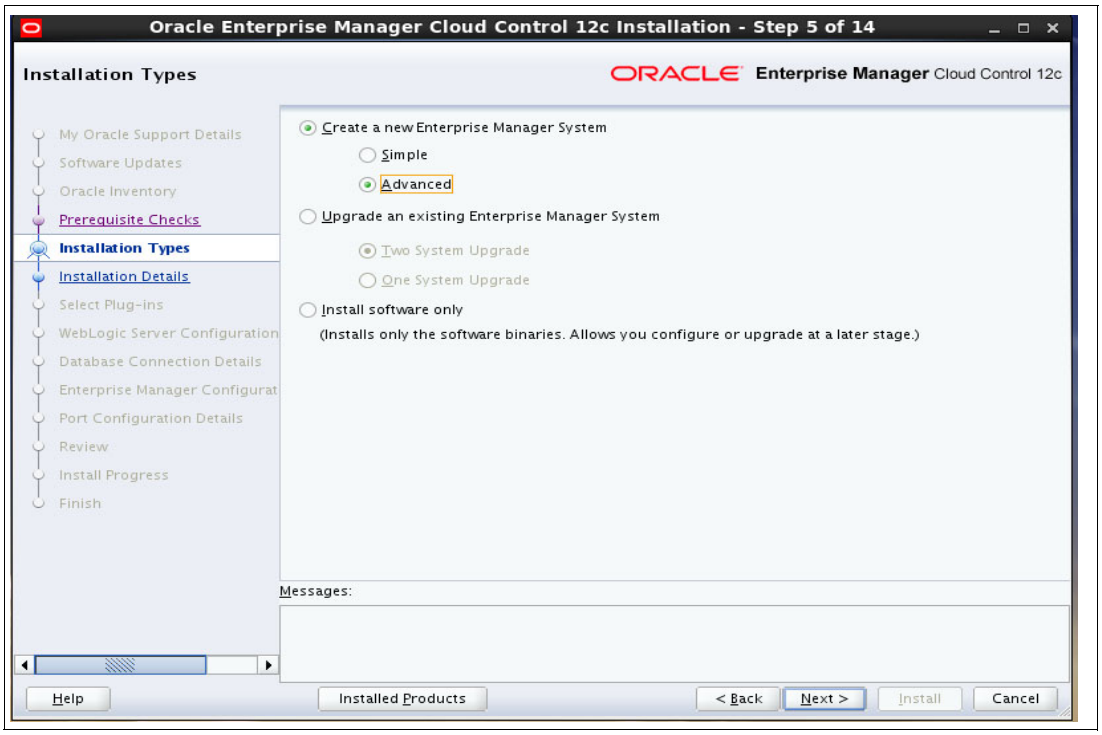


Figure 5-5 Installation Types

4. In the Installation Details window (Figure 5-6), specify the middleware home location, agent base directory location, and the host name where the installation is done.

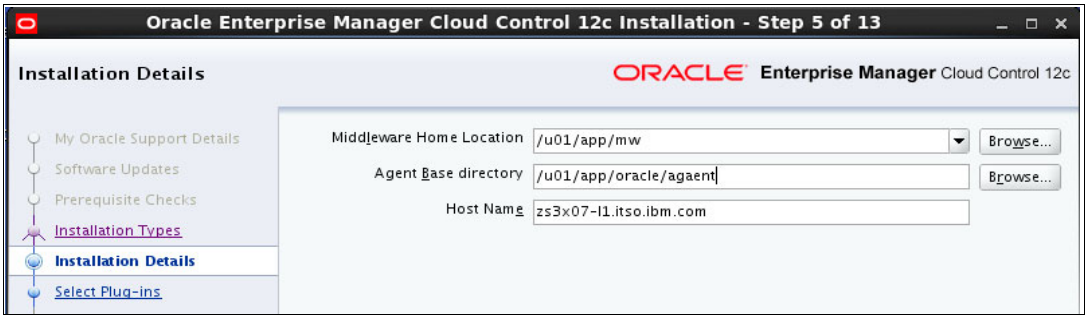


Figure 5-6 Installation Details

5. In the Select Plug-ins window on Figure 5-7, the mandatory plug-ins are automatically disabled. If any additional plug-ins are needed, then you can select them. In our case, we used the default selection.

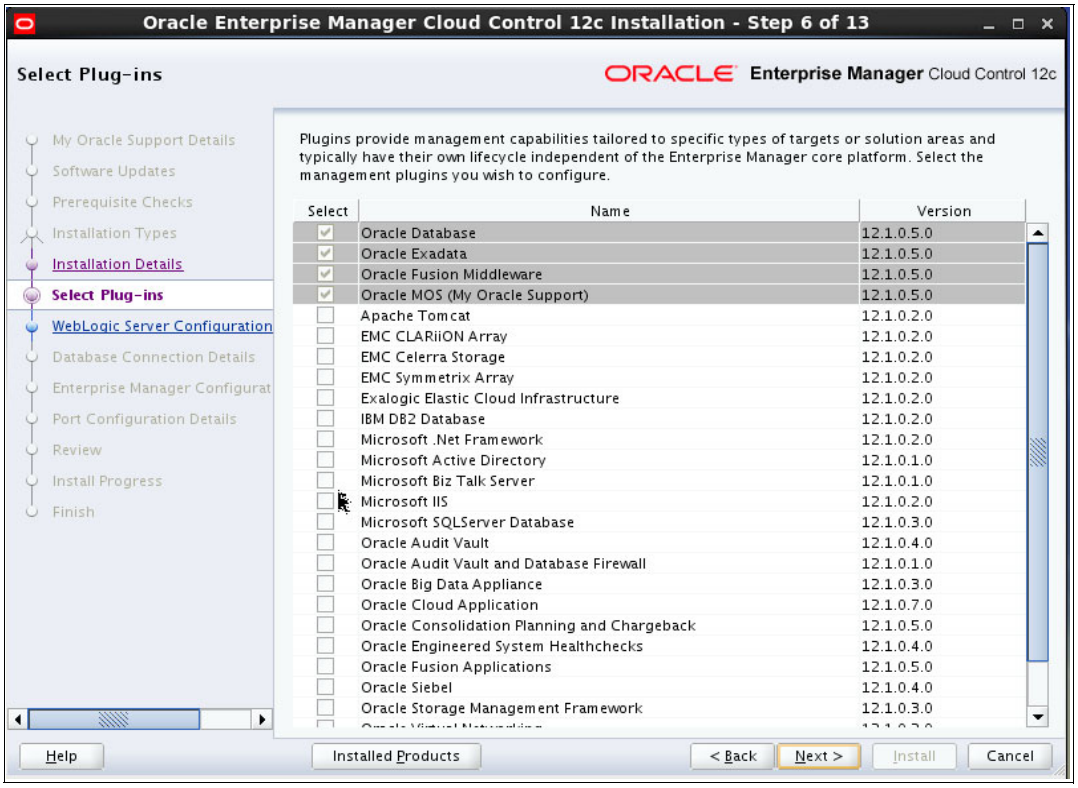


Figure 5-7 Select Plug-ins

6. In the WebLogic Server Configuration Details window that is shown in Figure 5-8, specify the required information for the Oracle WebLogic Server configuration requirements.

Figure 5-8 Oracle WebLogic Server Configuration Details

7. In the Database Connection Details window that is shown in Figure 5-9 on page 83, specify the required information for the installed database connection in the server. In our example, we also choose the deployment size as SMALL.

Figure 5-9 Database Connection Details

8. When we clicked **Next**, we encountered an error. Even though we did not configure the database for Enterprise Manager, when we created the database we got the error that is shown in Figure 5-10. We dropped the repository by running the following command:

```
$ emca -deconfig dbcontrol db -repos drop
```

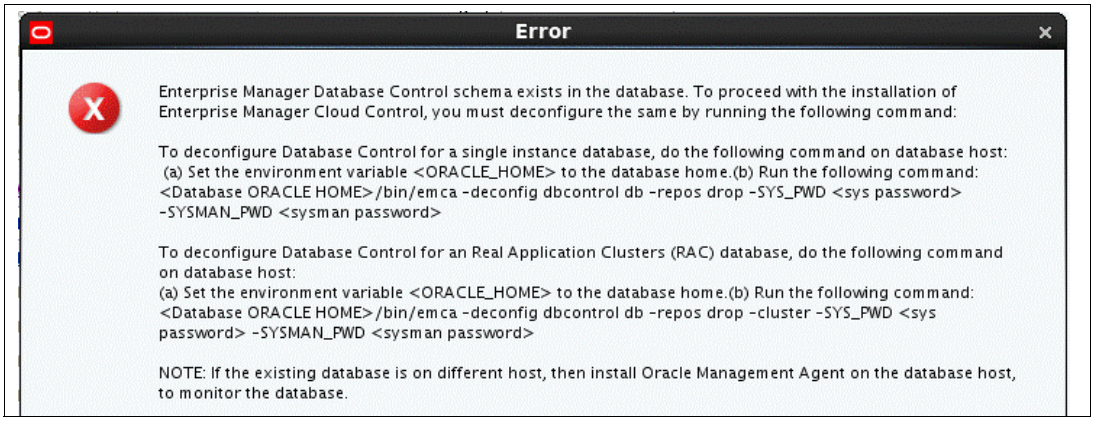


Figure 5-10 Repository existence error

Figure 5-11 shows the confirmation that the repository is dropped.

```
[oracle@zs3x07-l1 ~]$ emca -deconfig dbcontrol db -repos drop

STARTED EMCA at Nov 21, 2013 12:20:41 PM
EM Configuration Assistant, Version 11.2.0.3.0 Production
Copyright (c) 2003, 2011, Oracle.  All rights reserved.

Enter the following information:
Database SID: orcl
Listener port number: 1521
Password for SYS user:
Password for SYSMAN user:

----------------------------------------------------------------------
WARNING : While repository is dropped the database will be put in quiesce mode.
----------------------------------------------------------------------
Do you wish to continue? [yes(Y)/no(N)]: y
Nov 21, 2013 12:21:28 PM oracle.sysman.emcp.EMConfig perform
INFO: This operation is being logged at /u01/app/oracle/cfgtoollogs/emca/orcl/em
ca_2013_11_21_12_20_40.log.
Nov 21, 2013 12:21:28 PM oracle.sysman.emcp.util.GeneralUtil initSQLEngineLoacly
WARNING: ORA-28000: the account is locked

Nov 21, 2013 12:21:28 PM oracle.sysman.emcp.ParamsManager checkListenerStatusFor
DBControl
WARNING: Error initializing SQL connection. SQL operations cannot be performed
Nov 21, 2013 12:21:28 PM oracle.sysman.emcp.EMDBPreConfig performDeconfiguration
WARNING: EM is not configured for this database. No EM-specific actions can be p
erformed. Some of the possible reasons may be:
 1) EM is configured with different hostname then physical host. Set environment
 variable ORACLE_HOSTNAME=<hostname> and re-run EMCA script
 2) ORACLE_HOSTNAME is set. Unset it and re-run EMCA script
Nov 21, 2013 12:21:28 PM oracle.sysman.emcp.EMReposConfig invoke
INFO: Dropping the EM repository (this may take a while) ...
Nov 21, 2013 12:22:38 PM oracle.sysman.emcp.EMReposConfig invoke
INFO: Repository successfully dropped
Enterprise Manager configuration completed successfully
FINISHED EMCA at Nov 21, 2013 12:22:38 PM
[oracle@zs3x07-l1 ~]$
```

Figure 5-11 Drop the repository by running the emca command

9. The CBO stats gathering job prerequisite window opens, as shown in Figure 5-12 on page 85. Choose **Yes** to fix the issue automatically.

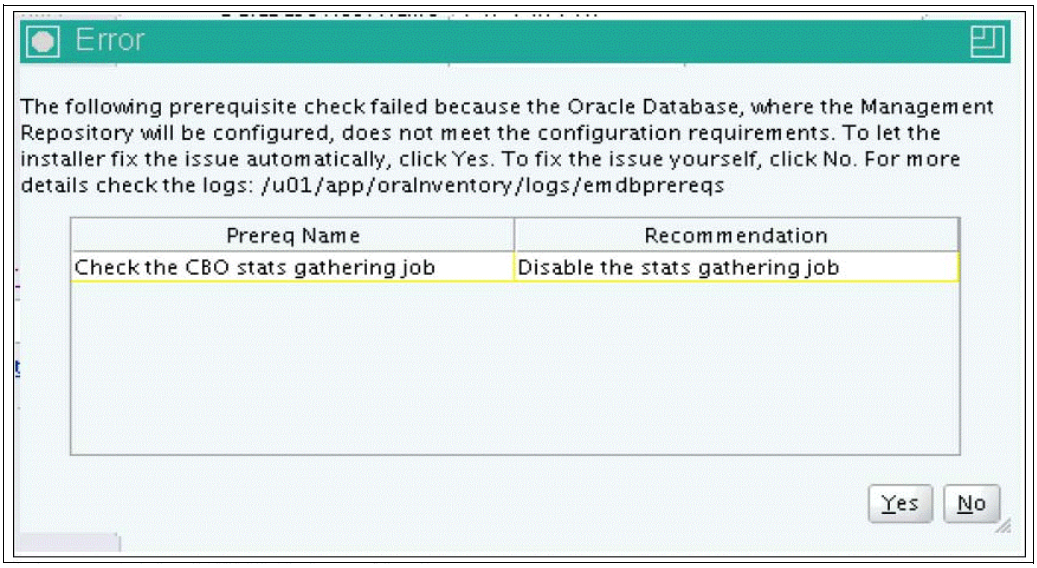


Figure 5-12 CBO stats gathering error

10. The Database configuration prereq warnings window opens, as shown in Figure 5-13. In our example, we chose to fix the database configurations as recommended by the installation wizard. We used the SQL*PLUS tool to change the parameters as suggested and then clicked **OK**.

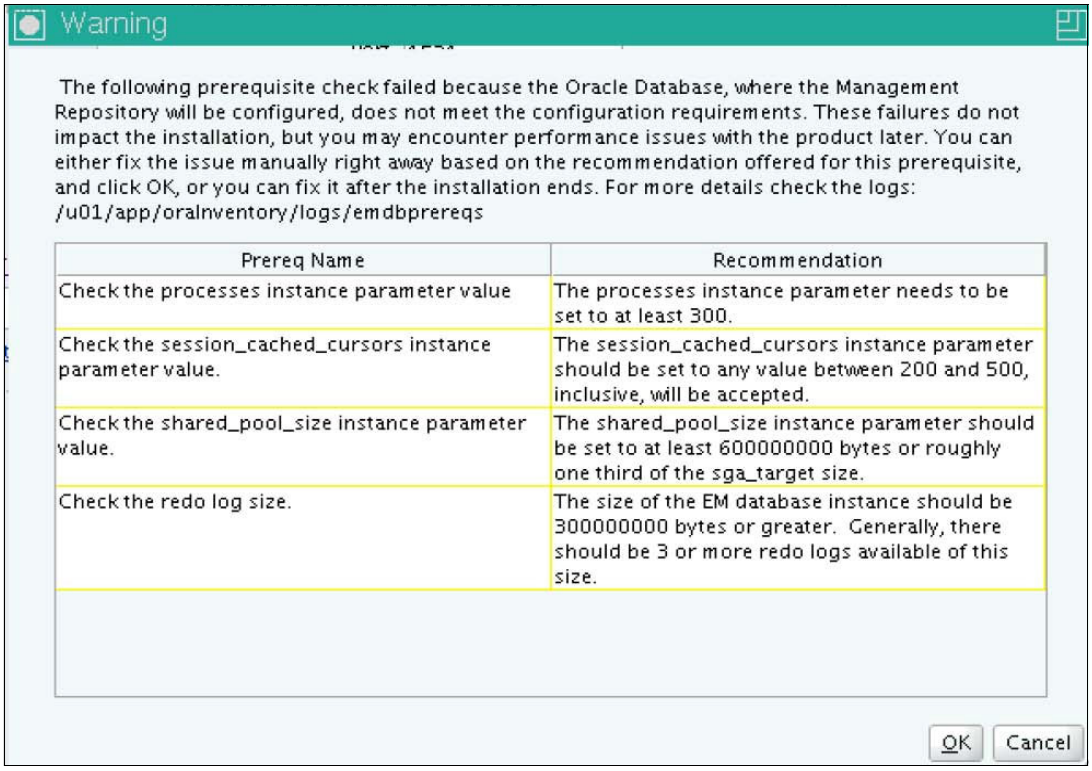


Figure 5-13 Database configuration prereq warnings

Note: Oracle now provides database templates to pre-configure the repository databases, which are available from Oracle Enterprise Manager Cloud Control 12c (12.1.0.3). By creating the repository database using those templates, you can avoid the above warnings and errors. The database templates can be downloaded from the following website:

http://www.oracle.com/technetwork/oem/enterprise-manager/downloads/index.html

After you access the website, look for the “Database Template (with EM 12.1.0.3 repository pre-configured) for Installing Oracle Enterprise Manager Cloud Control 12c Release 3 Plug-in Update 1 (12.1.0.3)” heading.

For more information about how to use these templates for installing Enterprise Manager 12.1.0.3 Plug-in Update 1, see *Enterprise Manager Cloud Control Basic Installation Guide 12c Release 2 (12.1.0.3)*, found at:

http://www.oracle.com/technetwork/oem/grid-control/documentation/oem-091904.htmlhere

The Repository configuration password details are populated in the Enterprise Manager Configuration Details window, as shown in Figure 5-14.

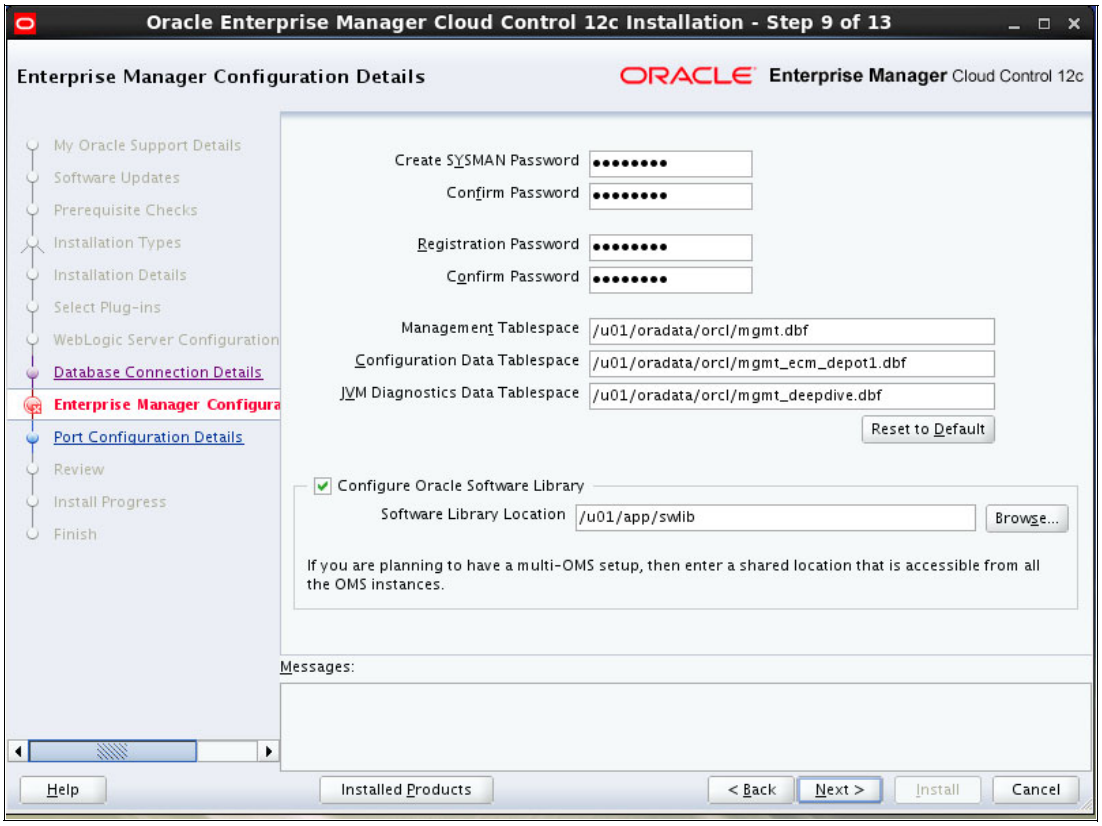


Figure 5-14 Enterprise Manager Configuration Details

11. In our example, we accept the default port values in the Port Configuration Details, as shown in Figure 5-15 on page 87.

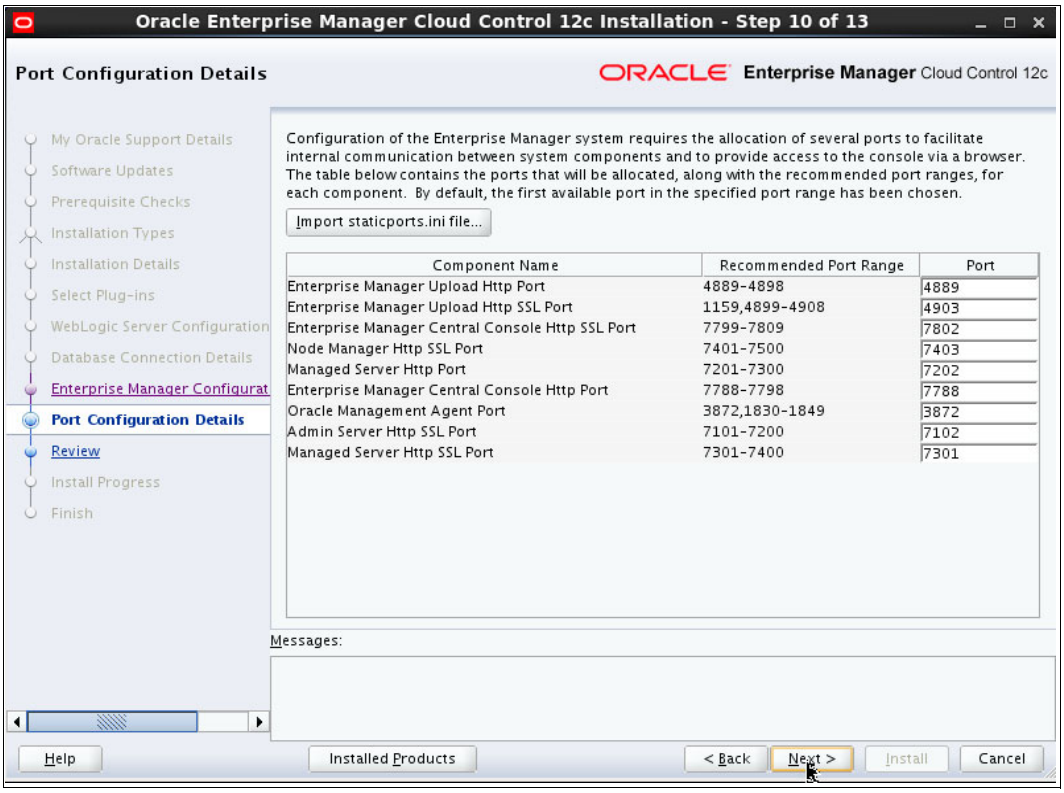


Figure 5-15 Port Configuration Details

12. Review the configuration values in the window that are shown in Figure 5-16 and click **Install**.

Figure 5-16 Review

13. The installation start and you can see the Installation Progress Details window. When the installation and configuration is complete, run `allroot.sh` as the root user using the instructions shown in the dialog box in Figure 5-17.

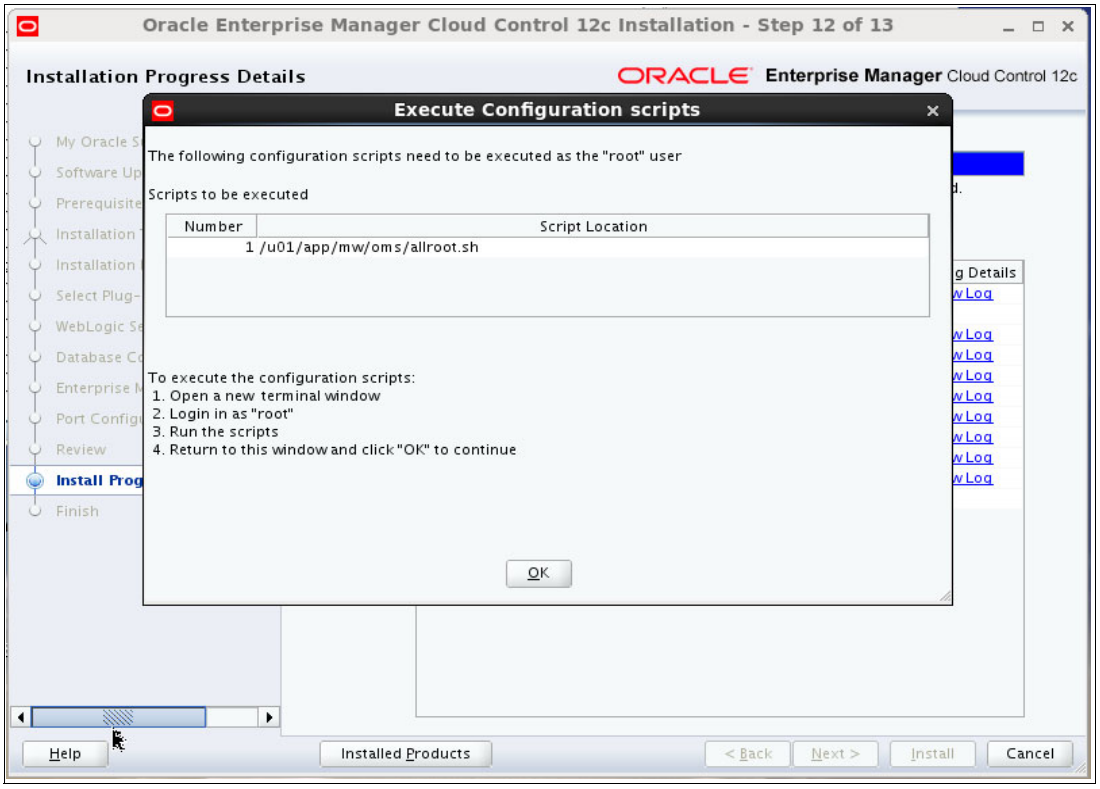


Figure 5-17 Installation Progress Details

In our example, the Enterprise Manager Cloud Control configuration and installation took more than 97 minutes to complete; at the end, the status is displayed. The Finish window that is shown on Figure 5-18 on page 89 also shows the URL and port number access information for Enterprise Manager Cloud Control and the Admin Server.

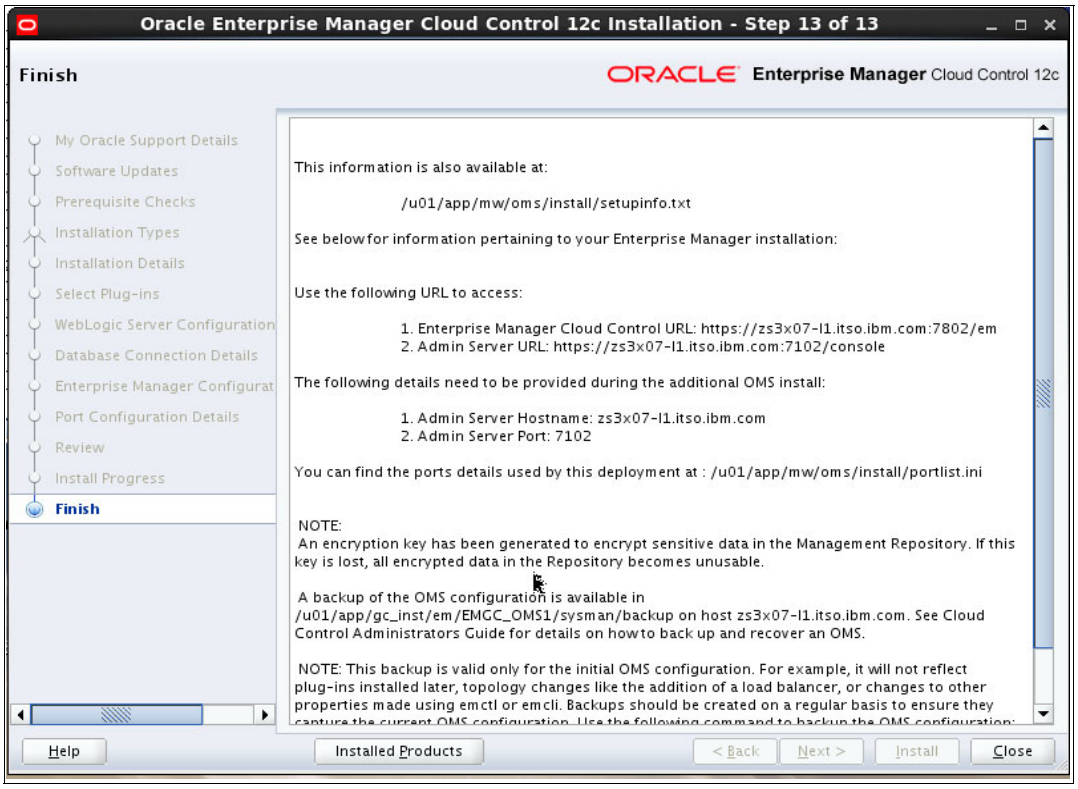


Figure 5-18 Finish

14. When you use the Enterprise Manager Cloud Control URL for the first time, you are asked to trust and certify and add the exception. Then, the Enterprise Manager Cloud Control window opens, as shown in Figure 5-19. Now, you can log on as sysman by using the assigned password.

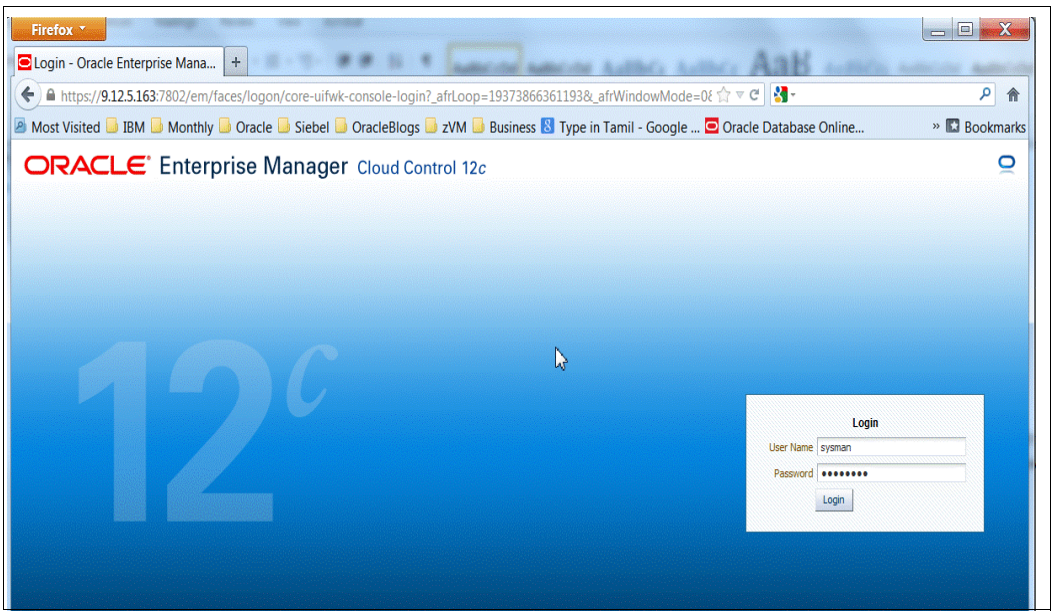


Figure 5-19 Enterprise Manager Cloud Control 12c

Accept the license requirement, which completes the Enterprise Manager Cloud Control 12c Server installation.

The steps in this section are for a simple configuration installation process. Enterprise Manager Cloud Control offers multiple configurations. For advanced installation and configuration, see the Oracle manuals and documentation.

5.3 Updating the agent at the Enterprise Manager Cloud Control to monitor Oracle Databases on Linux on System z (online)

Enterprise Manager Cloud Control 12c by default has the Cloud Control Agent software installed for the operating system where Enterprise Manager Cloud Control 12c is installed. In our case, the agent for the Linux x86-64 is available when the Enterprise Manager Cloud Control 12c is installed on the Linux x86-64 server. However, the agent to monitor the Oracle databases on Linux on System z architecture is not available in the base installation. Management Agent software for Linux on System z architecture must be downloaded and applied by using the Self Update feature. The Self Update feature is a dashboard option that is used to obtain information about new updates. It provides a process flow to review, download, and apply those updates.

The Software Library is a repository that stores software entities such as software patches and application software. The software library stores its repository on a file system that is accessible by the OMS. Depending on the usage, the size of this file can reach 50 GB. For more information about advanced features and the requirements of the Software Library, see the MOS document *Understanding and Configuring Software Library In 12C Cloud Control*, ID 1368035.1.

5.3.1 Configuring the Software Library storage space

The storage location in the Software Library represents a repository of files. These files are uploaded by the Software Library, and you must add at least one upload file storage location. This location can be either an OMS Shared location or OMS Agent location. This is the first step to be carried out, and in our case we decided to use an OMS Shared location. We used the default location, which was already configured in the system during the Enterprise Manager Cloud Control 12c installation.

Click **Setup** → **Provisioning and Patching** → **Software Library** to configure the Software Library, as shown in Figure 5-20 on page 91. In our case, `/u01/app/swlib` is already configured as a Software Library location for the OMS Shared File System, so we decided to use that location.

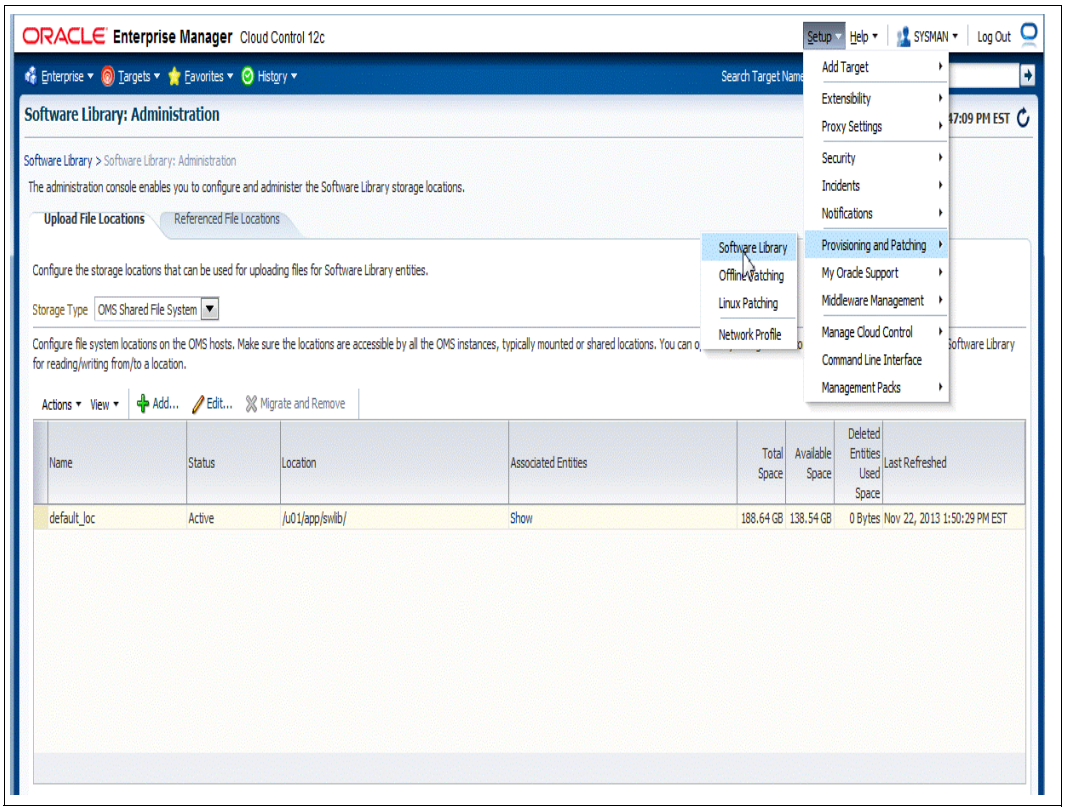


Figure 5-20 Software Library Administration

5.3.2 Acquiring the Linux on System z agent in online mode

The Enterprise Manager Cloud Control is in online mode when it has access to My Oracle Support through the internet. The following example shows how the Linux on System z agent is acquired in online mode on an Enterprise Manager Cloud Control running on an x86-64 Linux architecture.

In general the following operations are carried out:

- Setting up “My Oracle Support Credentials” in Enterprise Manager Cloud Control
- Verifying that Enterprise Manager Cloud Control is in online mode
- Updating the available agents in Enterprise Manager Cloud Control by using the Self Update feature
- Downloading and applying the Linux on System z Management Agent Software

Setting up “My Oracle Support Credentials” in Enterprise Manager Cloud Control

Complete the following steps:

1. Log on to Enterprise Manager Cloud Control 12c.

2. Click **Setup** → **My Oracle Support** → **Set Credentials**, as shown in Figure 5-21.

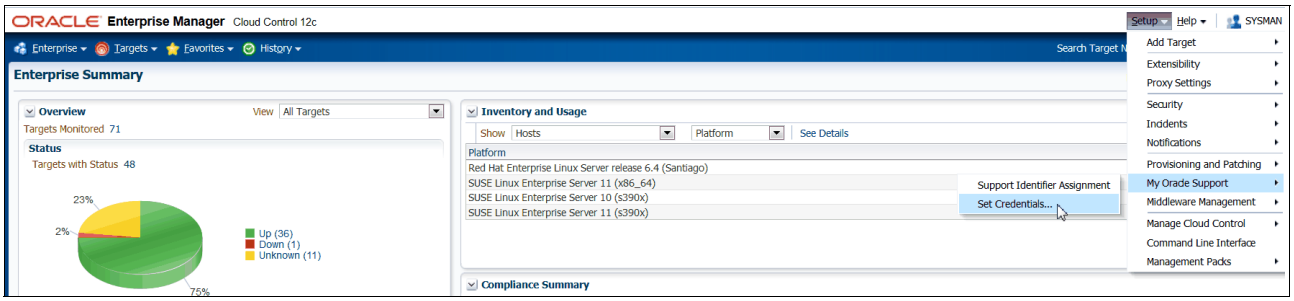


Figure 5-21 Enterprise Manager Cloud Control

3. Enter the My Oracle Support Credentials and clicked **Apply**, as shown in Figure 5-22.

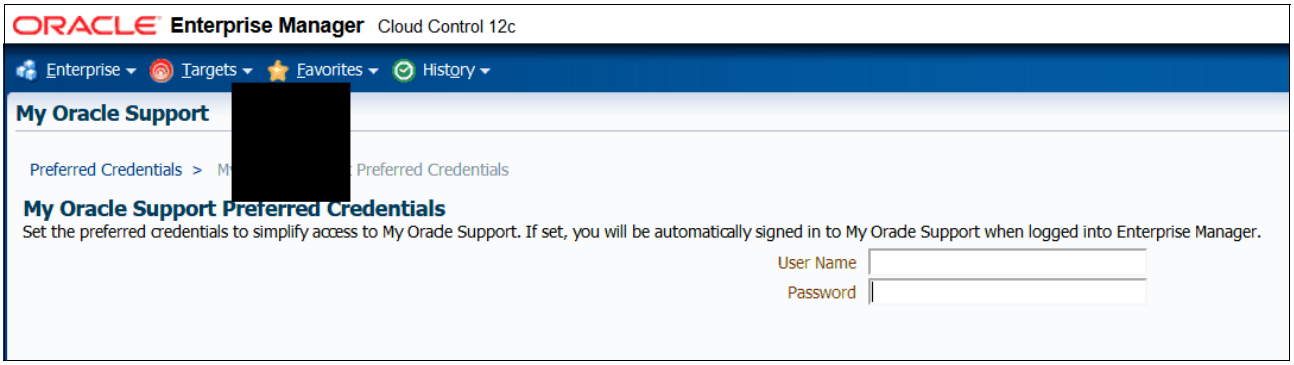


Figure 5-22 My Oracle Support Credentials

The My Oracle Support Preferred Credentials are set up in Cloud Control 12c.

Verifying that Enterprise Manager Cloud Control is in online mode

You must ensure that Cloud Control is set to the online mode. To do so, complete the following steps:

1. Click **Setup** → **Provisioning and Patching** → **Offline Patching**, and then change the setting for Connection to **Online**, as shown in Figure 5-23.

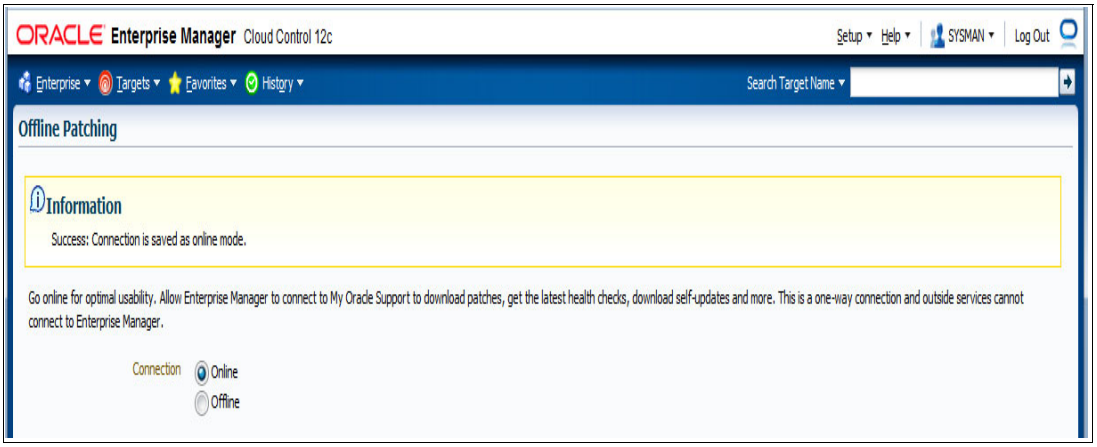


Figure 5-23 Online settings

2. Update the available agents in Enterprise Manager Cloud Control by using the Self Update feature. By default, only the Management Agent software for the OMS host platform is downloaded and applied. The other host agents availability must be checked by using the Self Update feature of the Enterprise Manager Cloud Control.
3. Click **Setup** → **Extensibility** → **Self Update**, as shown in Figure 5-24.

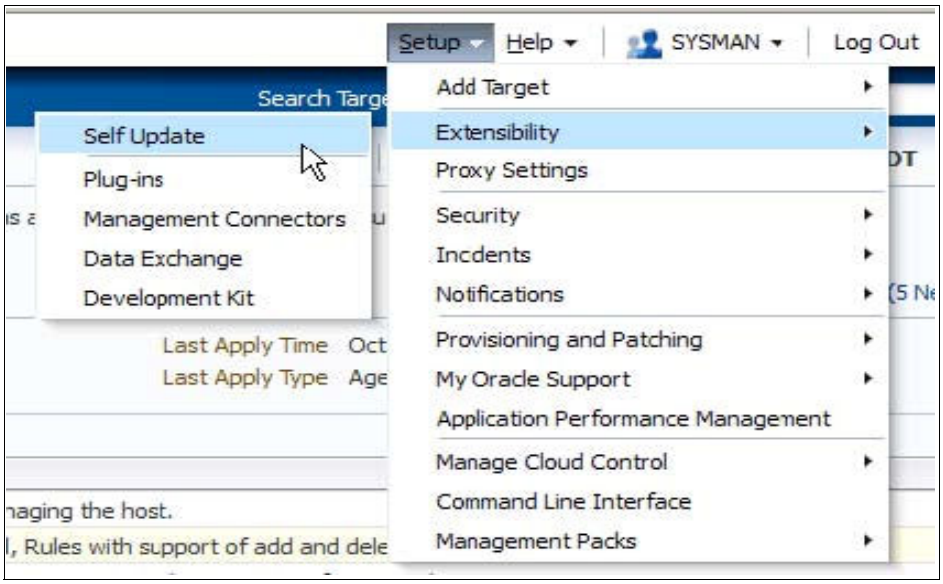


Figure 5-24 Self Update window

4. Click **Check Updates** to get the complete list of available updates for the Agent Software (Figure 5-25).

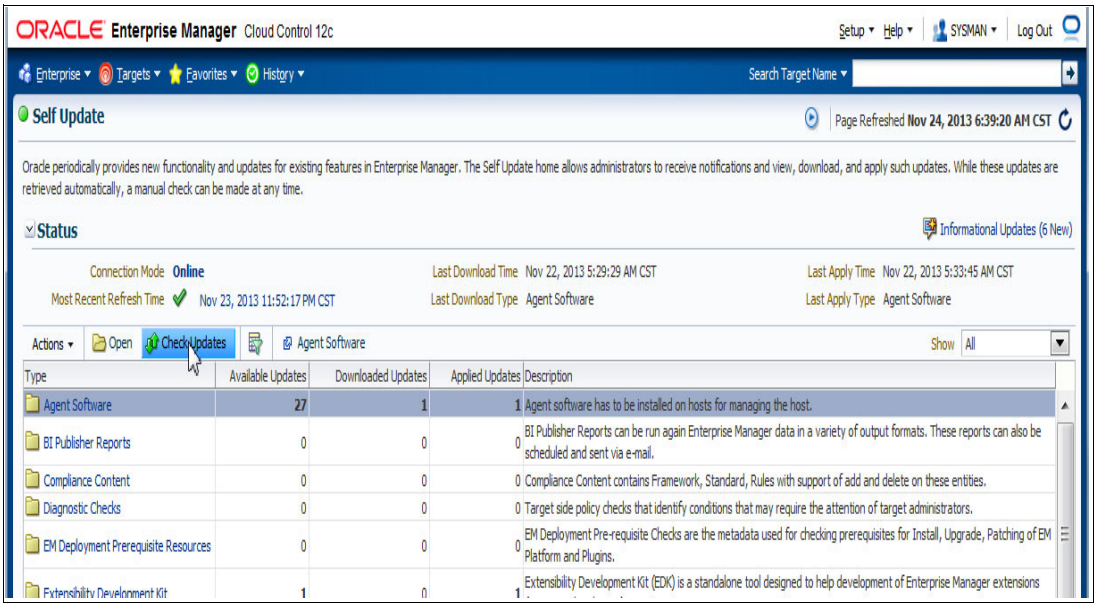


Figure 5-25 List of updates that are available

A background job is submitted to get the new updates from My Oracle Support. Figures Figure 5-26 and Figure 5-27 show the job's output.

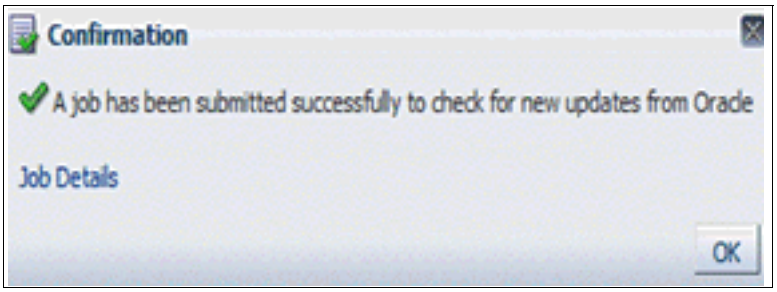


Figure 5-26 Output from the job - part 1

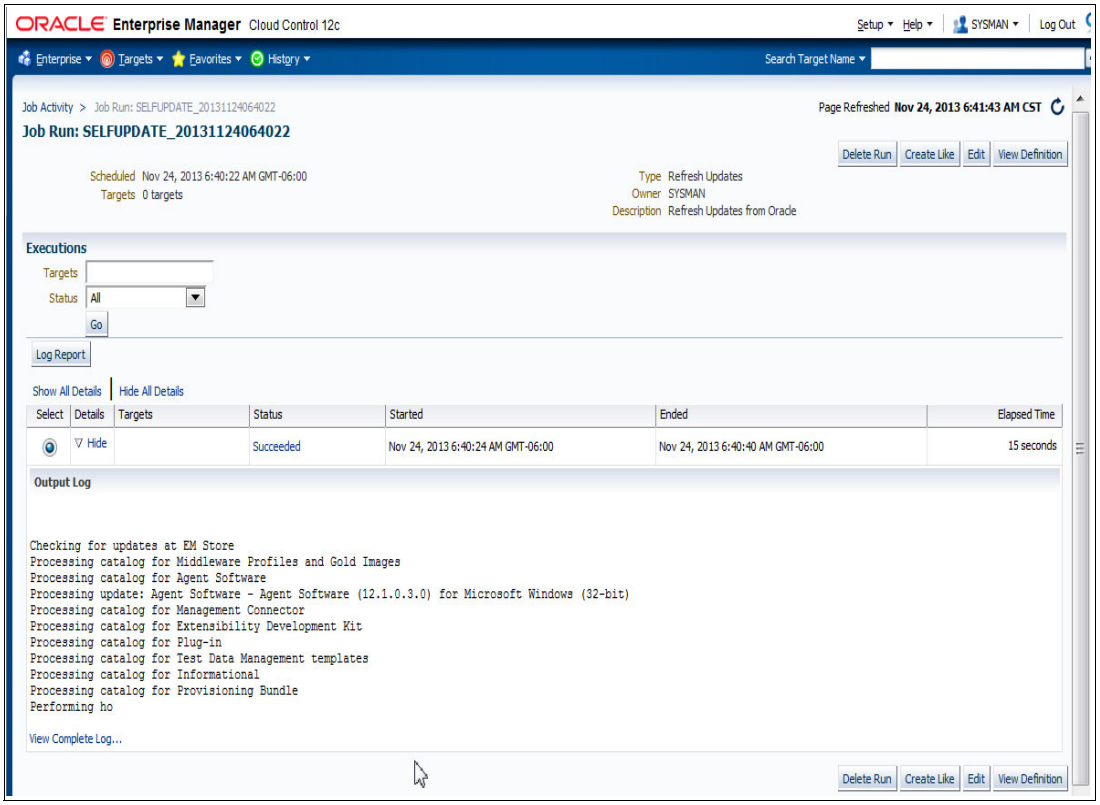


Figure 5-27 Output from the job - part 2

Downloading and applying the Linux on System z Management Agent Software

After the list of available updates is populated in the system, you can download the required Management Agent Software and then apply it to the OMS host. The steps are shown in Figure 5-28 on page 95 through Figure 5-36 on page 99.

Complete the following steps:

1. Click **Setup** → **Extensibility** → **Self Update**, as shown in Figure 5-28 on page 95,

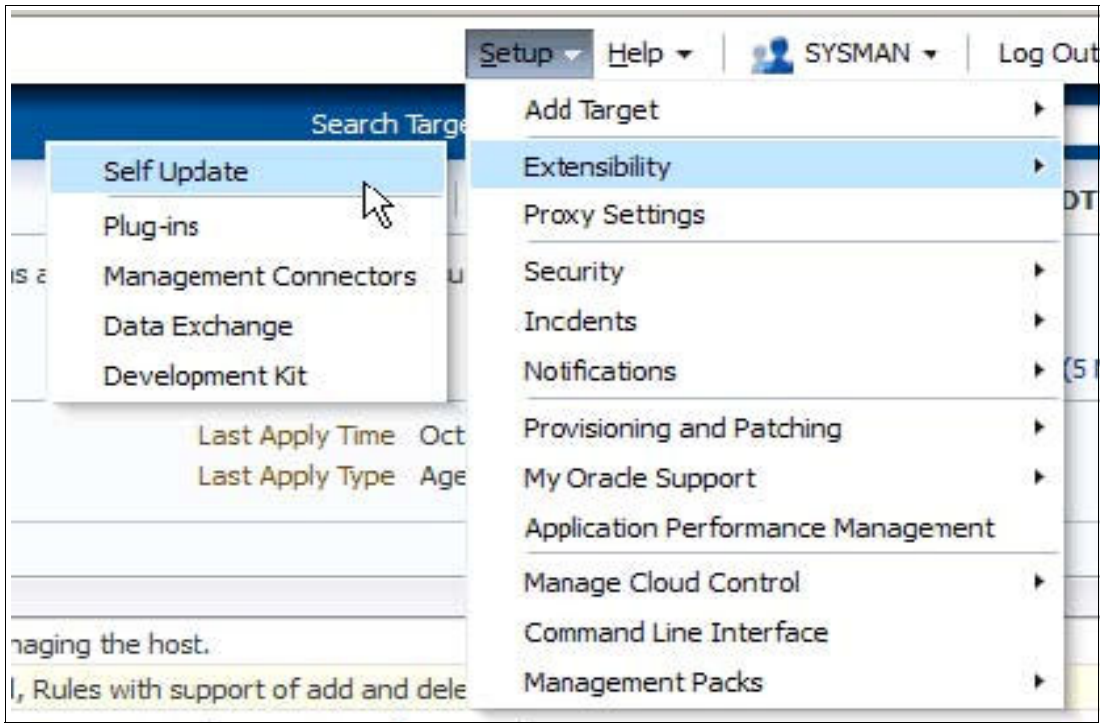


Figure 5-28 Setup menu

2. Select the entity type **Agent Software** and select **Open** from the Action menu. The entity type page shows agent software for different platforms, as shown in Figure 5-29.

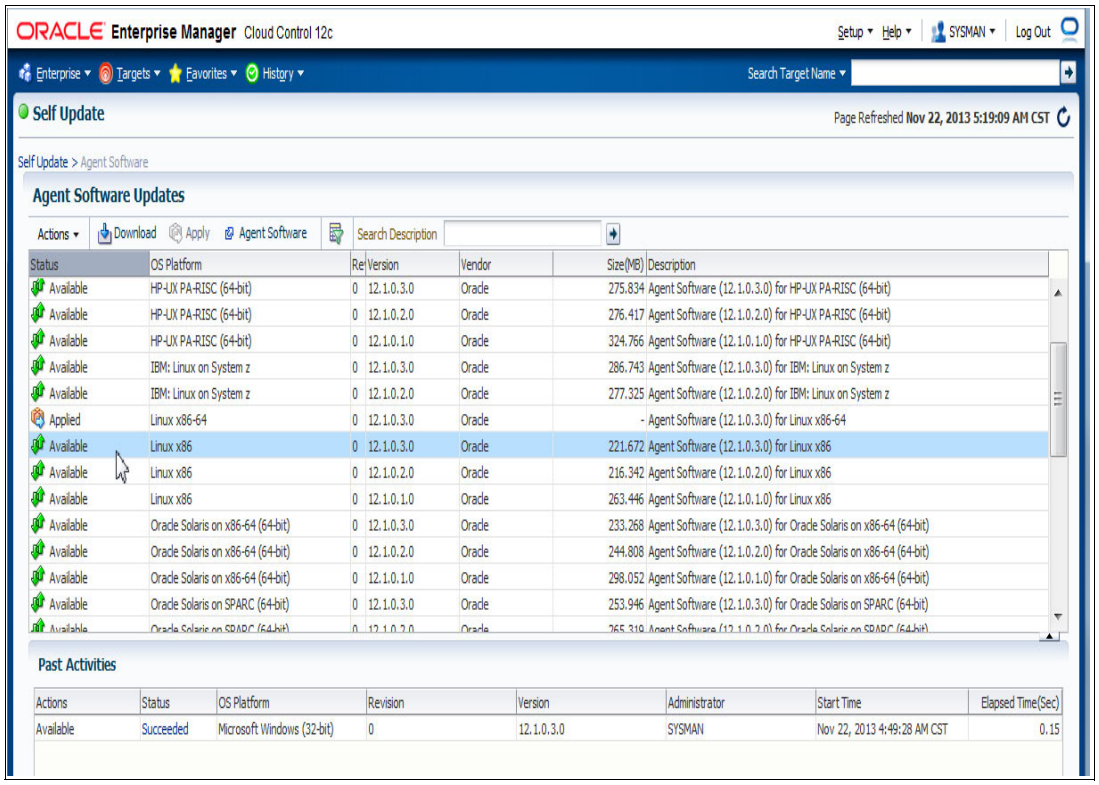


Figure 5-29 List of available software

3. In our example, we select IBM: Linux on System z OS Platform and Version 12.1.0.3 from the list of available updates.
4. Click **Download** and schedule the download job for immediate execution, as shown in Figure 5-30 and Figure 5-31.

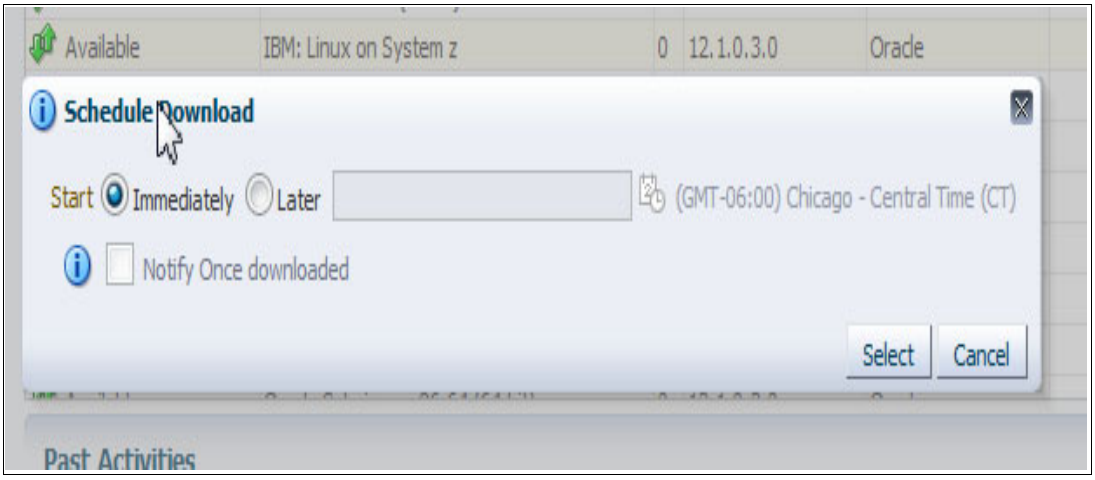


Figure 5-30 Schedule Download

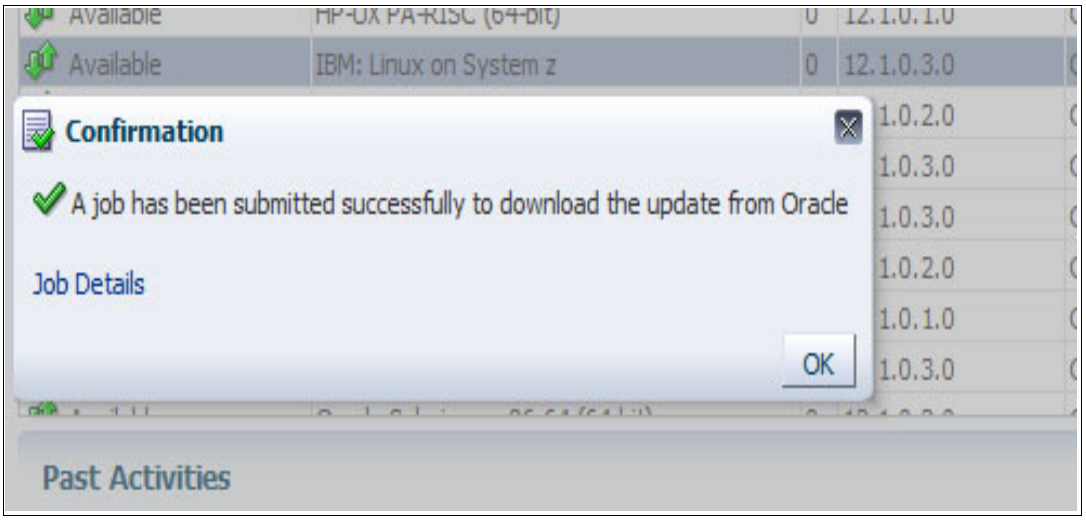


Figure 5-31 Job submitted

5. You can monitor the job. After the job completes, the results are shown in Figure 5-32 on page 97.

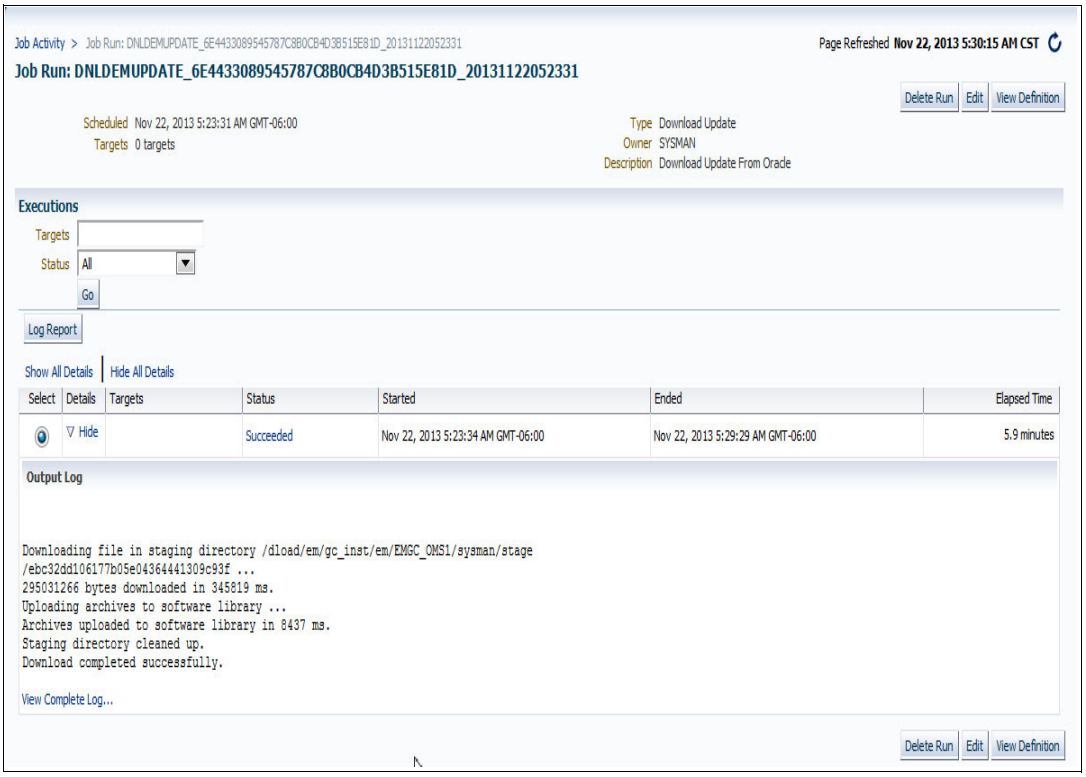


Figure 5-32 Monitor the download

6. The status is now Downloaded, as shown in Figure 5-33.

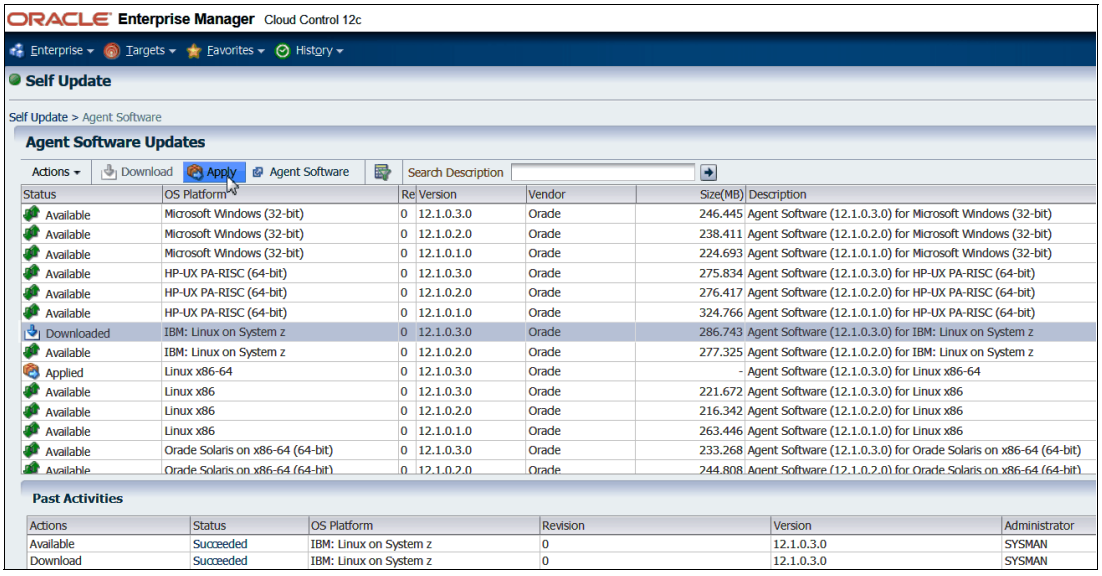


Figure 5-33 Status of download

7. Click Apply for the Downloaded Agent, as shown in Figure 5-34

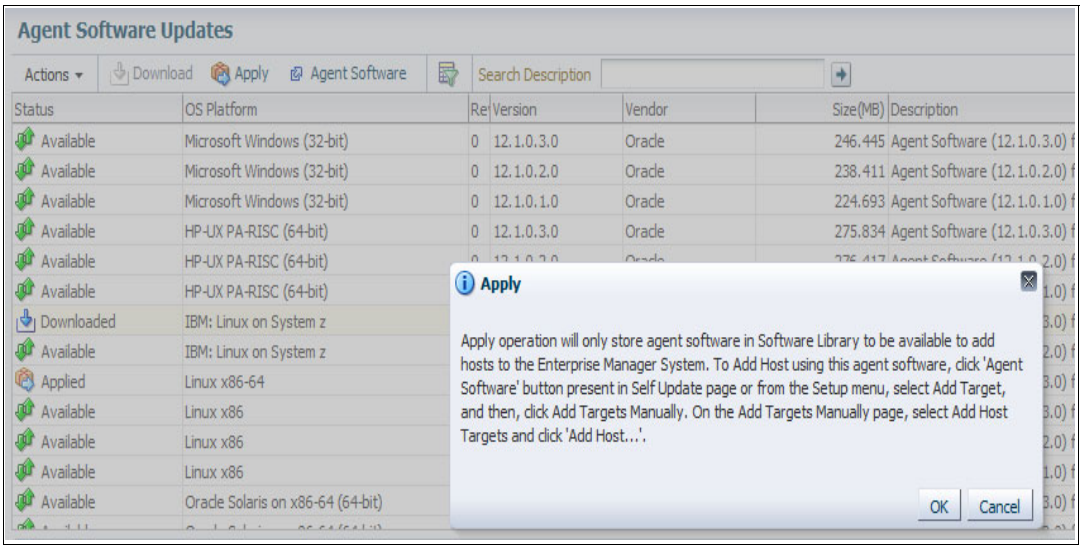


Figure 5-34 Confirm the apply step

8. This step stages the agent software in the Software Library and makes it available to the Add Targets wizard, which we used to install the agent on System z Linux host machines. Figure 5-35 shows the confirmation that the job was submitted.

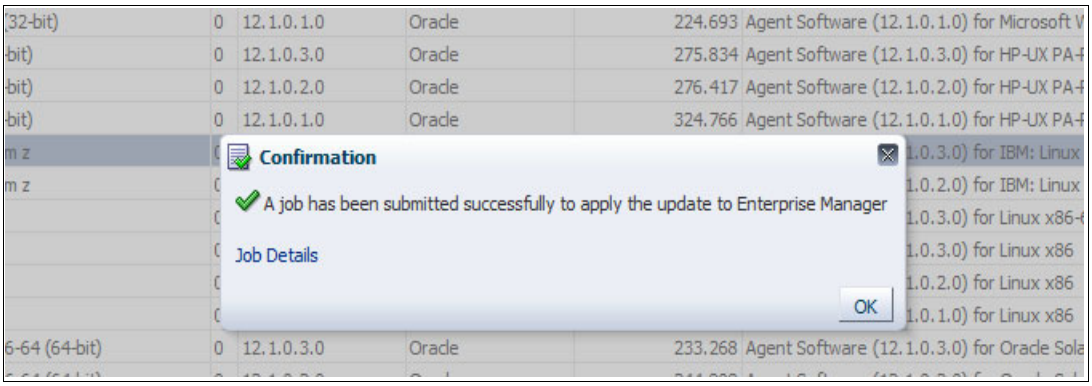


Figure 5-35 Confirmation of the job submitted

9. After the job completes, the status is now Applied, as shown in Figure 5-36 on page 99.

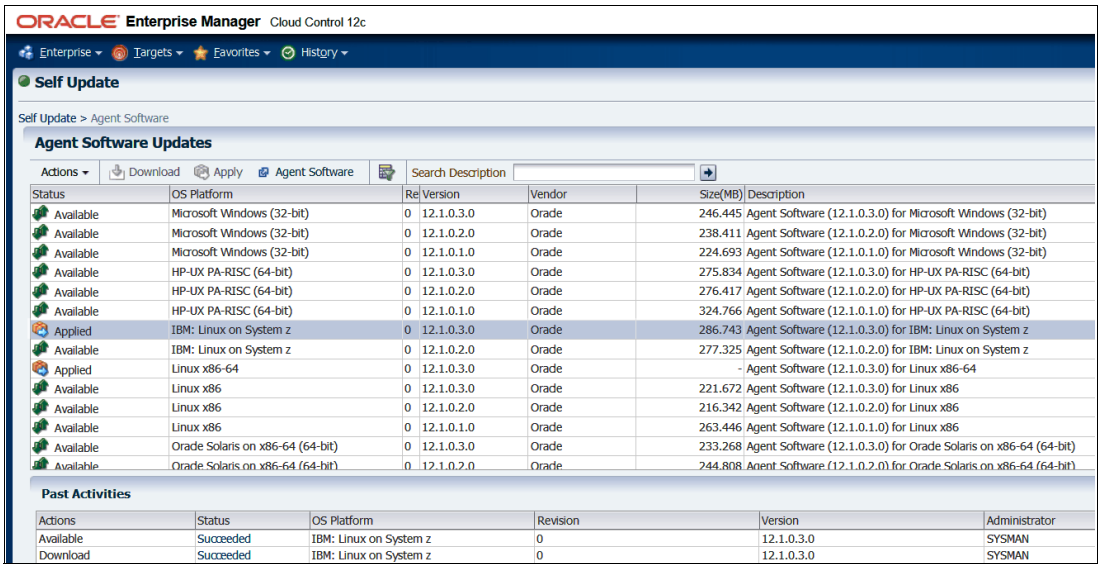


Figure 5-36 List of agents that are applied

This completes the online update process for the Management Agent Software at the Enterprise Manager Cloud Control. Now, the agent is available to deploy and monitor the Oracle databases on Linux of System z hosts.

5.4 Updating the agent at the Enterprise Manager Cloud Control to monitor Oracle Databases on Linux on System z (offline)

Section 5.3, “Updating the agent at the Enterprise Manager Cloud Control to monitor Oracle Databases on Linux on System z (online)” on page 90 showed the steps to update the Management Agent Software library in online mode. If the internet connection is not available on the OMS host server, then you must follow the offline procedures that are outlined in this section to update the Management Agent Software library.

In the following example, we show how the Linux on System z agent is acquired in offline mode on an Enterprise Manager Cloud Control running on an x86-64 Linux architecture.

5.4.1 Acquiring the Linux on System z agent in offline mode

In the following example, we show how the Software Library can be updated in offline mode on an Enterprise Manager Cloud Control running on an x86-64 Linux architecture to get the management agent for Linux on System z. Oracle requires that you use the Enterprise Manager Command-Line Interface (emcli) to update the Enterprise Manager Cloud Control Software updates.

In general, the following operations are performed:

- Verify that Enterprise Manager Cloud Control is in offline mode.
- Update the available agents in Enterprise Manager Cloud Control by using the Self Update feature.
- Use emcli to update the available software.

- Acquire Software Updates offline.
- Acquire Management Agent Software offline.

Verifying that Enterprise Manager Cloud Control is in offline mode

You must ensure that Cloud Control is set to the offline mode.

Click **Setup** → **Provisioning and Patching** → **Offline Patching**, and then change the setting for Connection to **Offline**, as shown in Figure 5-37.

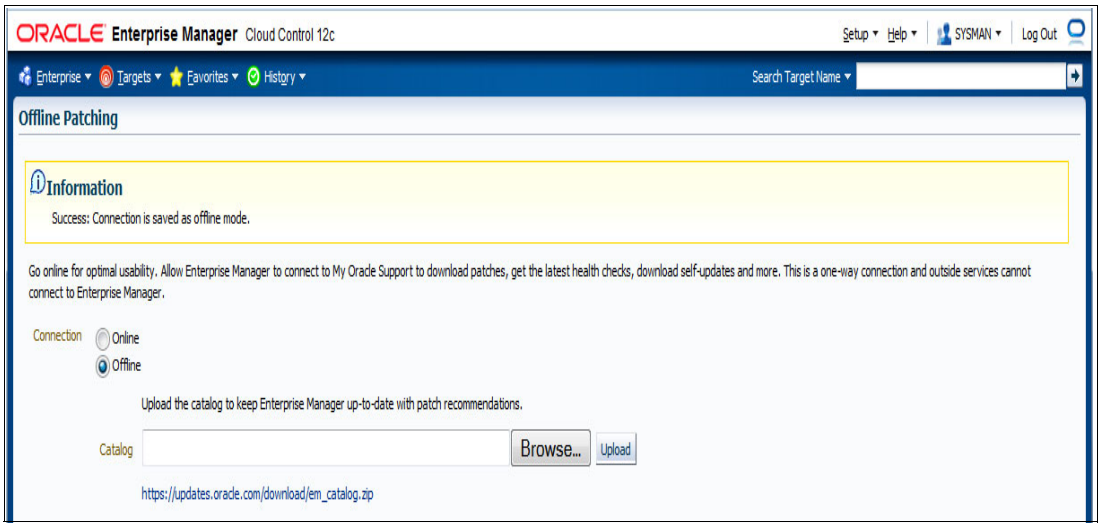


Figure 5-37 Offline settings

Updating the agents in Enterprise Manager Cloud Control using the Self Update feature

By default, only the Management Agent software for the OMS host platform is downloaded and applied. The other host agents' availability must be checked by using Enterprise Manager Cloud Control by using the Self Update feature. Complete the following steps:

1. To get the complete list of available updates for the agent software, click **Setup** → **Extensibility** → **Self Update**, and then click **Check Updates**. A dialog box opens and shows the URL that you use to download a catalog of all the updates for the agents. (Figure 5-38 on page 101).

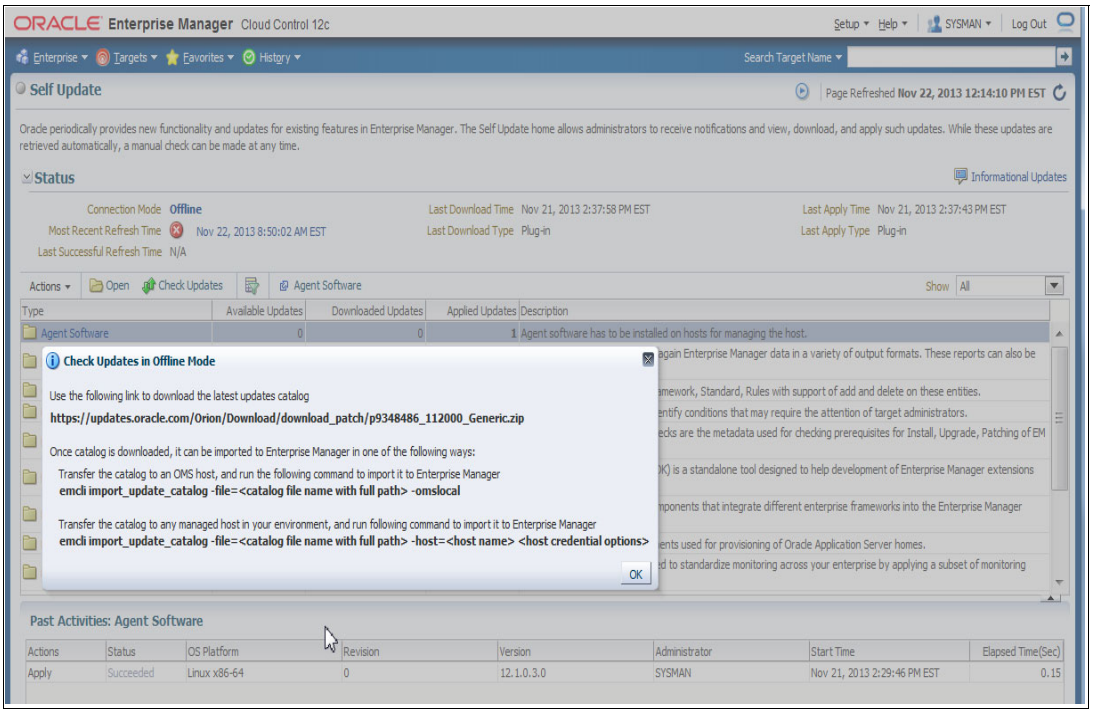


Figure 5-38 Check updates in offline mode

2. From any computer that has an internet connection, download the catalog file using the URL. Figure 5-39 shows the dialog box for downloading the catalog updates. Copy the downloaded compressed file to the Enterprise Manager Cloud Control Server where the OMS is running.

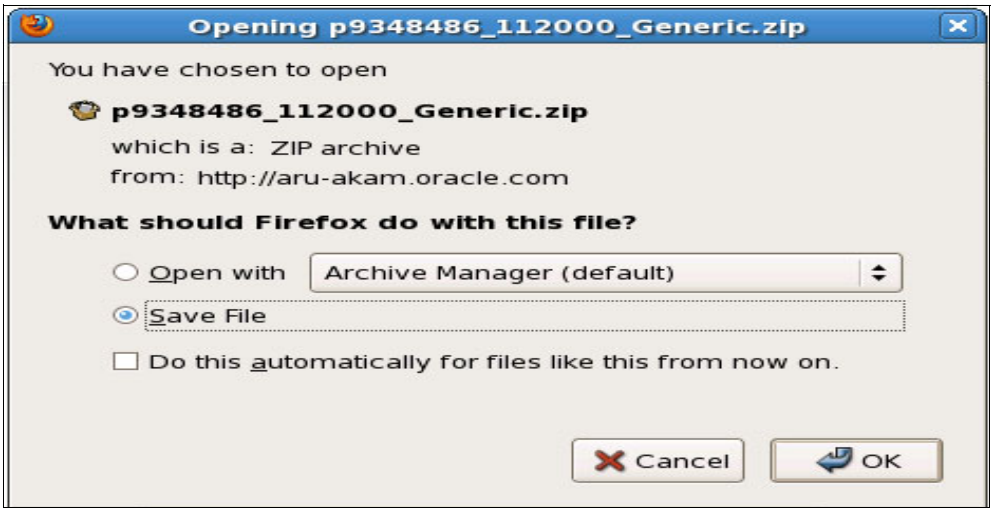


Figure 5-39 Save the compressed file

The name of the compressed file in our example is `p9348486_112000_Generic.zip`.

Using emcli to update the available software

Oracle provides the emcli command-line utility to perform some of the Enterprise Manager Cloud Control functions. This utility is installed and configured during OMS installation.

To update the available software by using emcli, complete the following steps:

1. Run emcli to log in (from OMS home) (Figure 5-40).

```
[oracle@zs3x07-l1 oms]$ bin/emcli login -username=sysman
Enter password

Login successful
[oracle@zs3x07-l1 oms]$
```

Figure 5-40 emcli login

2. Synchronize Enterprise Manager CLI by running **`emcli sync`** (Figure 5-41).

```
[oracle@zs3x07-l1 oms]$ pwd
/u01/app/mw/oms
[oracle@zs3x07-l1 oms]$ bin/emcli sync
Synchronized successfully
[oracle@zs3x07-l1 oms]$
```

Figure 5-41 emcli sync

3. Ensure that the Software Library is configured in the system by clicking **Setup** → **Select Provisioning and Patching** → **Software Library**, as shown in Figure 5-42. In our case, `/u01/app/swlib` is used for Software Library.

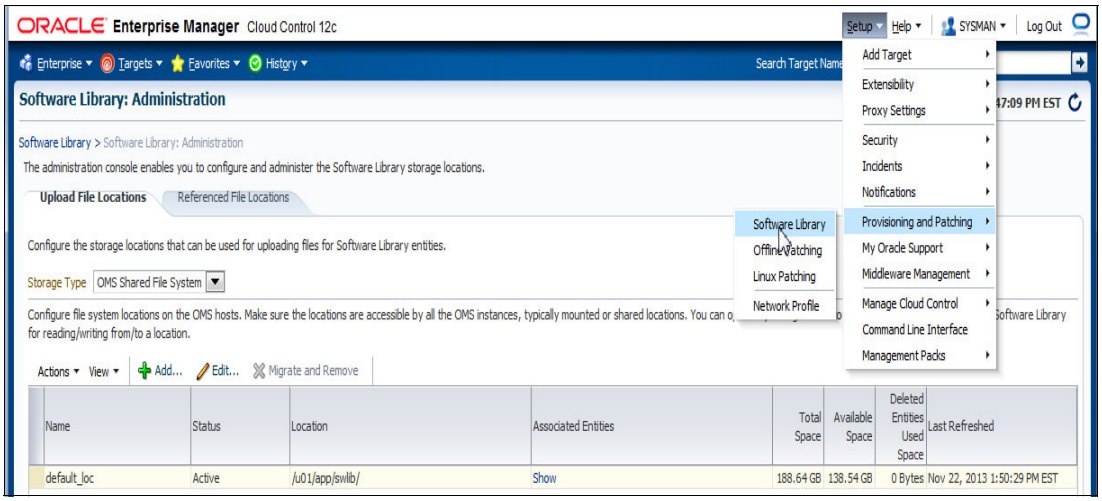


Figure 5-42 Software Library Administration

4. To import the downloaded compressed archive in to the Oracle Management Service instance, run **`emcli import_update_catalog`**, as shown in Figure 5-43 on page 103.

```
[oracle@zs3x07-l1 oms]$ bin/emcli import_update_catalog -omslocal -file=/u01/p93
48486_112000_Generic.zip
Processing catalog for Middleware Profiles and Gold Images
Processing update: Middleware Profiles and Gold Images - Three Fusion Middleware
 Provisioning Profiles with different heap size configuration
Processing catalog for Agent Software
Processing update: Agent Software - Agent Software (12.1.0.3.0) for Microsoft Wi
ndows (32-bit)
Processing update: Agent Software - Agent Software (12.1.0.2.0) for Microsoft Wi
ndows (32-bit)
Processing update: Agent Software - Agent Software (12.1.0.1.0) for Microsoft Wi
ndows (32-bit)
Processing update: Agent Software - Agent Software (12.1.0.3.0) for HP-UX PA-RIS
C (64-bit)
Processing update: Agent Software - Agent Software (12.1.0.2.0) for HP-UX PA-RIS
C (64-bit)
Processing update: Agent Software - Agent Software (12.1.0.1.0) for HP-UX PA-RIS
C (64-bit)
Processing update: Agent Software - Agent Software (12.1.0.3.0) for Linux x86
Processing update: Agent Software - Agent Software (12.1.0.2.0) for Linux x86
Processing update: Agent Software - Agent Software (12.1.0.1.0) for Linux x86
Processing update: Agent Software - Agent Software (12.1.0.3.0) for Oracle Solar
is on x86-64 (64-bit)
```

Figure 5-43 emcli import_update_catalog

5. After the command completes, you can see that the agents are shown as available in the Self Update window, as shown in Figure 5-44. Click **Setup** → **Extensibility** → **Self Update**, select the entity type **Agent Software**, and select **Open** from the Action menu. The entity type page shows agent software for different platforms, as shown in Figure 5-44.

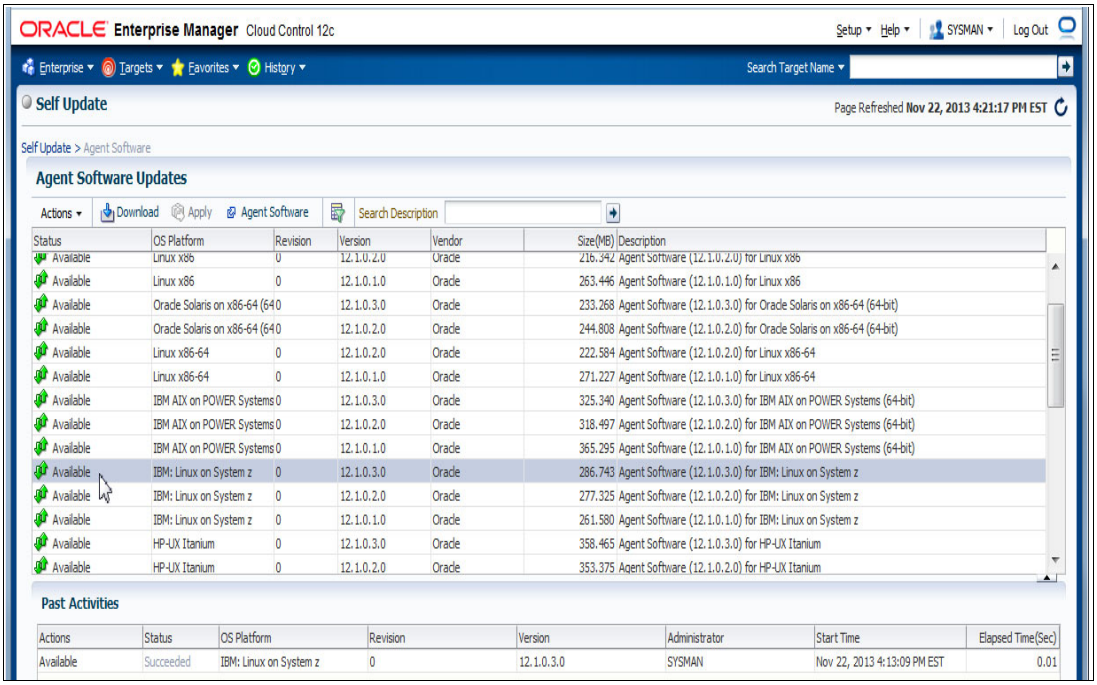


Figure 5-44 List of software updates that are available

Acquiring the Management Agent Software offline

To acquire the Management Agent Software offline, complete the following steps:

1. Select your OS platform and version. In our example, we select IBM: Linux on System z for the OS Platform and 12.1.0.3 for the version from the list of available updates.
2. A dialog box opens and provides a link to download the selected agent and instructions about how to import the agent software updates into Enterprise Manager, as shown in Figure 5-45. Using this link, download the compressed file to any computer with an internet connection (Figure 5-46) and copy the downloaded compressed file to the Enterprise Manager Cloud Control Server where the OMS is running.

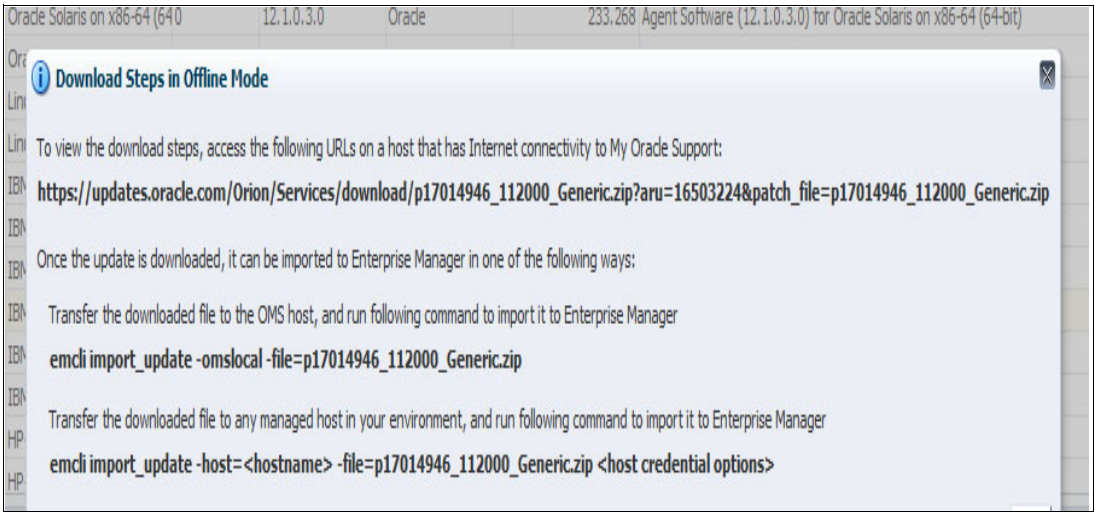


Figure 5-45 Download the agent compressed file - part 1

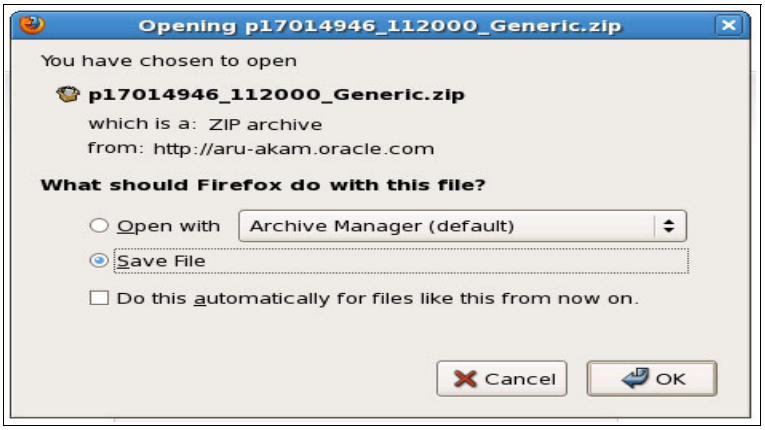


Figure 5-46 Download the agent compressed file - part 2

3. Run **`emcli`** to log in (from OMS home) (Figure 5-47).

```
[oracle@zs3x07-11 oms]$ bin/emcli login -username=sysman
Enter password

Login successful
[oracle@zs3x07-11 oms]$
```

Figure 5-47 emcli login

4. Synchronize the Enterprise Manager CLI by running **`emcli sync`** (Figure 5-48).

```
[oracle@zs3x07-l1 oms]$ pwd
/u01/app/mw/oms
[oracle@zs3x07-l1 oms]$ bin/emcli sync
Synchronized successfully
[oracle@zs3x07-l1 oms]$
```

Figure 5-48 emcli sync

5. Run **`emcli import_update`** to specify the absolute location for the downloaded patch file and **`omslocal`** options, as shown in Figure 5-49.

```
[oracle@zs3x07-l1 oms]$ bin/emcli import_update -omslocal -file=/u01/p17014946_1
12000_Generic.zip
Processing update: Agent Software - Agent Software (12.1.0.3.0) for IBM: Linux o
n System z
Successfully uploaded the update to Enterprise Manager. Use the Self Update Cons
ole to manage this update.
[oracle@zs3x07-l1 oms]$
```

Figure 5-49 emcli import_update

This step completes the Agent Updates in offline mode. Now, in the Self Update window the status is shown as “Downloaded”, as shown in Figure 5-50 for the “IBM: Linux on System z” agent type.

6. Click **Apply** for the Downloaded Agent, as shown in Figure 5-50. This step stages the agent software in the Software Library and makes it available to the Add Targets wizard, which we used to install the agent on System z Linux host machines in our example.

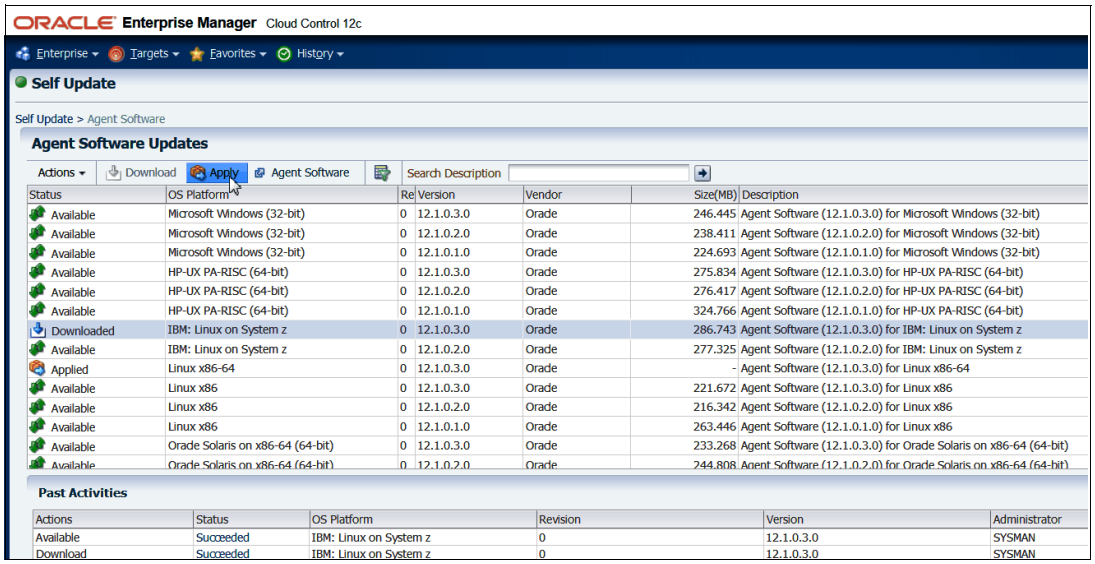


Figure 5-50 Agent is applied

7. Confirm the Apply action to submit the job, as shown in Figure 5-51.

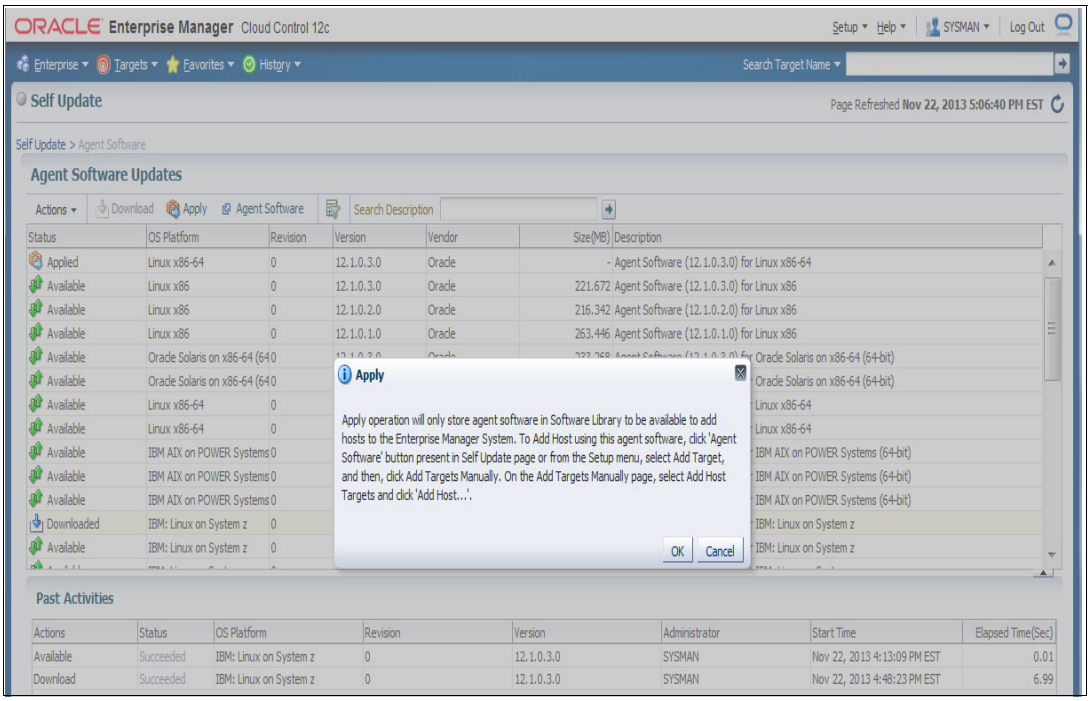


Figure 5-51 Apply confirmation

8. Wait for the job to complete (Figure 5-52).

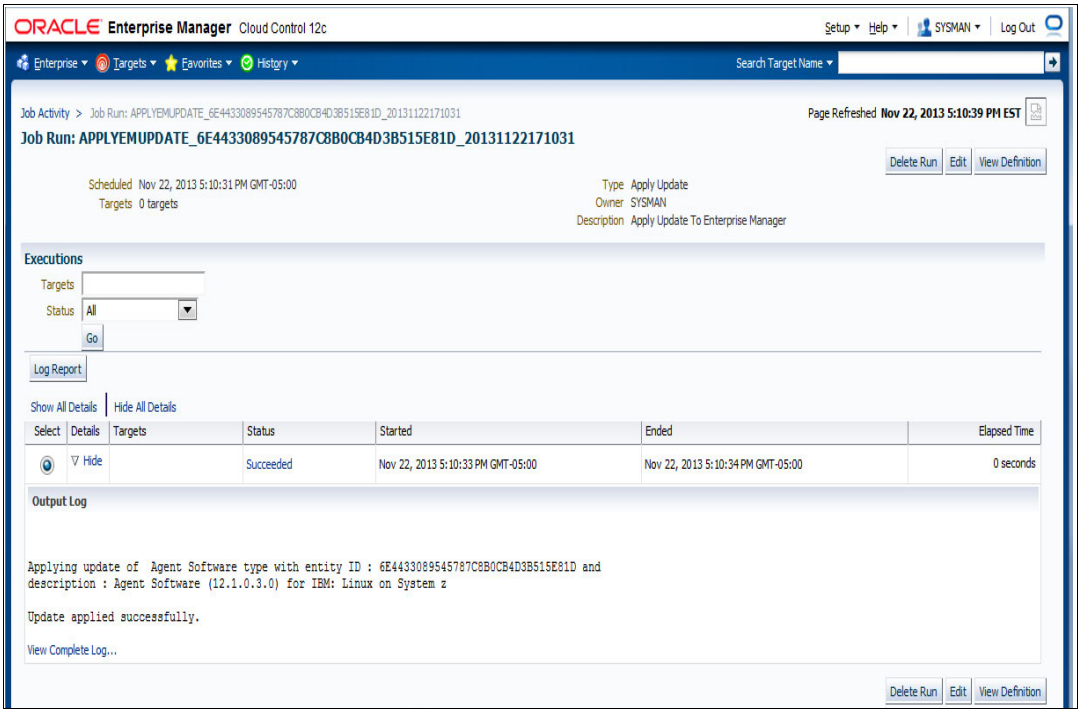


Figure 5-52 Agent Apply job is finished

After the job is complete, the status is Applied, as shown in Figure 5-53 on page 107.

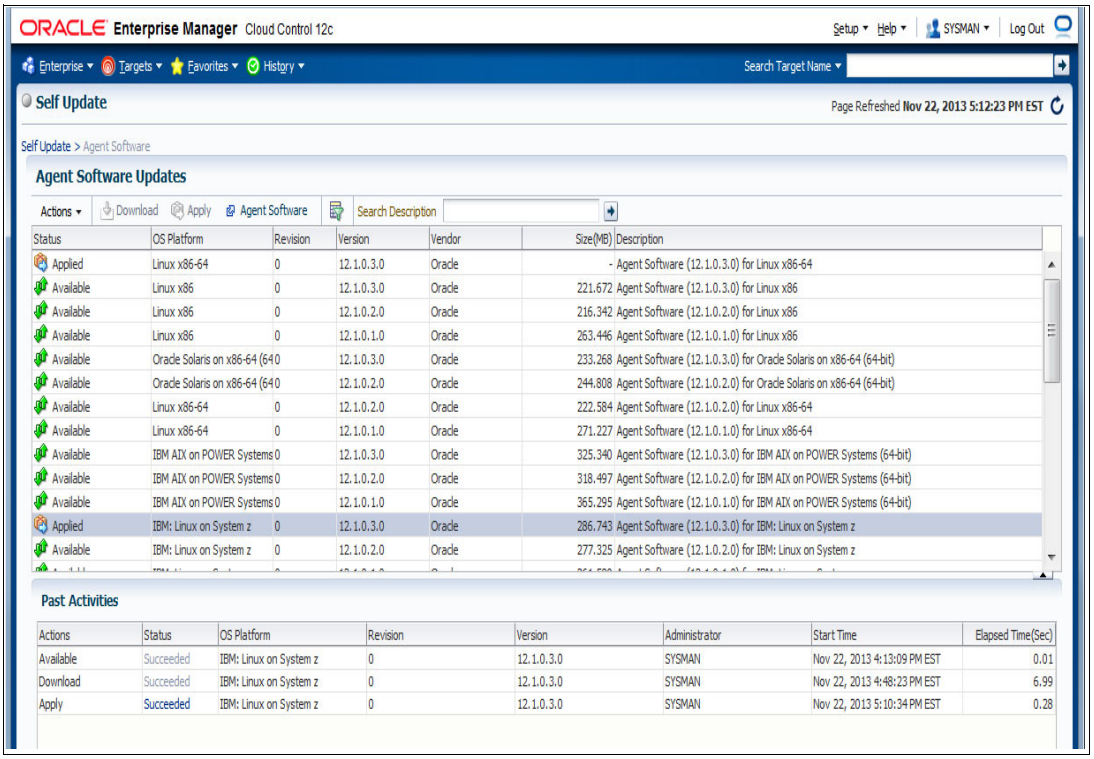


Figure 5-53 Agent is now available

The agent is available to deploy and monitor the Oracle databases on Linux on System z hosts.

5.5 Deploying the agents from the Cloud Control console

Oracle Management Agent 12c for Linux on System z hosts can be deployed from the Enterprise Manager Cloud Control 12c console or by the silent installation method. This section outlines the processes to deploy the agents from the Enterprise Manager Cloud Control 12c console. Oracle recommends using the Add Host Targets wizard, which converts an unmanaged host to a managed host in the Enterprise Manager system by installing an Oracle Management Agent 12c. For Oracle Real Application Clusters (RACs) with multiple nodes, the Management Agent must be installed on each of the nodes separately in the Add Host Targets wizard by adding each node explicitly as a destination host.

For the hardware and software requirements for installing the Cloud Control Agent, see the relevant Oracle documentation.

The network between the Cloud Control Server, where the OMS is running, and the destination hosts should be accessible.

In our example, we used the ping by host name method to ensure that both the OMS Server and hosts can be reached.

To install Oracle Management Agent 12c for Linux on System z from Enterprise Manager Cloud Control 12c, complete the following steps:

1. To add/install an agent on a host, the software distribution of the agent corresponding to the host's platform must be available in the Software Library. In our example, we verified the availability of Linux on System z agents' availability in the Enterprise Manager Cloud Control Server as follows:

   a. Log on to Enterprise Manager Cloud Control 12c.

   b. Click **Setup** → **Extensibility** → **Self Update** in the Status section of the Self Update window. Click the **Agent Software** type, as shown on Figure 5-54.

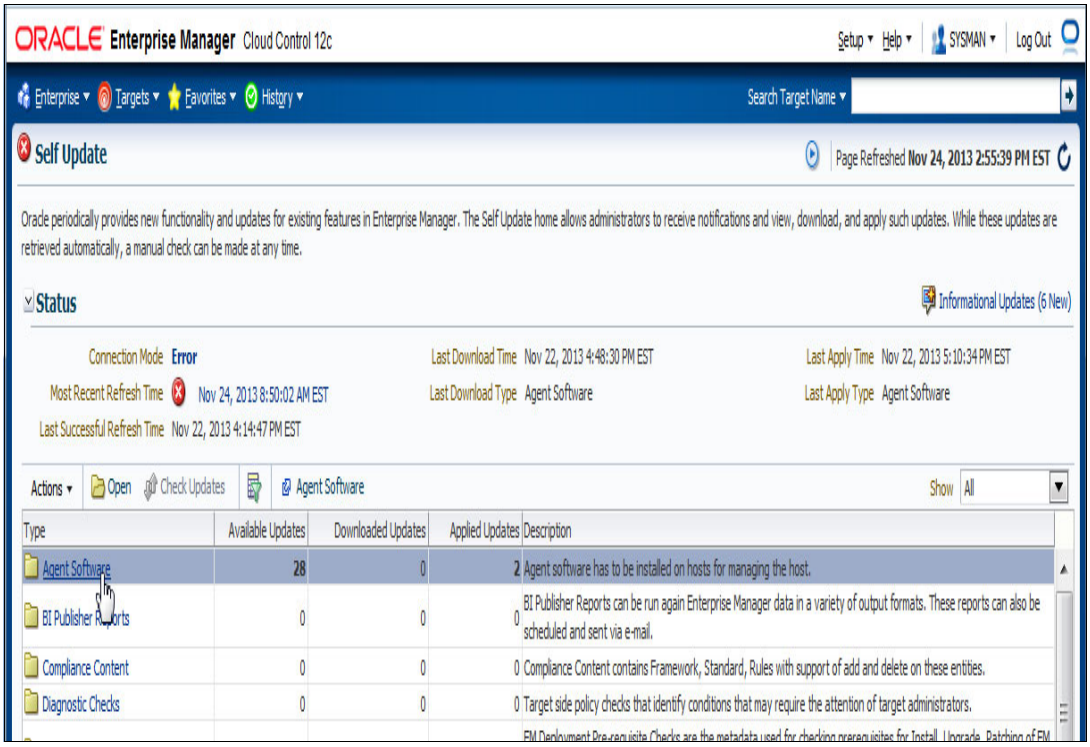


Figure 5-54 Select the agents

   c. You can see that the Agent Software for Linux on System z has a status of Applied in the Agent Software Updates section of Figure 5-55 on page 109. When we highlighted the rows, the bottom pane showed a status similar to when the agent software was available, downloaded, and applied.

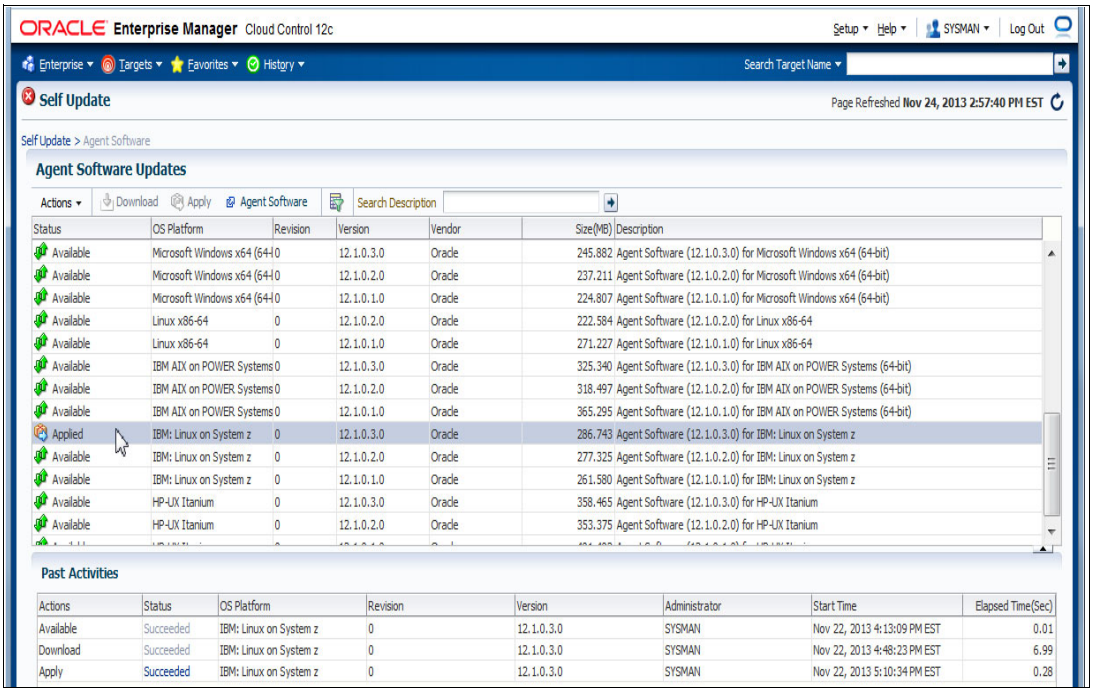


Figure 5-55 Status of the agent

2. Now you are ready to deploy the agent. Click **Setup** → **Add Target** → **Add Targets Manually** (Figure 5-56).

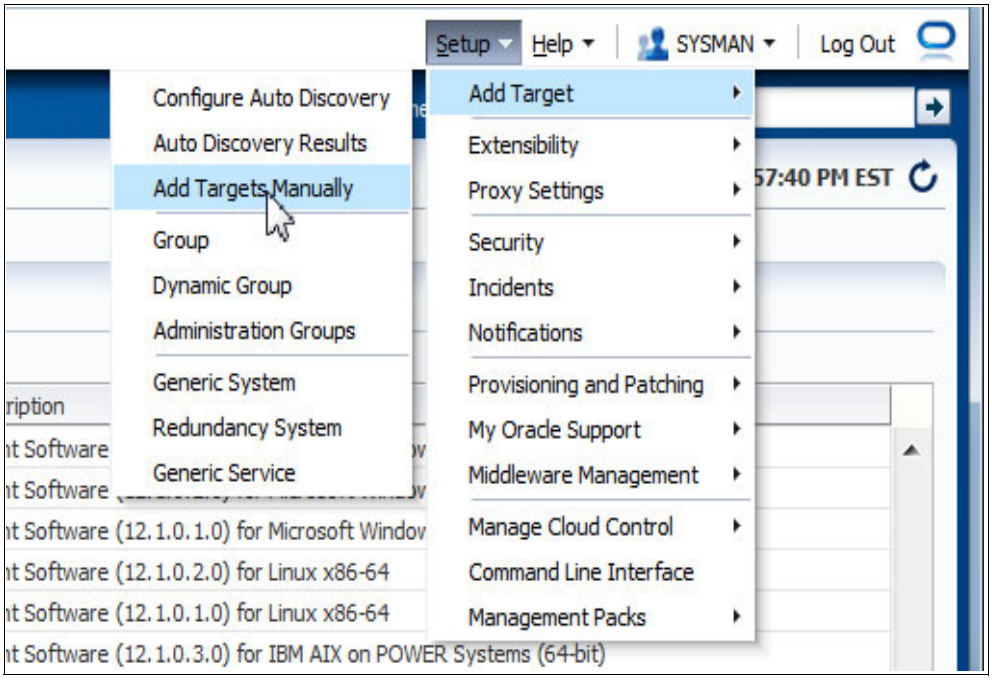


Figure 5-56 Add Targets Manually

3. On the Add Targets Manually window, select **Add Host Targets** and click **Add Host...**. (Figure 5-57).

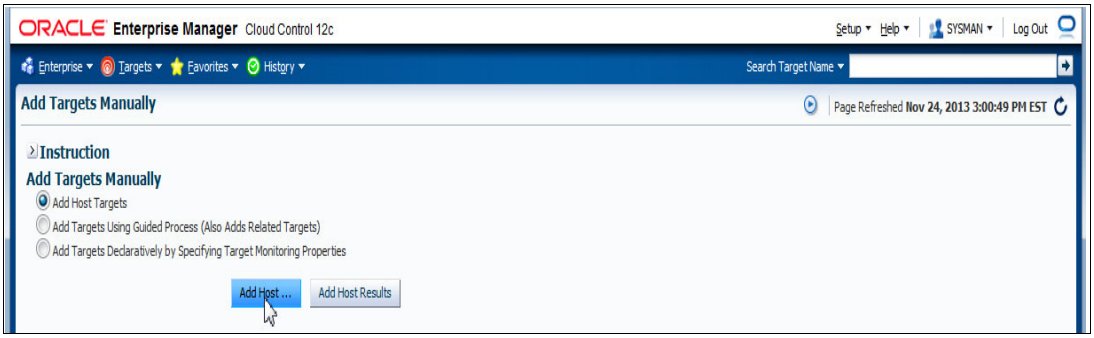


Figure 5-57 Add a host

4. In the Host and Platform window (Figure 5-58), we complete the following steps for our example:
   a. Accept the default name that is assigned for this session.
   b. Click **Add** and enter the fully qualified name of the host. We select IBM: Linux on System z as the platform of the host on where we wanted to install the Management Agent and click **Next**.

Figure 5-58 Add Host Targets: Host And Platform

5. In the Installation Details window, which is shown in Figure 5-59 on page 111, we complete the following steps:
   a. In the Installation Details section, for Installation Base Directory, we enter the absolute path to the base directory (the software binary files, security files, and inventory files of Management Agent are copied here). In our case, it is `/oracle/agentHome`.
   b. For Instance Directory, we accept the default instance directory location (all Management Agent-related configuration files can be stored here). In our case, it is `/oracle/agentHome/agent_inst`.

> **Note:** Maintain the instance directory inside the installation base directory.

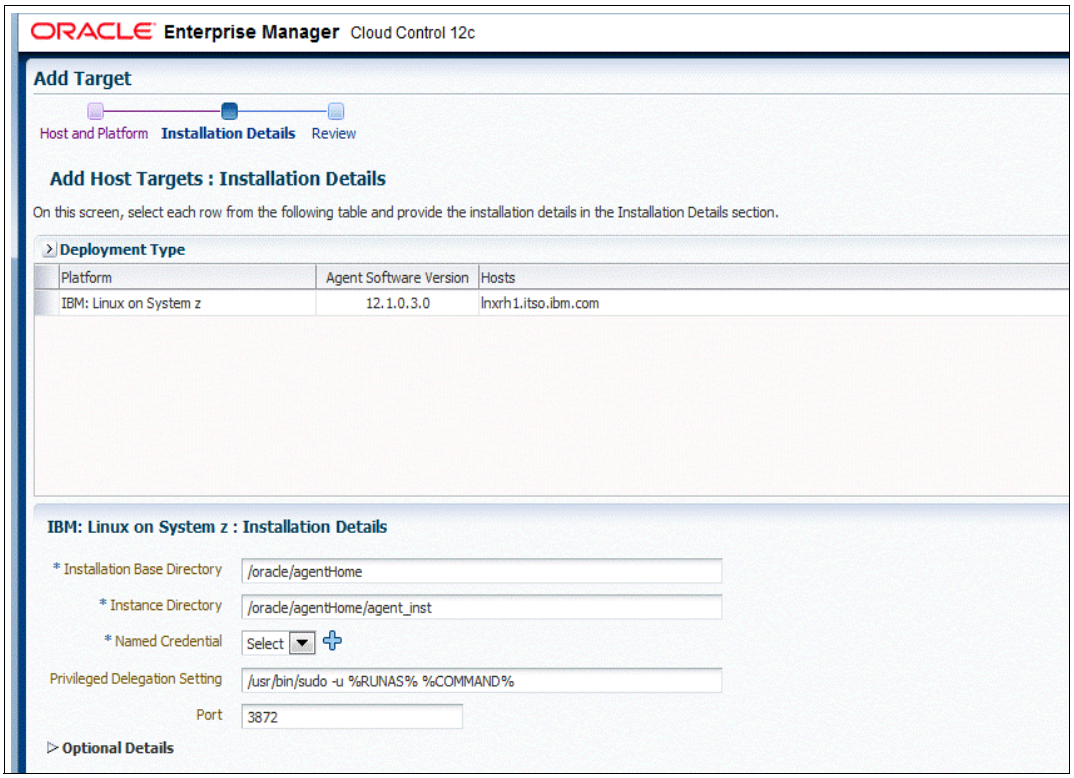


Figure 5-59 Installation Details

6. From Named Credential list, we add a profile whose credentials are used for setting up the SSH connectivity between the OMS and the remote host, and for installing a Management Agent, as shown in Figure 5-60, and then click **Next**.

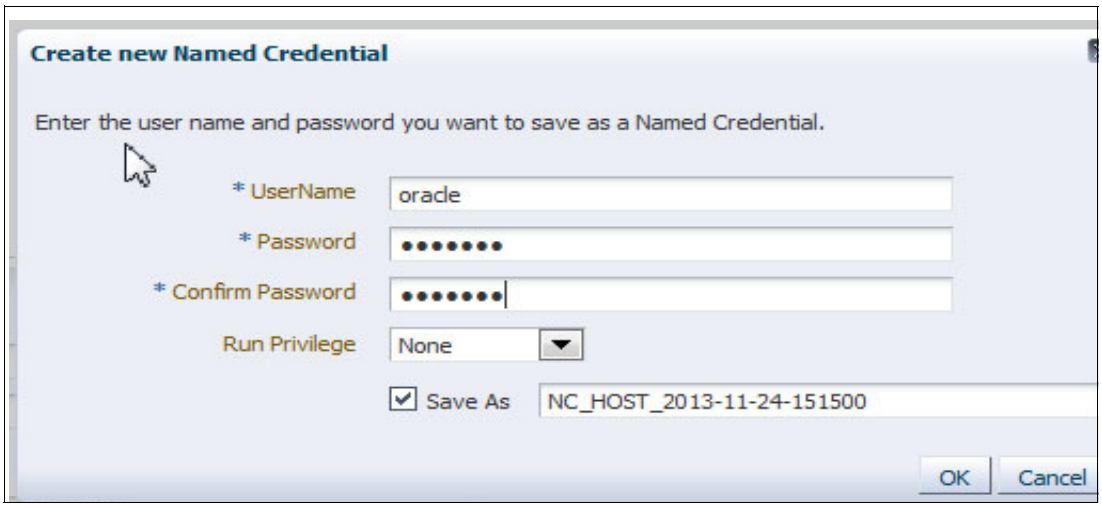


Figure 5-60 User name

7. In the Review window, which is shown in Figure 5-61, we review the details and then click **Deploy Agent** to install the Management Agent.

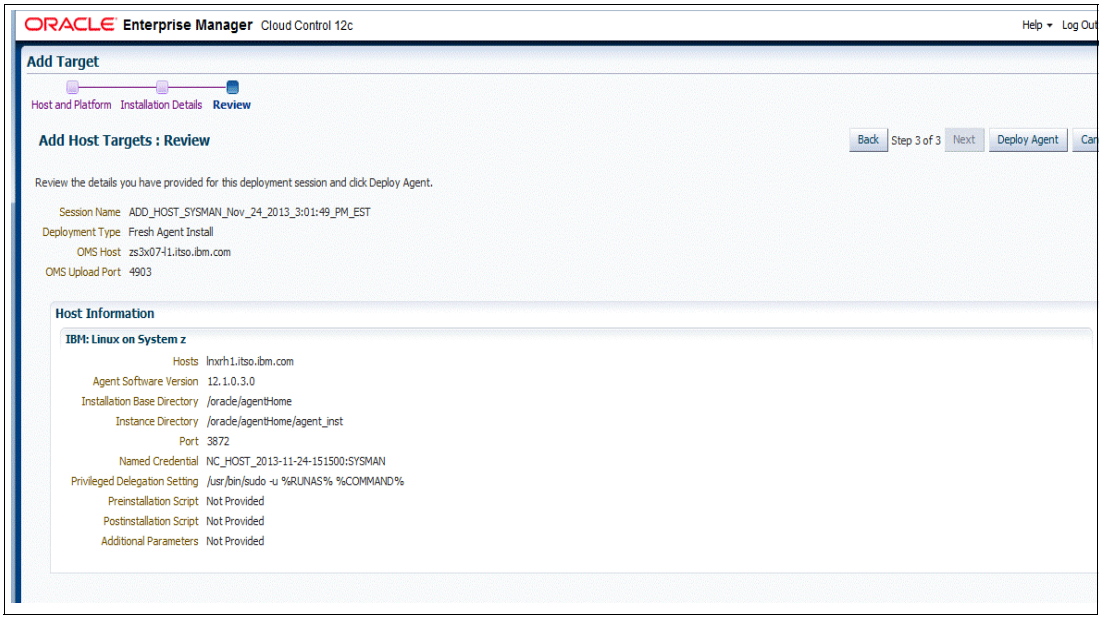


Figure 5-61 Review window

8. We can watch the progress of the installation in the Add Hosts Status window, which is shown in Figure 5-62.

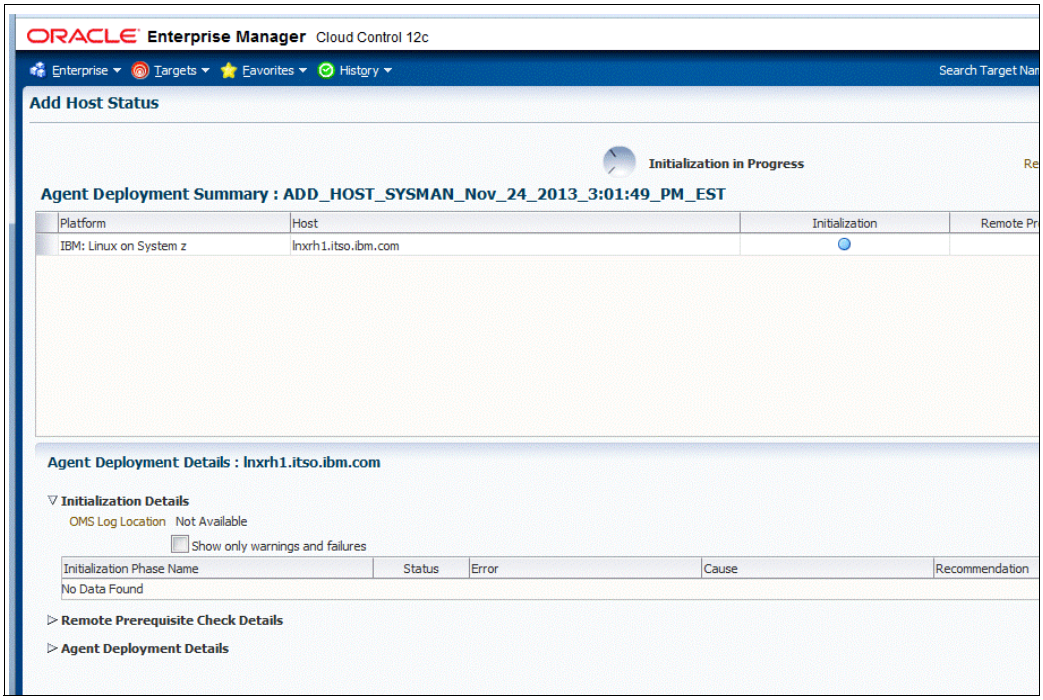


Figure 5-62 Add Host Status

9. During the prerequisite check stage, the deployment failed, and `root.sh` authorization messages were displayed (Figure 5-63 on page 113).

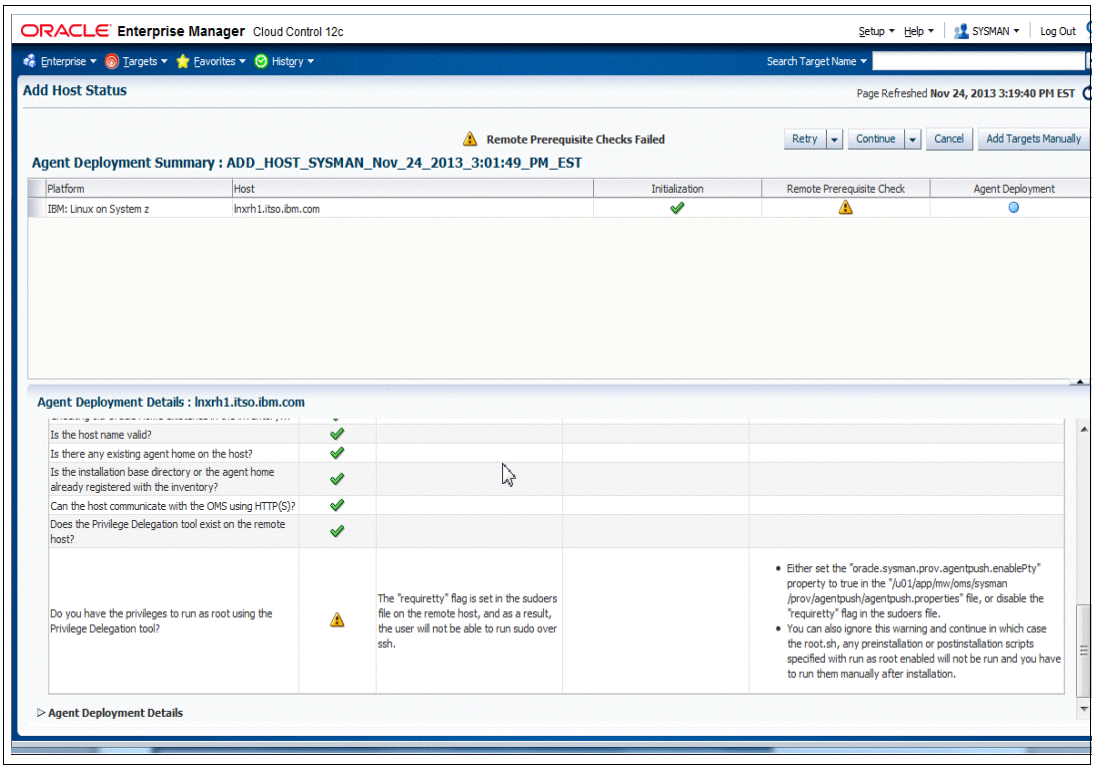


Figure 5-63 Prerequisite check

10. We continue the installation by selecting the **Continue all Hosts** option (Figure 5-64).

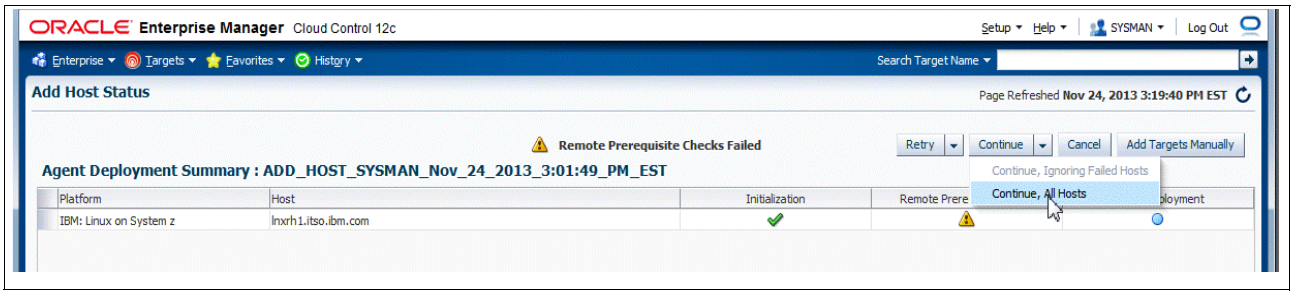


Figure 5-64 Continue the Host status option

11. The Agent Deployment Summary message displays when the process completes. The deployment of the agent shows the status that is shown in Figure 5-65.

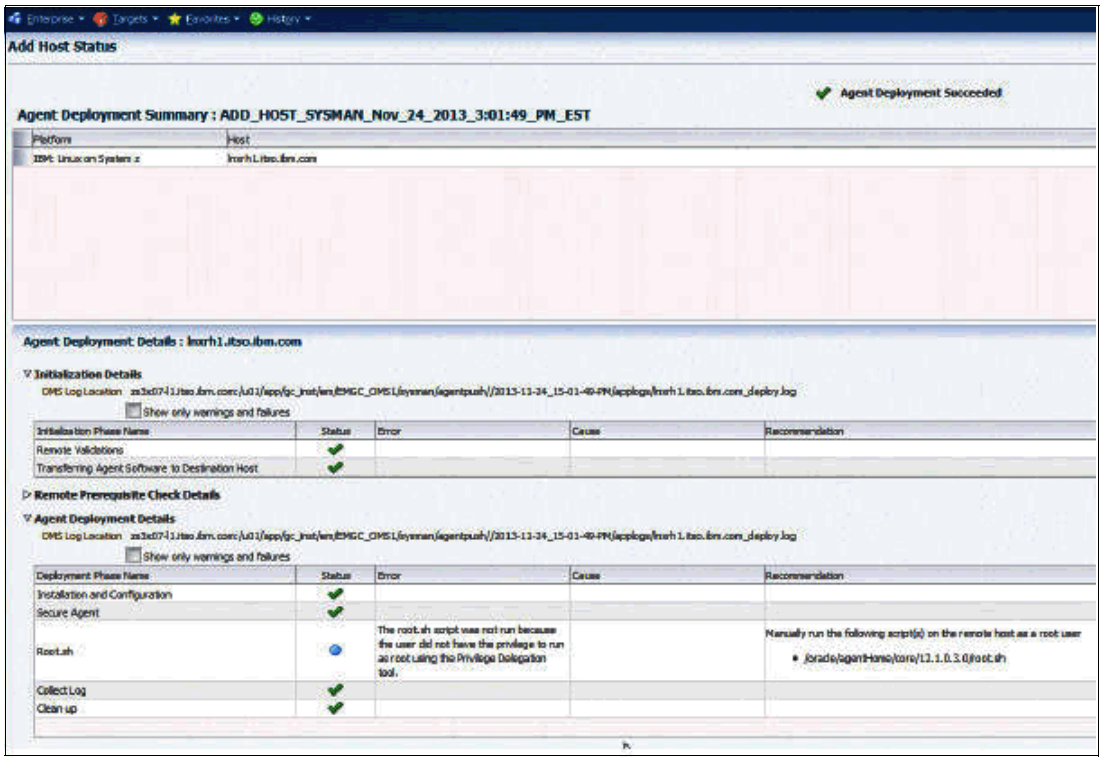


Figure 5-65 Host status

12. We run `root.sh` in the host location as recommended and then click **Done**.

13. To check the availability of the hosts, click **Targets** → **Hosts** in the Cloud Control window, as shown in Figure 5-66.

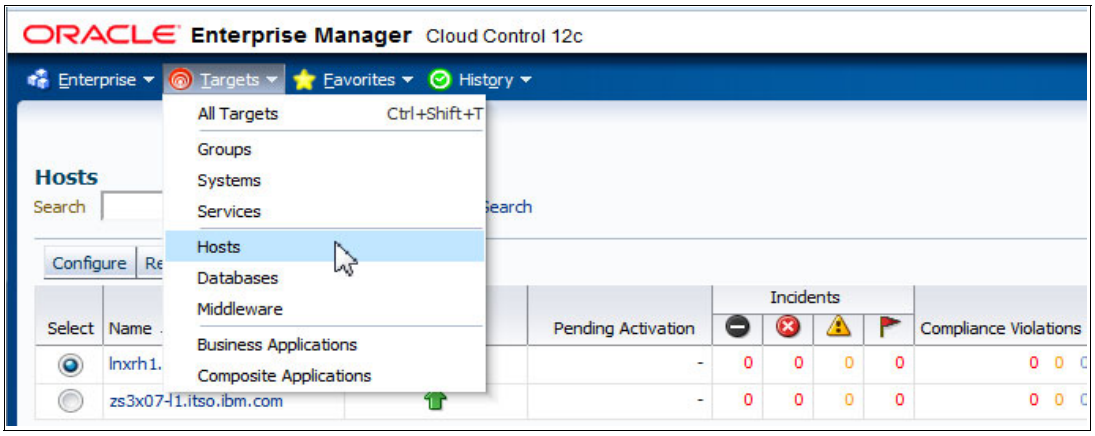


Figure 5-66 Host options

The availability of the hosts is shown in the Hosts window (Figure 5-67 on page 115).

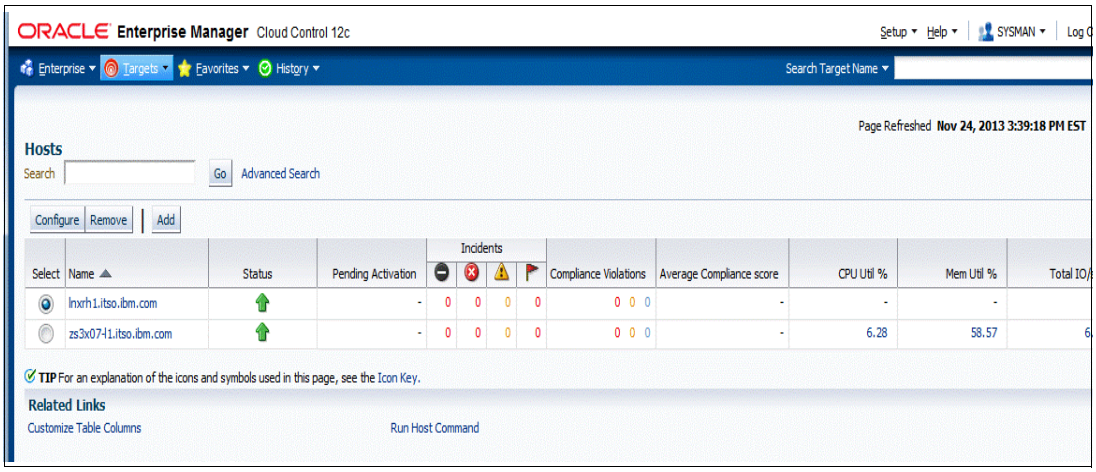


Figure 5-67 Availability of hosts

Oracle Management Agent 12c for Linux on System z hosts is deployed from Enterprise Manager Cloud Control 12c console.

5.6 Deploying the agents in silent mode

Oracle Management Agent 12c for Linux on System z hosts can be deployed from the Enterprise Manager Cloud Control 12c console or by the silent installation method. This section outlines the processes to deploy it in silent mode.

Installing a Management Agent in silent mode requires the Enterprise Manager CLI utility. Using Enterprise Manager CLI, you can install fresh Management Agents, install Shared Agents, and clone existing Management Agents.

To install Oracle Management Agent 12c for Linux on System z in silent mode, complete the following steps:

1. Run the **emcli** commands to check the list of supported platforms.
2. Run **emcli** to log in (from OMS home) (Figure 5-68).

```
[oracle@zs3x07-l1 oms]$ bin/emcli login -username=sysman
Enter password

Login successful
[oracle@zs3x07-l1 oms]$
```

Figure 5-68 emcli login

3. Synchronize Enterprise Manager CLI by running **`emcli sync`** (Figure 5-69).

```
[oracle@zs3x07-l1 oms]$ pwd
/u01/app/mw/oms
[oracle@zs3x07-l1 oms]$ bin/emcli sync
Synchronized successfully
[oracle@zs3x07-l1 oms]$
```

Figure 5-69 emcli sync

4. Ensure that the Software Library is configured and available in the system by running **`emcli list_add_host_platforms`** (Figure 5-70). This command lists the platforms for which the Management Agent software is available in Software Library.

   From the displayed output, you can see that IBM: Linux on System z, is available in the Enterprise Manager Cloud Control Server.

```
[oracle@zs3x07-l1 oms]$ bin/emcli list_add_host_platforms
Platform ID  Platform Name
226          Linux x86-64
209          IBM: Linux on System z
[oracle@zs3x07-l1 oms]$
```

Figure 5-70 emcli list add_host_platforms

5. Create named credentials for the “oracle” user on the target server, which are monitored by the **`emcli create_named_credential`** command with the parameters **`-cred_name`**, **`-auth_target_type`**, **`-cred-type,`** and **`-attributes`**, as shown in Figure 5-71.

```
[oracle@zs3x07-l1 oms]$ bin/emcli create_named_credential -cred_name=zs3x07-l1 -
auth_target_type=host -cred_type=HostCreds -attributes="HostUserName:oracle;Host
Password:ibmpass"
Credential ZS3X07-L1 created.
[oracle@zs3x07-l1 oms]$
```

Figure 5-71 emcli create_named_credential

6. Now, run **`submit_add_host`** to submit the Add Host command, as shown in Figure 5-72.

```
[oracle@zs3x07-l1 oms]$ bin/emcli submit_add_host -host_names=lnxrh1.itso.ibm.co
m -platform=209 -installation_base_directory=/oracle/agentHome -credential_name=
zs3x07-l1
An Add Host session with the name "ADD_HOST_SYSMAN_Nov_24_2013_9:26:57_PM_EST" h
as been submitted.
You can track the progress of this session using the command "emcli get_add_host
_status -session_name=ADD_HOST_SYSMAN_Nov_24_2013_9:26:57_PM_EST"
```

Figure 5-72 submit_add_host

7. Now, you can track the running of the **`submit_add_host`** command, as shown in Figure 5-73.

```
[oracle@zs3x07-l1 oms]$ bin/emcli get_add_host_status -session_name=ADD_HOST_SYS
MAN_Nov_24_2013_9:26:57_PM_EST
OverAll Status : Agent Deployment Succeeded

Host                Platform Name          Initialization  Remote Prerequisite
  Agent Deployment  Error
lnxrh1.itso.ibm.com  IBM: Linux on System z  Succeeded       Succeeded
  Succeeded
[oracle@zs3x07-l1 oms]$
```

Figure 5-73 submit_add_host status

8. After the job status is Succeeded, you can see that the host is added in the Enterprise Manager Cloud Control, as shown in Figure 5-74.

   The logs for the agent deployment at the target server can be found under the agent installation base directory `/oracle/agentHome/agent_inst/install/logs`.

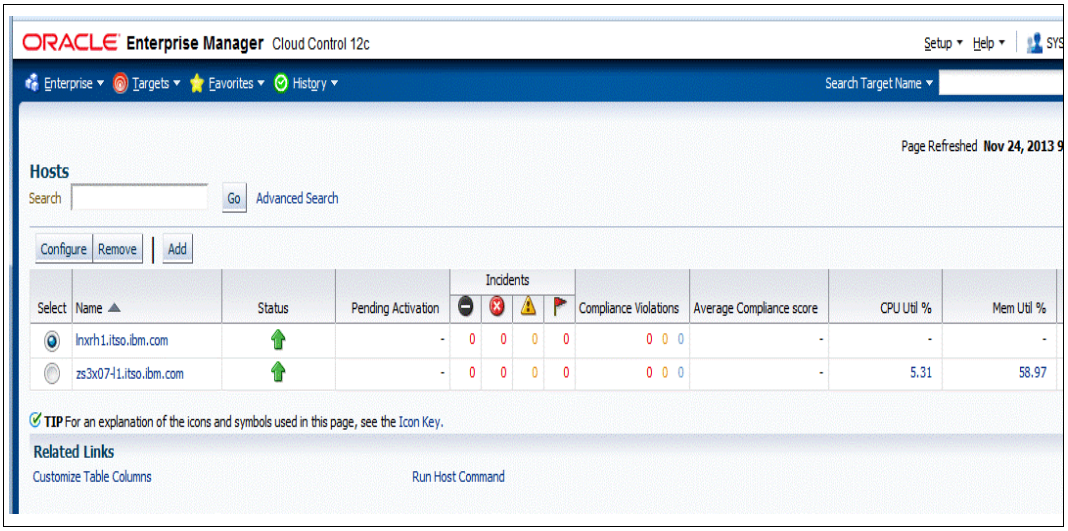


Figure 5-74 Host status

9. You can check the agent status by navigating to the Management Agent home at the target server and running the **`status`** command, as shown in Figure 5-75.

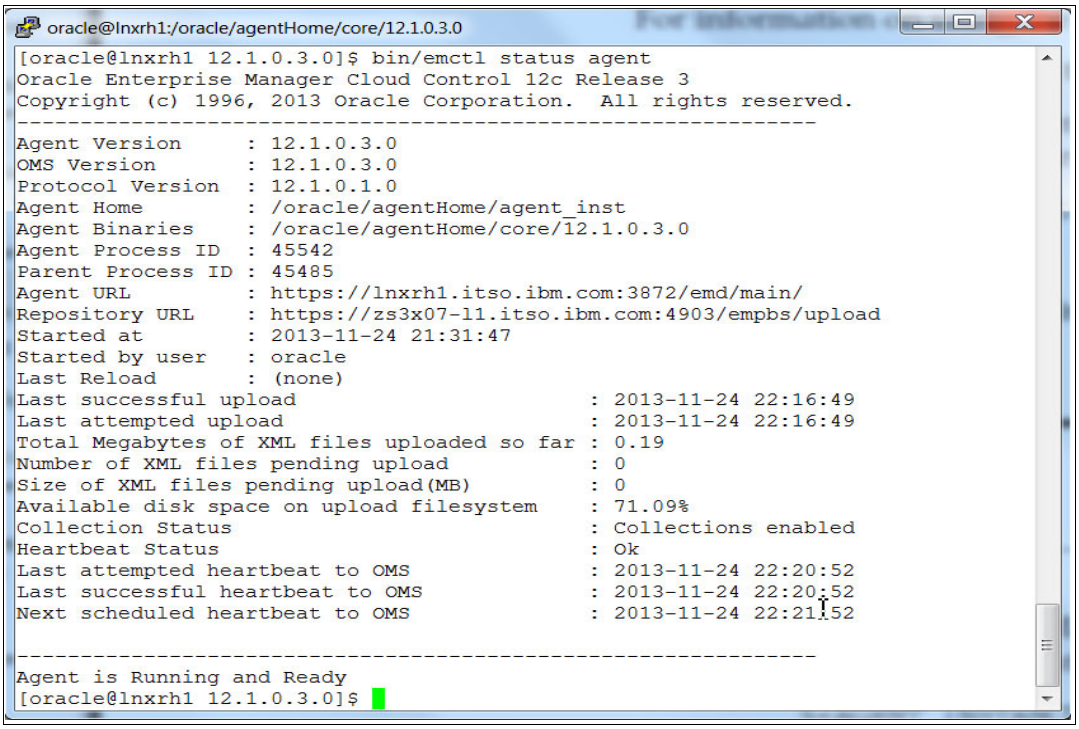


Figure 5-75 Agent status

10. You can check that the EMD upload completed successfully by navigating to the Management Agent home at the target server and running the **`upload agent`** command, as shown in Figure 5-76.

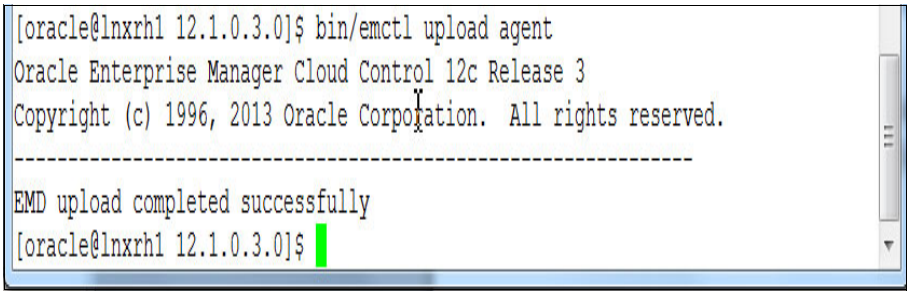


Figure 5-76 EMD Upload

11. To verify that the Management Agent is running, click **Setup** → **Manage Cloud Control** → **Agents** (Figure 5-77 on page 119).

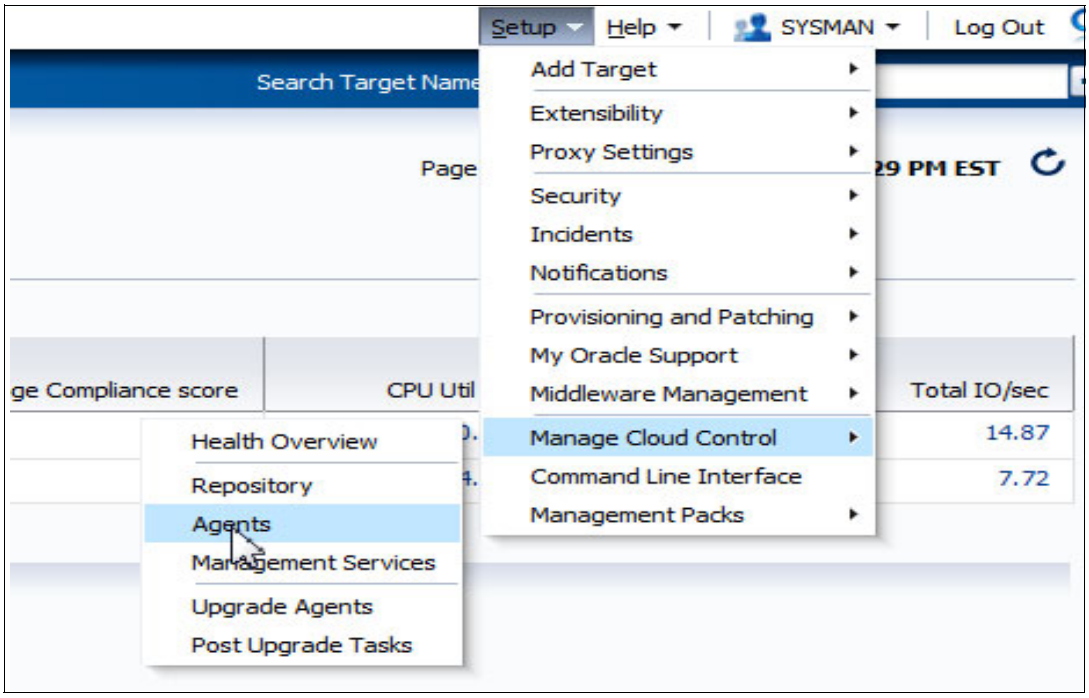


Figure 5-77 Agents

The Management Agent is running, as shown in Figure 5-78.

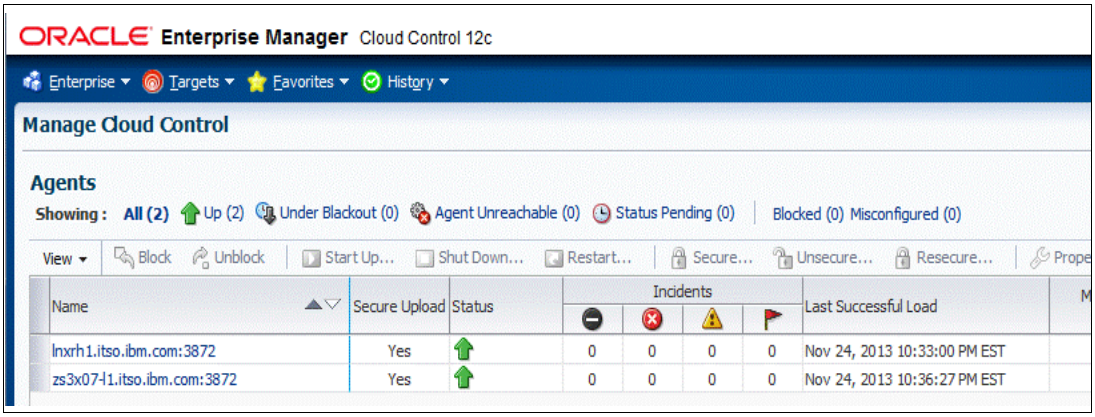


Figure 5-78 Agent status

5.7 Adding the databases for monitoring

After the agent for Linux on System z is deployed, you can discover the Oracle databases on that host for monitoring. To do so, complete the following steps:

1. In the Cloud Control window, click **Targets** → **Databases**, select **Search List** in the Databases section, and click **Add** (Figure 5-79).

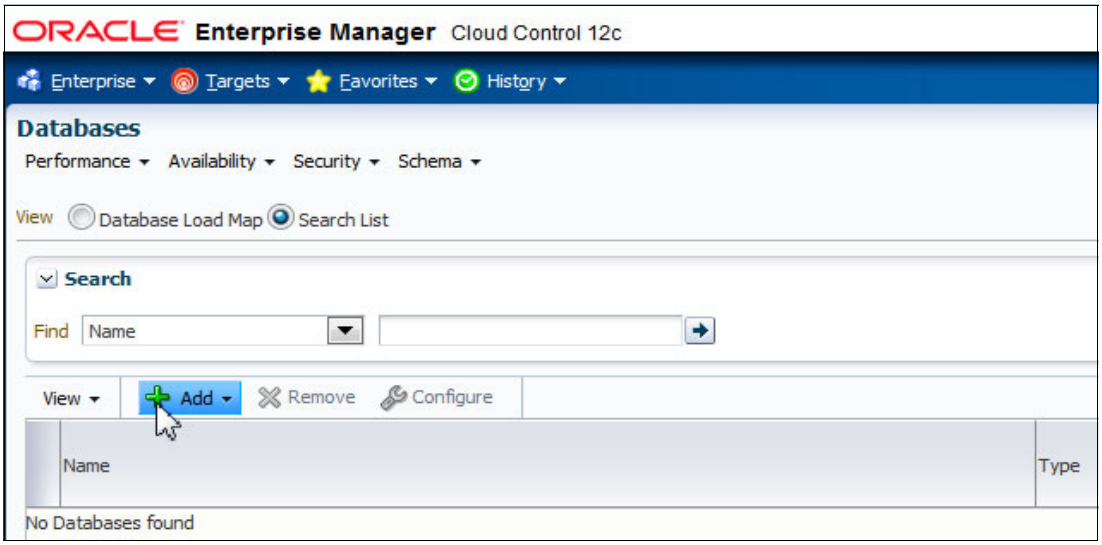


Figure 5-79 Discover the database target

2. In the Add Database Instance Target window, specify the Host window. In the Host field in our example, we specify the fully qualified host name, lnxrh1.itso.ibm.com, and click **Continue** (Figure 5-80).

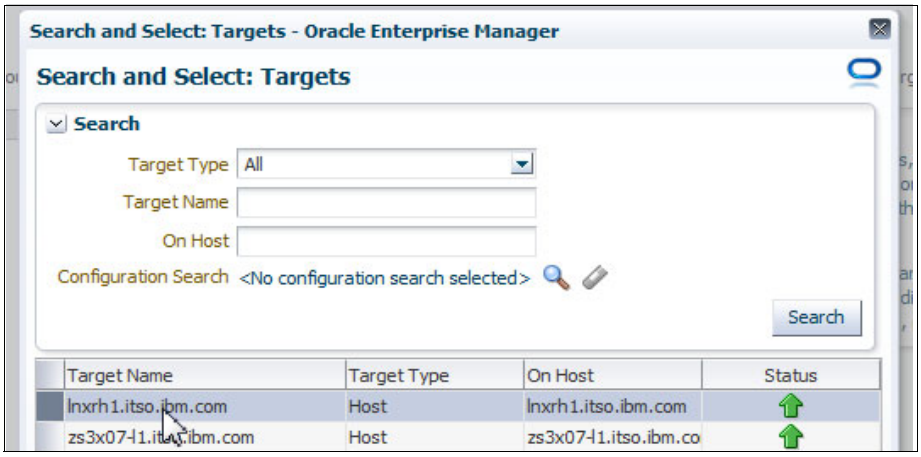


Figure 5-80 Select target

3. The agent discovers the database (orcl.itso.ibm.com) and the Listener, as shown in Figure 5-81.

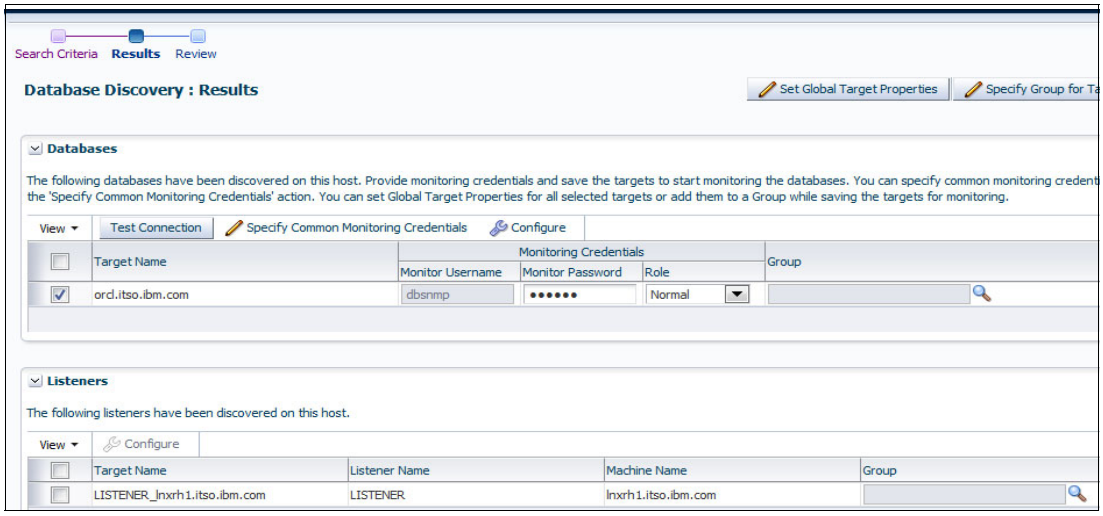


Figure 5-81 Database discovery results

4. Configure the database by selecting the Configure window at the orcl line and specifying the Database related parameters, as shown in Figure 5-82.

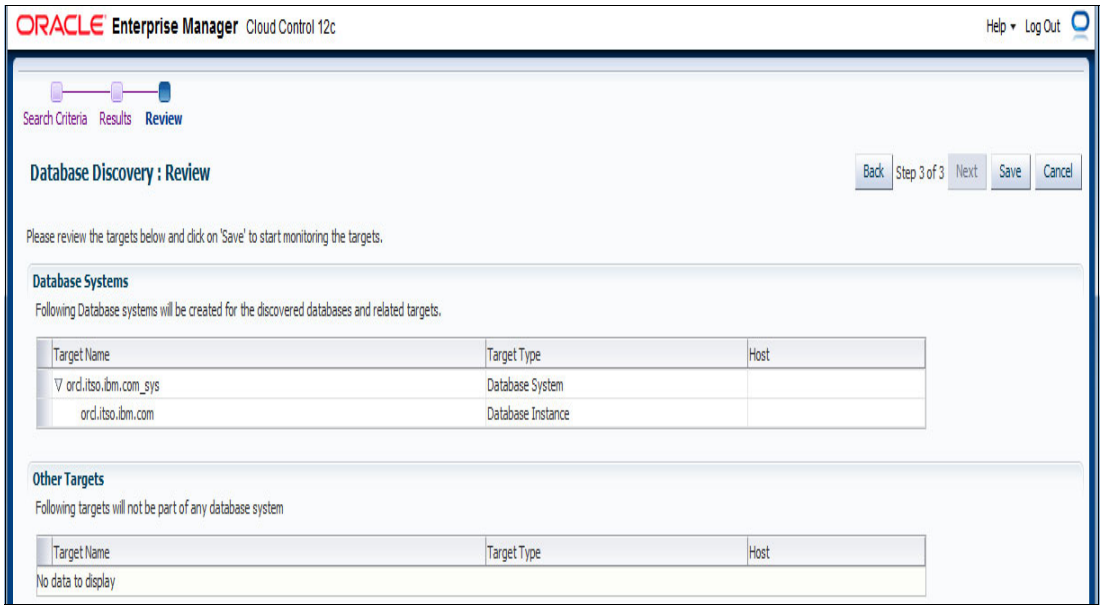


Figure 5-82 Discover the database review

5. Figure 5-83 shows a successful save.

Figure 5-83 Target saved

The database configuration is complete. You can monitor the databases running on Linux on System z in the Oracle Enterprise Manager Cloud Control, as shown in Figure 5-84.

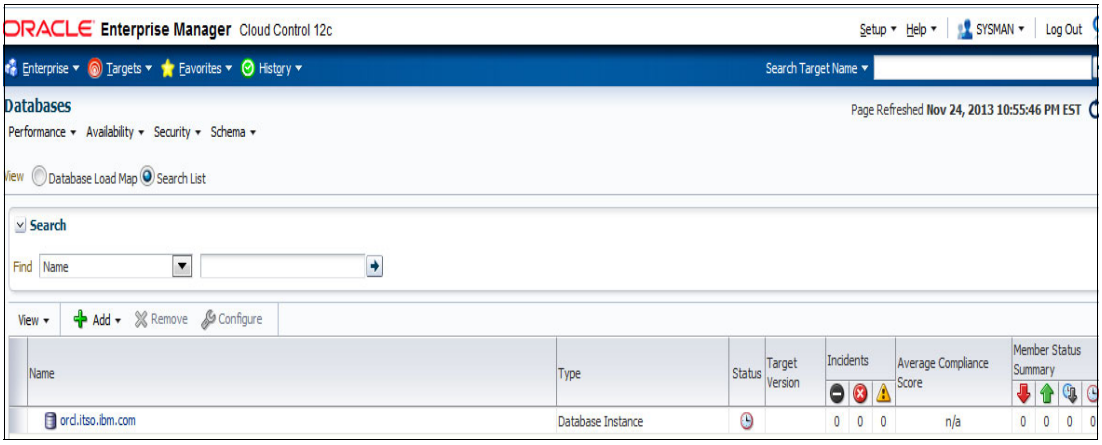


Figure 5-84 Discovered databases

5.8 Summary

In this chapter, we shared our experiences with installing a Cloud Control Server on an x86-based Linux server. We deployed the agents from there to monitor the databases running on Linux on System z. Before deploying the agents, we also updated the Cloud Control Software Library with the required levels of agent software and plug-ins by connecting to the Oracle repository site online. Then, starting with Oracle Enterprise Manager Cloud Control 12c Release 2 (12.1.0.3), we showed how the command-line utility **`emcli`** can also be used to update the Grid Control Software Library in offline mode. The agents were deployed from the Cloud Control Console and by using the silent agent deployment option at the Linux guests. We finished this chapter by showing how to enable the Cloud Control to monitor Oracle databases.

6

Installation and initial tuning of Oracle WebLogic Server 12c on Linux on System z

This chapter describes the experience we had installing Oracle WebLogic 12c on Linux on System z.

This chapter describes the following topics:

- The setup of the Linux guest
- Downloading the code
- The installation process
- The initial setting of parameters
- The monitoring process
- Running a workload

6.1 Preparing the Linux guest

In our example, we prepare a Linux guest with the following z/VM Virtual Guest configuration:

- Two CPUs
- 4 GB memory
- Five 6.8 GB disks
- One NIC

Complete the following steps:

1. As the root user, make the following kernel parameters changes. First, make a copy of the `/etc/sysctl.conf` files by running the following commands (if you are making any changes). Use the **-p** option to preserve the date.

   ```
   #cp -p /etc/sysctl.conf /etc/sysctl.conf.old
   #cat /etc/sysctl.conf
   ```

   Example 6-1 shows a sample configuration file.

Example 6-1 Sample /etc/sysctl.conf

```
fs.file_max = 64000
net.ipv4.tcp_wmem = 131072 131072 262144
net.ipv4.tcp_rmem = 2097152 2097152  4194304
net.ipv4.tcp_window_scaling =   1
net.core.wmem_max       =       262144
net.core.rmem_max = 4194304
net.core.wmem_default = 131072
net.core.rmem_default = 2097152
vm.swappiness = 10
```

2. Then, create a user ID for installing Oracle WebLogic Server, as shown in Example 6-2.

Example 6-2 Commands to create users

```
/usr/sbin/groupadd -g 501 oinstall
/usr/sbin/useradd -u 502 -g oinstall -G dba -s /bin/ksh -m oracle
```

3. Run the following command to set the password for the Oracle users:

   ```
   passwd oracle
   ```

6.2 Downloading the code

Oracle WebLogic Server 12c is available as a generic download. That same download file can be used for AIX, Linux on z, and Linux on x86, as it is Java based.

A problem that we encountered in our example is that, on http://edelivery.oracle.com, if you search for “Oracle Fusion Middleware” and select the Linux on System z platform, no Oracle WebLogic Server 12c file is listed. So, we used the file for the AIX platform, as it is the same for Linux on System z. The file has the following name:

```
Oracle WebLogic Server 12c (12.1.1.0) Generic and Coherence V31344-01 996M
```

After you extract the file, its size is 1,045,221,652 and the file name is `wls1211_generic.jar`.

6.3 Installation steps

After you extract the files into the installation media directory, set up a vncserver for the GUI interface. To install Oracle WebLogic Server, run the following commands:

```
cd  /directory of install media/  (wls1211_generic.jar)
java -jar wls1211_generic.jar
```

Now, complete the following steps:

1. Choose the inventory directory, as shown in Figure 6-1. Click **OK**.

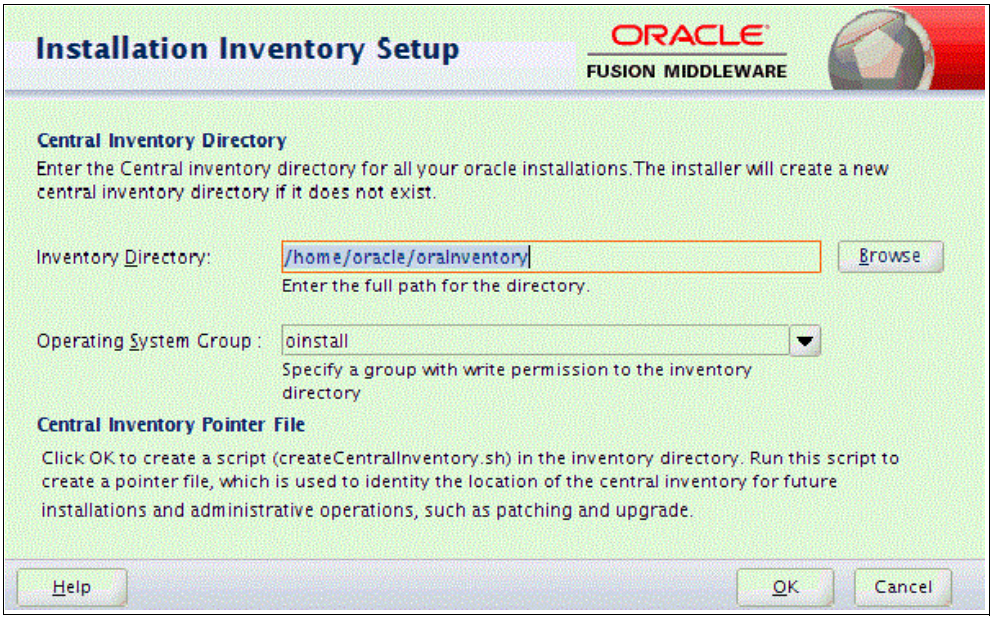


Figure 6-1 Set up the inventory directory

2. When the Welcome window for the installation opens, click **Next**, as shown in Figure 6-2.

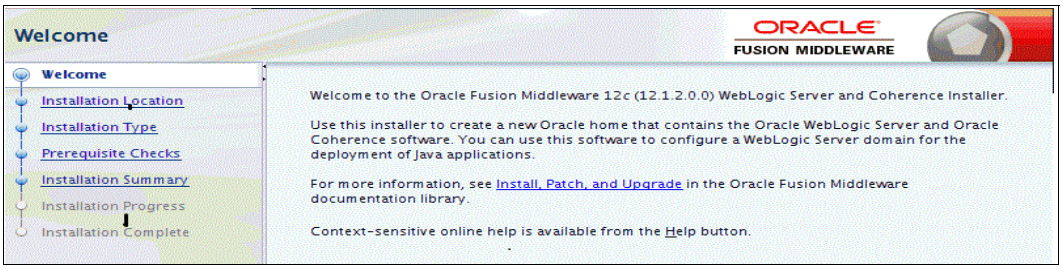


Figure 6-2 Welcome window

3. Select **Create a new Middleware Home**, enter a location for Middleware, and select **Next**. We use the `/oracle/Oracle/Middleware/WLS_Home` directory for the installation, as shown in Figure 6-3.

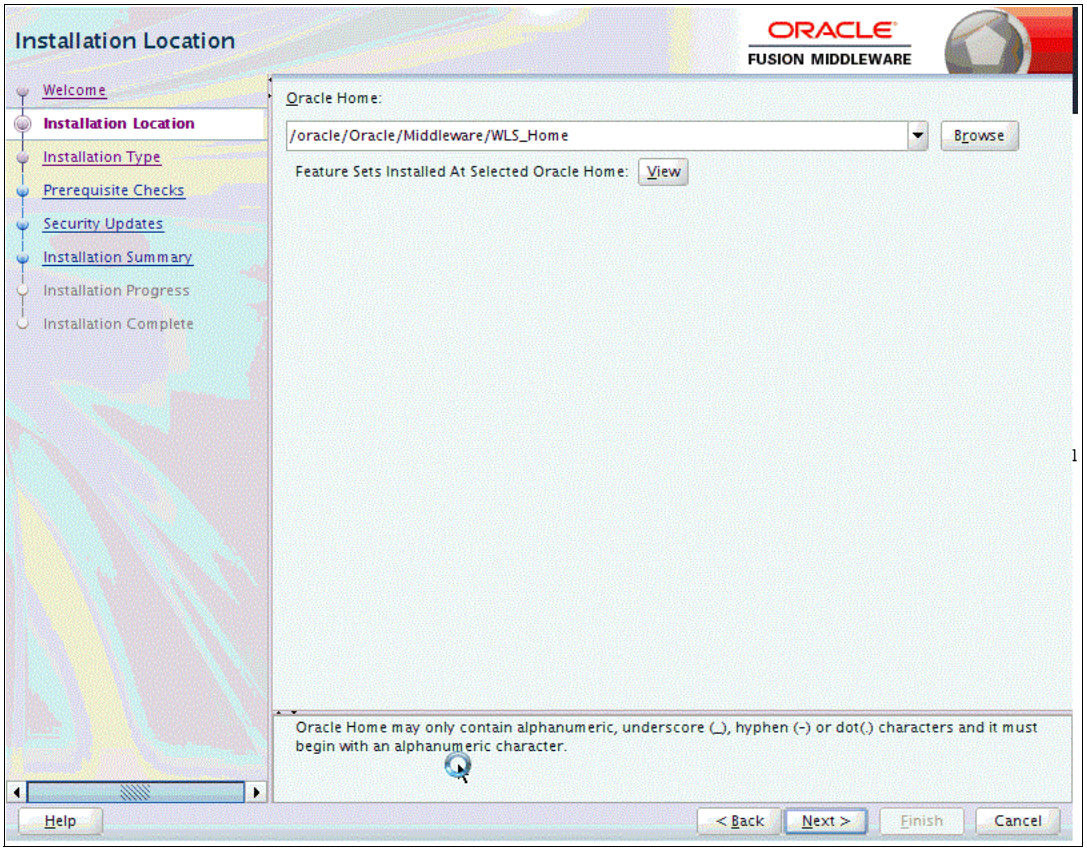


Figure 6-3 Choose the Home directory

4. In our example, we select **Complete Installation**, as shown in Figure 6-4. This option installs all the sample code that we used to verify the installation.

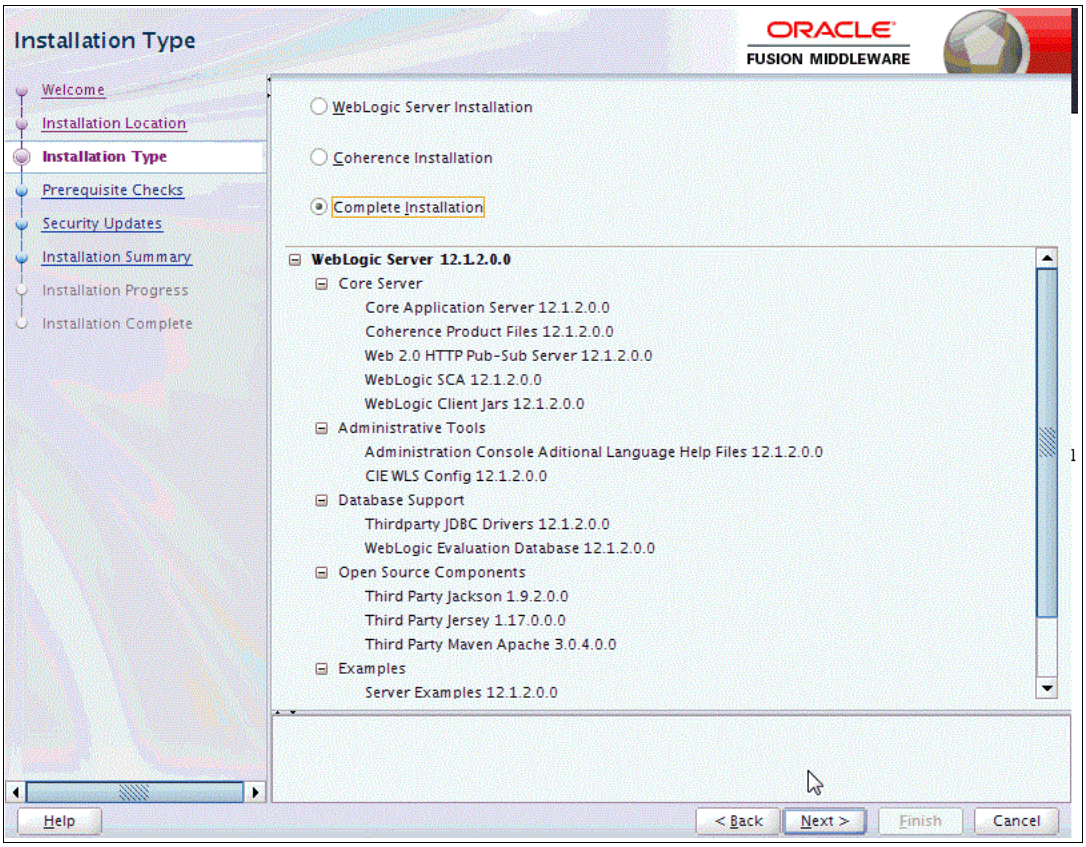


Figure 6-4 Choose Complete Installation

5. A warning about RHEL 6.4 displays, as shown in Figure 6-5. In our example, we previously verified that RHEL 6.4 was certified, so we proceed with the installation. Click **Next**.

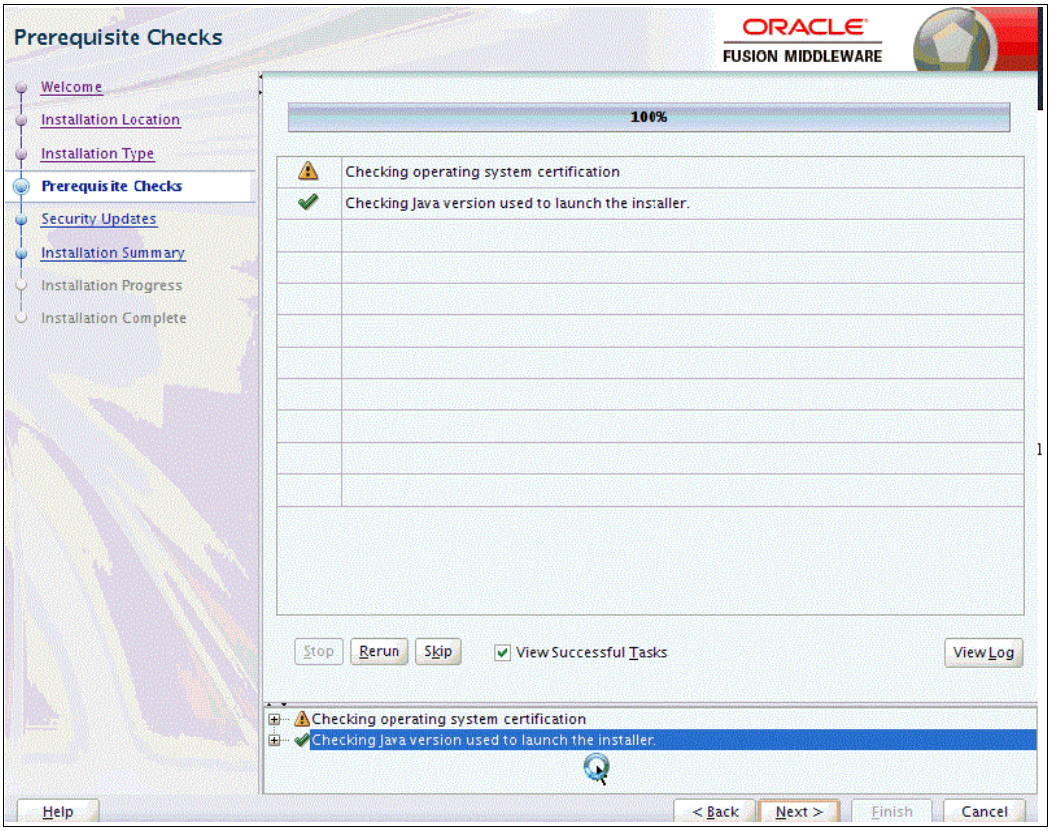


Figure 6-5 Prerequisite check

6. In our example, we clear the **I wish to receive security updates via My Oracle Support** check box because we do not have access to My Oracle support. If you want to receive the updates, complete the fields in Figure 6-6 and then click **Next**.

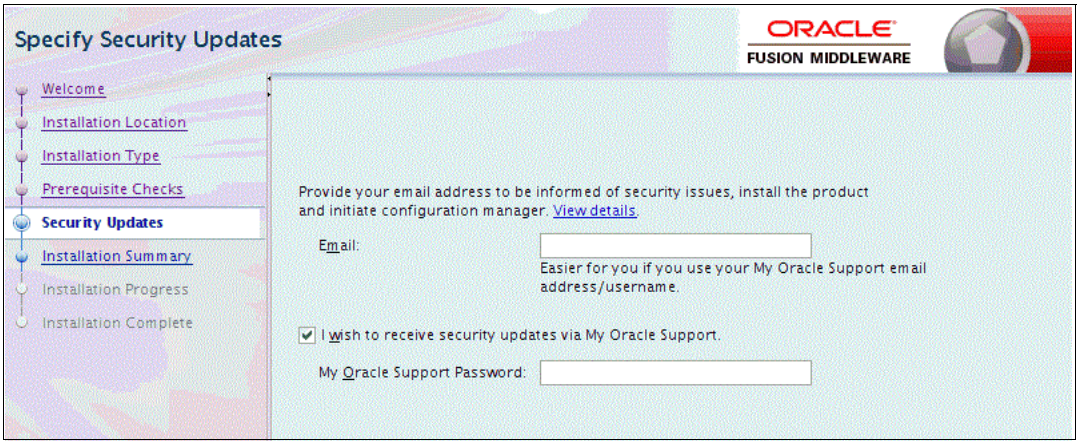


Figure 6-6 Security updates

7. Figure 6-7 shows the installation summary. You may save your response file now. Click **Install** to proceed.

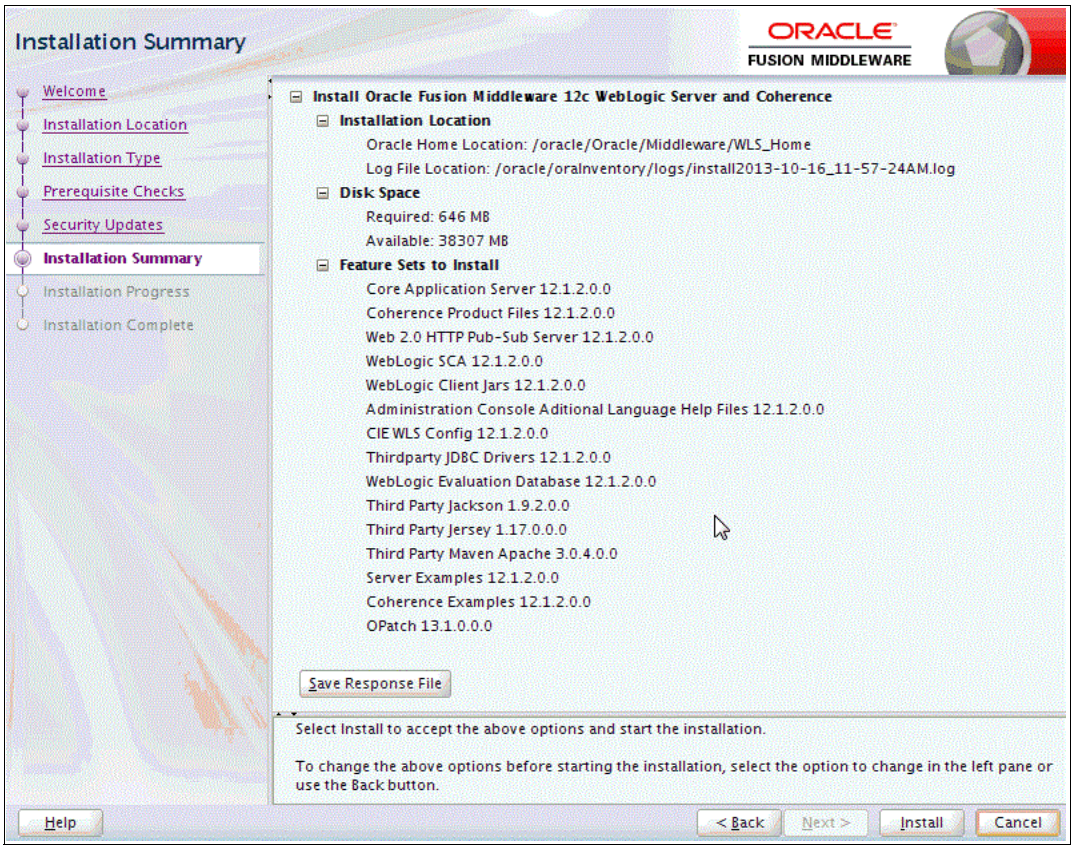


Figure 6-7 Installation summary

8. Figure 6-8 shows that the software installation is successful. Click **Next**.

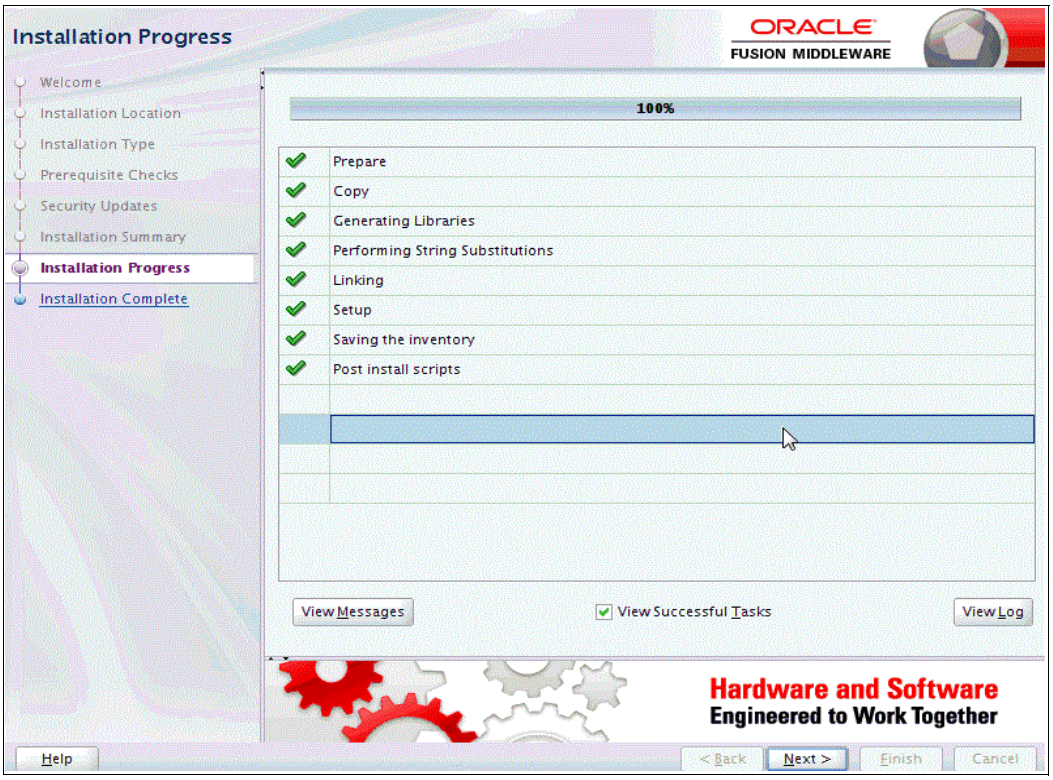


Figure 6-8 Installation progress

9. Figure 6-9 shows that the Launch Quickstart is selected. Leave it selected and click **Finish**.

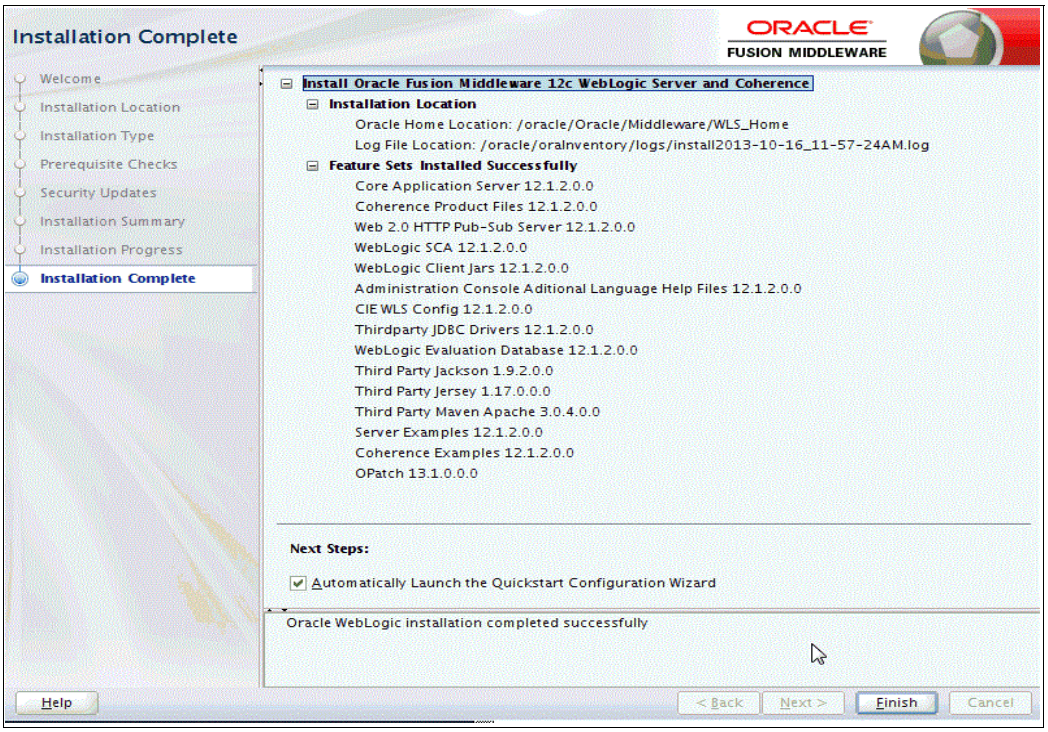


Figure 6-9 Installation complete

10. Enter a password for the Oracle WebLogic Server Administrator Account and save the password, as shown in Figure 6-10. Note the port number for later use. Click **Create**.

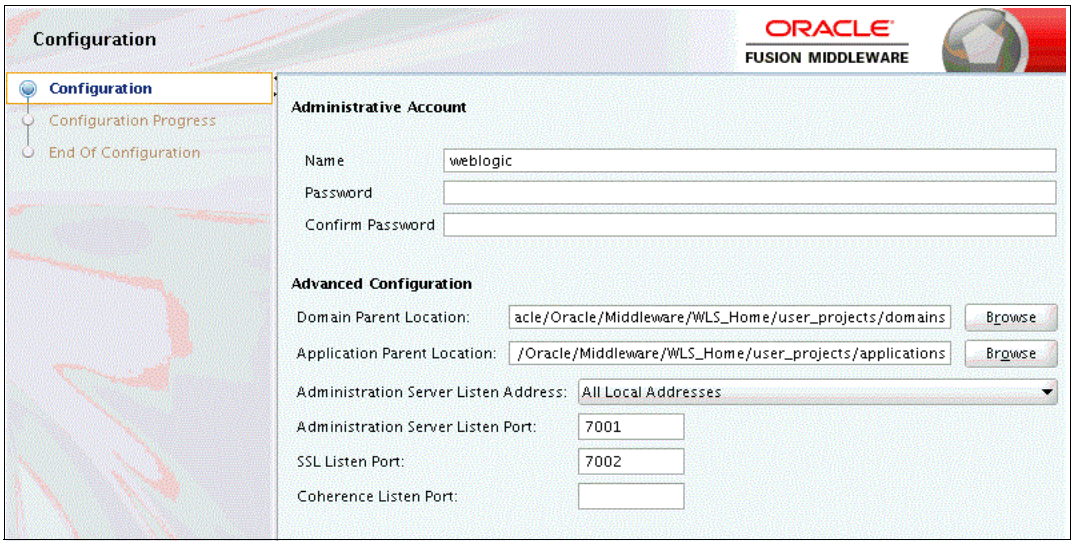


Figure 6-10 Password for Oracle WebLogic Server Administration Account

11. Figure 6-11 shows the three domains for the administrator server for the MEDREC servers. MEDREC is the sample application. Click **Next** to proceed.

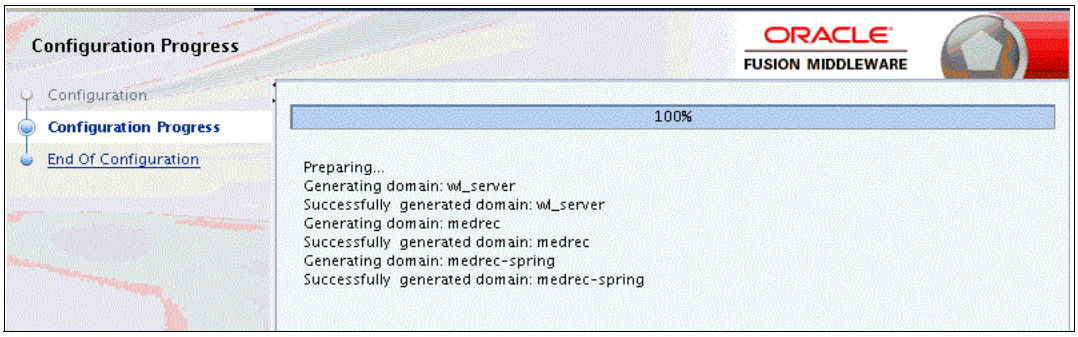


Figure 6-11 Domains for MEDREC servers

12. Save this information, as shown in Figure 6-12, because it has the home directories for each domain. Click **Finish**.

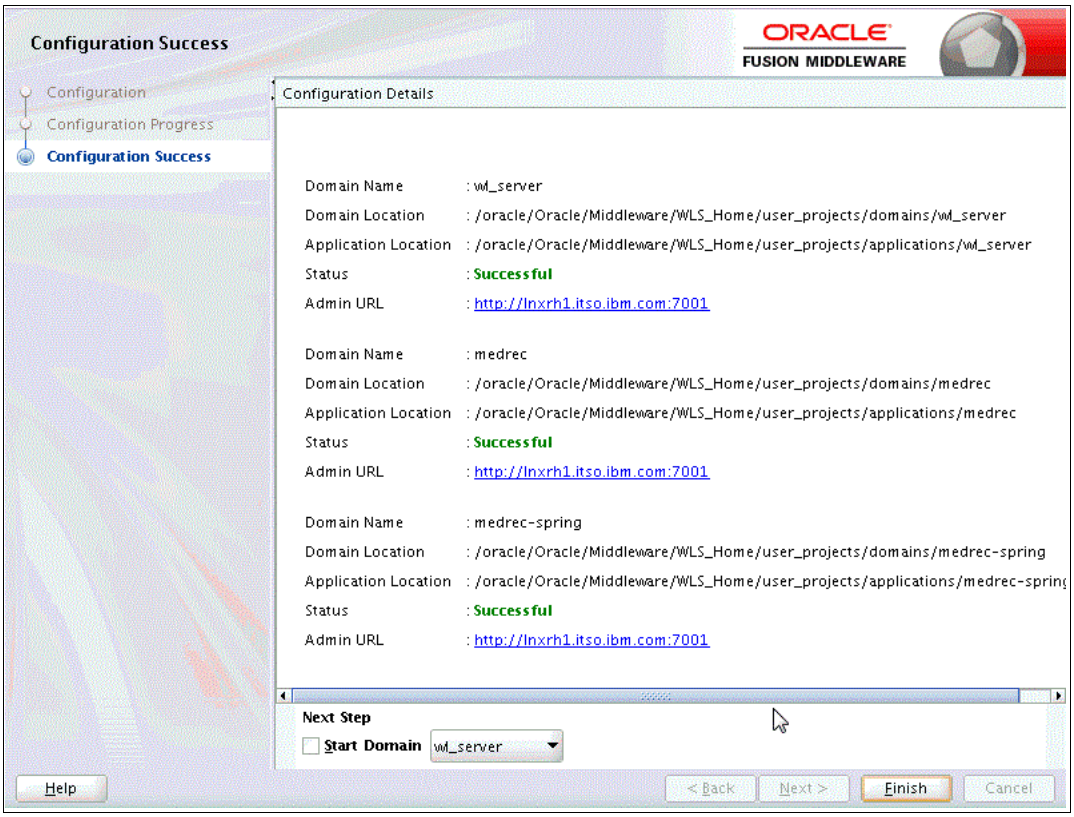


Figure 6-12 Home directories for the domains

13. To start WebLogic Server, run the following commands:

```
cd /Middleware home directory/user_projects/domains/Domain Name/
./startWeblogicserver.sh
```

14. Wait to receive the message `RUNNING STATE`. Then, you can log in to the Administrative Server at the following URL:

```
http://hostname:7001/console
```

15. To stop WebLogic Server, run the following command:

```
CRTL C
```

6.4 Postinstallation tasks

Tuning Oracle WebLogic Server is an ongoing task. The first step is to set the initial parameter for the HEAP size and the garbage collection.

6.4.1 Initial setting of the Java parameters

As the Oracle user, make these changes to `WLS_home/user_projects/domains/base_domain/bin/setDomainEnv.sh`.

Note: You should first make a copy of the `setDomainEnv.sh` file before you make any changes.

Find `USER_MEM_ARGS` and insert the following line:

```
USER_MEM_ARGS = "Xgcpolicy:balanced Xms1024m Xmx1024m Xcompressedrefs"
```

Note: **`Xgcpolicy:balanced`** is a Java 7 option. For Java 6, use **`Xgcpolicy:gencon`**.

In our example, we set the HEAP size minimum and maximum values to be equal to prevent the allocation memory function from taking resources during peak times. In some applications, you might want this to be a range. For more information about this topic, go to the following website:

http://publib.boulder.ibm.com/infocenter/javasdk/v5r0/topic/com.ibm.java.doc.diagnostics.50/diag/understanding/mm_heapsizing_initial.html

6.4.2 Creating a startup script

To start the Administrative Server without entering a user ID and password every time, create a boot.properties file under the following directory:

```
/user_projects/domains/my_domain/servers/AdminServer/security
```

Add the following entries to the file and save the changes:

```
username=weblogic
password=welcome1
```

Note: After the first start of the Administrative Server, the user name and password are encrypted.

The next steps are to create two Linux services to start the Node Manager and Administrative Server at boot time.

Node Manager service

Create a wlsndm script (Example 6-3) in `/etc/init.d`.

Example 6-3 wlsndm script

```
#startup script for node manager
#
# chkconfig: - 74 15
# description: weblogic
# processname: WLSNDM
# Source function library
. /etc/rc.d/init.d/functions
WL_HOME=/u01/oracle/Middleware
export WL_HOME
echo $WL_HOME
start() {
echo -n $"Starting $prog: "
nohup su - oracle -c ${WL_HOME}'/wlserver_12.1/server/bin/startNodeManager.sh \
'${WL_HOME}'/wlserver_12.1/server/logs/wlsndm.log 2>&1 &'
echo "OK"
```

```
}
case "$1" in
start)
start
;;
*)
echo $"Usage: $prog {start}"
exit 1
esac
exit 1
```

Administrative Server

Complete the following steps:

1. Create a wlsadmin script (Example 6-4) in `/etc/init.d`.

Example 6-4 wlsadmin script

```
#startup script for administration server
#
# chkconfig: - 75 15
# description: weblogic
# processname: WLSADM

# Source function library
. /etc/rc.d/init.d/functions
WL_HOME=/u01/oracle/Middleware
export WL_HOME
echo $WL_HOME
start() {
echo -n $"Starting $prog: "

nohup su - oracle -c  \
${WL_HOME}'/user_projects/domains/base_domain/bin/startWebLogic.sh  \
>'${WL_HOME}'/user_projects/domains/base_domain/servers/AdminServer/logs/wlsa.log
2>&1 &'
echo "OK"
}

status() {
echo 'getting status'
export PATH=$PATH:/opt/ibm/java-s390x-70/jre/bin
CLASSPATH="/u01/oracle/Middleware/wlserver_12.1/server/lib/weblogic.jar"
export CLASSPATH
echo 'Getting Status for AdminServer'
status=`java weblogic.Admin -adminurl t3://pazxxt11.us.oracle.com:7001 -username \
weblogic -password ibmpass9 GETSTATE AdminServer`
echo $status
}

stop() {
echo 'wait shutting down'
export PATH=$PATH:/opt/ibm/java-s390x-70/jre/bin
CLASSPATH="/u01/oracle/Middleware/wlserver_12.1/server/lib/weblogic.jar"
export CLASSPATH
echo 'Stopping AdminServer Please wait'
```

```
status=`java weblogic.Admin -adminurl t3://pazxxt11.us.oracle.com:7001  - username
\ weblogic -password ibmpass9 SHUTDOWN AdminServer  | awk '{print$6}'`
echo $status
}

case "$1" in
start)
start
;;
status)
status
;;
stop)
stop
;;
*)
echo $"Usage: $prog {start status stop}"
exit 1
esac
exit 1
```

2. Create two links in /etc/rc.5/ by running the following commands

```
ln -s /etc/init.d/wlsndm /etc/rc5.d/S74NodeManager
ln -s /etc/init.d/wlsadmin /etc/rc5.d/S75AdminServer
```

3. Create background services by running the following commands:

```
chkconfig --add wlsadmin
chkconfig --add wlsndm
```

4. Activate background services by running the following commands:

```
chkconfig --level 35 wlsadmin on
chkconfig --level 35 wlsndm on
```

6.4.3 Updating the Managed Server JVM options

If you are starting Managed Servers by using NodeManager, complete the following steps:

1. Log in to the Administration Console.
2. In the navigation tree on the left, expand **Environment** and click **Servers**, as shown in Figure 6-13.

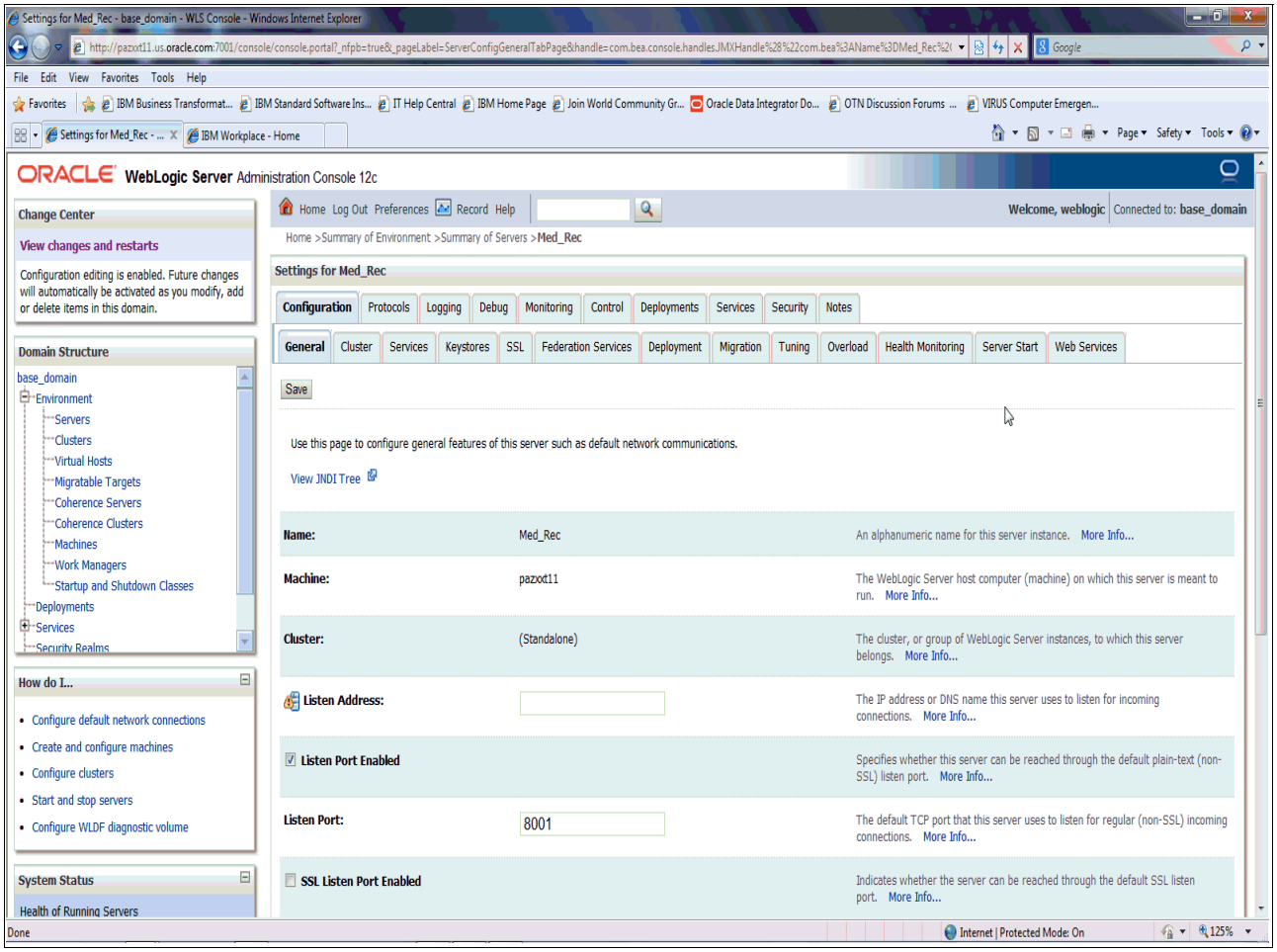


Figure 6-13 Monitoring Oracle WebLogic Server

3. In the Servers table, click the name of the server instance you want to configure.
4. On the Configuration tab, click **Server Start**, as shown in Figure 6-14 on page 137.

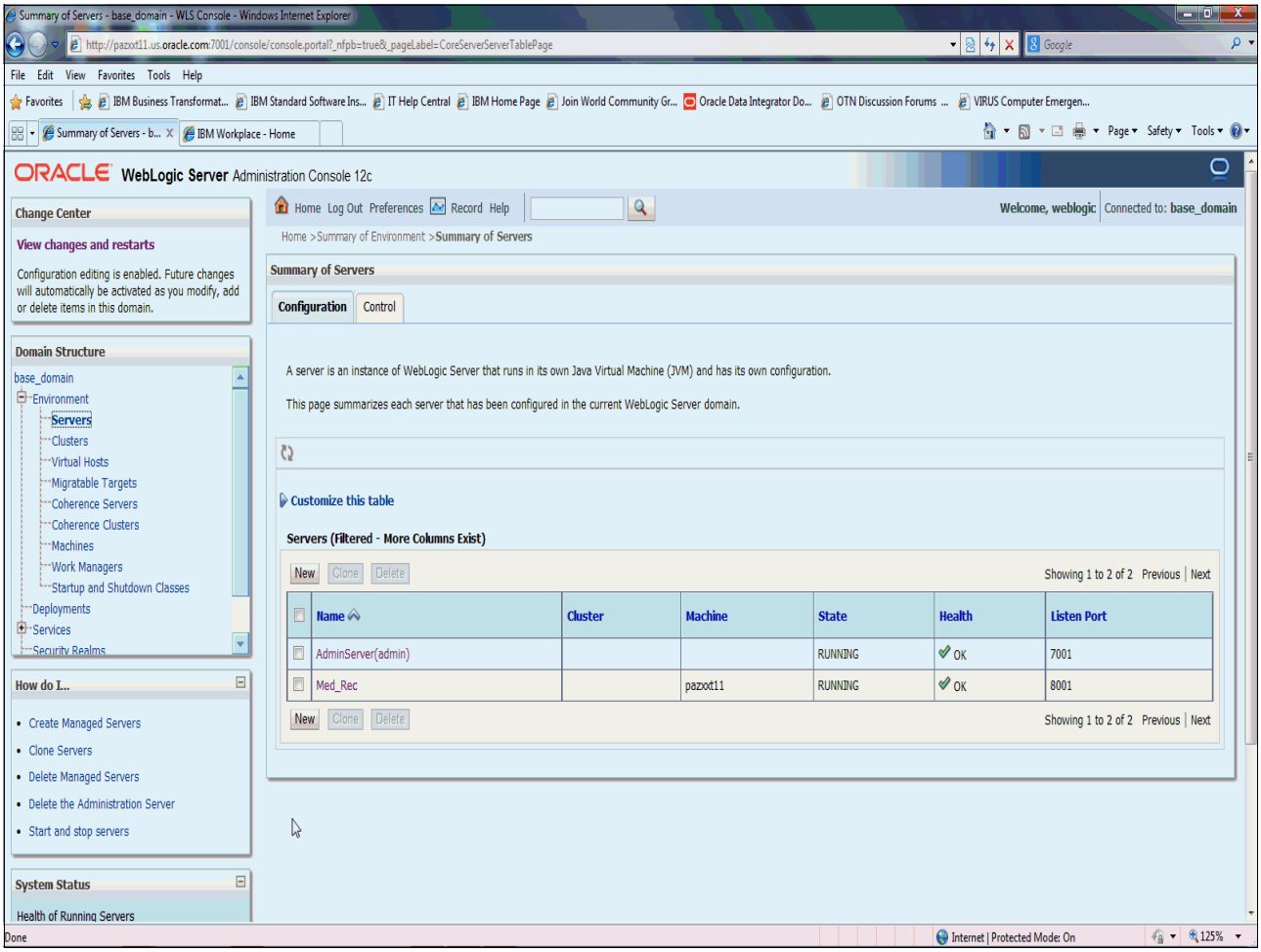


Figure 6-14 Oracle WebLogic Server Administration Console

5. In the Arguments field, specify the following Java option:

   ```
   -Xmn1024m -Xmx1024m -Xcompressedrefs
   -Xgcpolicy balanced
   ```

6. Click **Save**.
7. To activate the change, in the Change Center in the upper left, click **Activate Changes**.
8. Restart the Managed Server.

6.4.4 Monitoring WebLogic

WebLogic Server records information about events and errors in several logs:

- Standard Out: All messages of warning or higher.
- Standard Error: All error messages.
- Server Logs: Messages from subsystems and application.
- Domain Logs: The administration server writes messages and all server instances in a domain forward messages here.
- Node Manager Logs: Startup and status messages.
- HTTP Logs: A log of http requests.

- JTA: JTA Transaction log.
- JDBC Logs: JDBC message logs.

Through the Administration Console, you can view the status of the following items:

- Clusters
- Servers
- Node Manager
- Machines
- Deployments
- Services

For more information about configuring and viewing logs and their status, see the relevant Oracle documentation.

Links to Oracle documentation

Here are some websites that have Oracle documentation that describes more information about the topics in this chapter.

- Logs description and Viewing status

  http://docs.oracle.com/cd/E24329_01/web.1211/e24428/logging_services.htm

- Oracle WebLogic 12c Documentation Library

  http://docs.oracle.com/cd/E24329_01/index.htm

6.5 Samples of Linux and JVM settings

In our example, we did some initial tuning. Table 6-1 shows the JVM options.

Table 6-1 JVM options

JVM option	Description	Value used
Xgcpolicy	Garbage Collection behavior - (Default for JDK 6) gencon - concurrent mark phase combined with generational - (Default for JDK 7) balanced—mark, sweep, compact, and generational	balanced
Xms	Initial heap size.	1024m
Xmx	Maximum heap size.	1024m
Xcompressedrefs	New option that reduces heap size and gc.	Default for Java 1.7
Xmns	Initial new size area - gencon.	
Xmos	Initial size old heap.	
Xlp	Enable large page support.	
verbosegc	Collect GC information.	
Xverboseglco	Direct gc information output to file.	/tmp/gclog

Table 6-2 on page 139 shows the Linux kernel parameters.

Table 6-2 Linux kernel parameters

Kernel parameter	Description	Value used
fs.file_max	Maximum number of open file descriptors	64000
net.ipv4.tcp_wmem	Memory that is reserved for send buffers TCP - minimum, default, and maximum	
net.ipv4.tcp_rmem	Memory that is reserved for receive buffers TCP - minimum, default, and maximum	5242880 52428800 20971520 50MB 50MB 200MB
net.ipv4.tcp_mem	TCP Autotuning	2097152 2097152 4194304
net.ipv4.tcp_Window_scaling	TCP Window scaling on/off	1
net.core.wmem_max	OS send buffer maximum size	104857600
net.core.rmem_max	OS receive buffer maximum size	20971520
net.core.wmem_default	OS send buffer default size	26214400
net.core.rmem_default	OS receive buffer default size	5242880
net.core.netdev_max.backlog	Maximum number of packets, queued on the input side	5000
vm.swappiness	Swap behavior, the higher the number the more swapping	10

6.6 Running a workload

It is a preferred practice to continually monitor a production Oracle WebLogic Server system so you can tune it as the workload changes. A good starting point is to run a test workload, similar to what you expect in production, monitor it, and then try changing the tuning parameters to maximize performance.

Tips:

- Oracle Enterprise Manager Cloud Control 12c offers good monitoring options for Oracle WebLogic Server.
- Oracle Application Test Suite can be used to generate workloads for your testing.

7

Upgrading Oracle Database 11gR2 to a Oracle Database 12c on Linux on System z

There are several ways that you can upgrade your existing database to Oracle Database 12c Release 1. A paper titled *Upgrading to Oracle Database12c* that describes the options can be found at:

http://www.oracle.com/technetwork/database/upgrade/overview/index.html

In our example, we upgrade an existing Oracle Database on Linux on z that is running on version 11.2.0.4.

This chapter covers some of the details that are involved in upgrading an Oracle Database 11.2.0.4 to Oracle Database 12c R1 by using the Database Upgrade Assistant (DBUA). The Oracle document, *Oracle Database Upgrade Guide 12c Release 1 (12.1)*, E17642-13 is invaluable in doing an upgrade to Oracle Database 12c. After the upgrade, the database is converted into a pluggable Database.

Before you start the upgrade process, you should ensure that you have a complete backup of your database. Also, the upgrade process should be tested before you upgrade your production database.

7.1 Overview

In this example, the Oracle Database 11.2.0.4 home is `/oracle/base/11204/si` and the database was created with the Database Configuration Assistant (DBCA) from the general-purpose template and included the sample schemas. The data files are on an ext4 file system and the distribution of Linux is Red Hat 6.4.

The basic outline of the upgrade that is covered here is to install the Oracle Database 12c software and then use DBUA in Oracle Database 12c. This process results in a non-CDB database on Oracle Database 12c. An extra step is done to plug the database in to a CDB as a PDB.

As shown in Figure 7-1, only the Oracle Database 12c software will be installed.

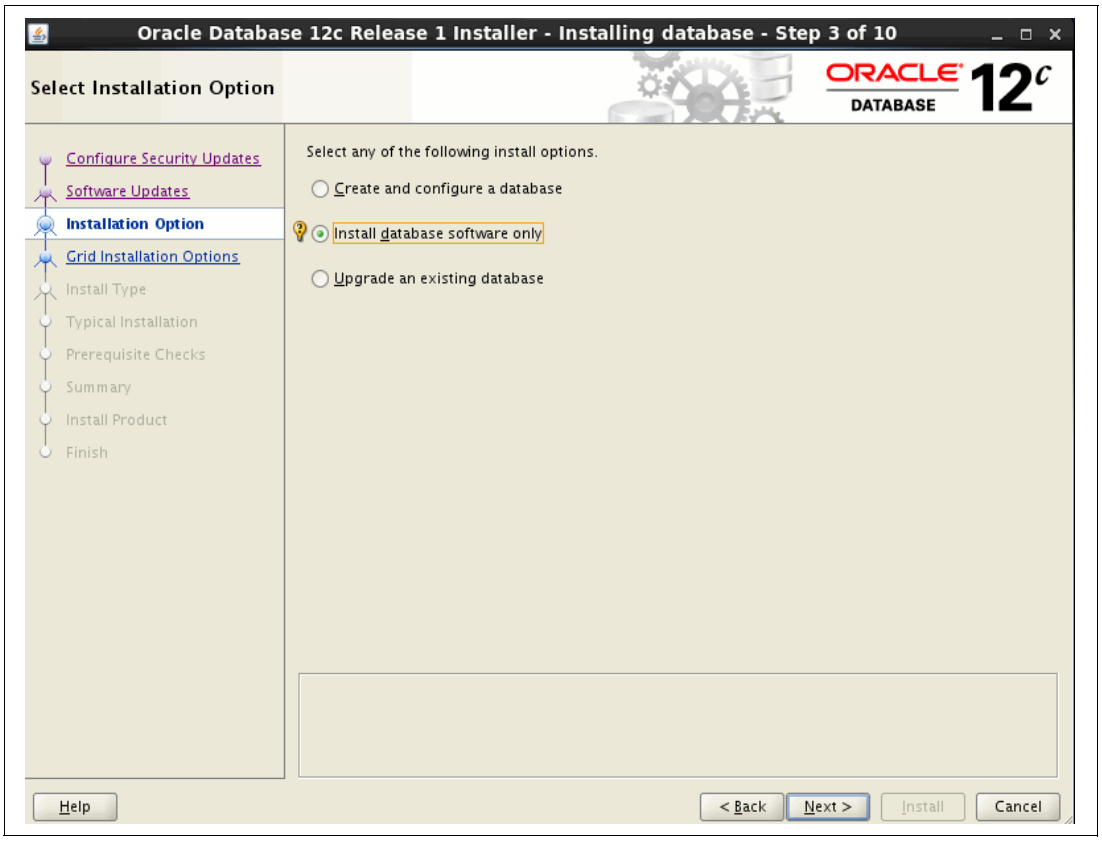


Figure 7-1 Install Oracle Database 12c software

7.2 Pre-upgrade

After the Oracle Database 12c software is installed, the upgrade process begins. The first step is to analyze the Oracle Database 11.2.0.4 database by running the `preupgrd.sql` script on the Oracle Database 11.2.0.4 system. The script is in `<ORACLE_HOME>/rdbms/admin` on the Oracle Database 12c database software in our example. This script, and a script it depends on, is copied to the 11.2.0.4 system by running the following commands:

```
[oracle@strkc165 ~]$ cp /oracle/base/12c/si/rdbms/admin/preupgrd.sql
/oracle/base/11204/si/dbs
```

```
[oracle@strkc165 ~]$ cp /oracle/base/12c/si/rdbms/admin/utluppkg.sql
/oracle/base/11204/si/dbs
```

The scripts can be anywhere that is available to Oracle Database 11.2.0.4, but they both must be in the same directory.

In our environment, the first execution of the `preupgrd.sql` script yielded the following output:

```
************  Summary  ************

 0 ERRORS exist in your database.
 3 WARNINGS that Oracle suggests are addressed to improve database performance.
 2 INFORMATIONAL messages that should be reviewed prior to your upgrade.
```

The warning about the number of processes is removed by setting the number of processes to 300 and bouncing the Oracle Database 11.2.0.4 instance:

```
WARNING: --> Process Count may be too low
     Database has a maximum process count of 150 which is lower than the
     default value of 300 for this release.
     You should update your processes value prior to the upgrade
     to a value of at least 300.

SQL> alter system set processes=300 scope=spfile;
System altered.
```

The Oracle Database 11.2.0.4 instance is using DB Control, and DB Control is not available in Oracle Database 12c, as shown in the following output. In Oracle Database 12c, the function in DB Control is now in Oracle Enterprise Manager 12c Cloud and Enterprise Manager Database Express.

```
WARNING: --> Enterprise Manager Database Control repository found in the database
In Oracle Database 12c, Database Control is removed during
     the upgrade. To save time during the Upgrade, this action
     can be done prior to upgrading using the following steps after
     copying rdbms/admin/emremove.sql from the new Oracle home
   - Stop EM Database Control:
$> emctl stop dbconsole
   - Connect to the Database using the SYS account AS SYSDBA:
   SET ECHO ON;
   SET SERVEROUTPUT ON;
   @emremove.sql
     Without the set echo and serveroutput commands you will not
     be able to follow the progress of the script.
```

Database Control was stopped by running the following command:

```
[oracle@strkc165 dbs]$ emctl stop dbconsole
Oracle Enterprise Manager 11g Database Control Release 11.2.0.4.0
Copyright (c) 1996, 2013 Oracle Corporation.  All rights reserved.
https://strkc165.us.oracle.com:1158/em/console/aboutApplication
Stopping Oracle Enterprise Manager 11g Database Control ...
 ...  Stopped.
```

Note: To recover the Oracle Database 11.2.0.4 DB Control in a downgrade, the `emdwgrd` script in the Oracle Database 12c directory `/ oracle/base/12c/si/bin` must be run before `emremove.sql` to save the DB Control files and configuration.

The `emremove.sql` script is copied to the Oracle Database 11.2.0.4 system and run to remove the DB Control configuration from the Oracle Database 11.2.0.4 database, as shown in the following output:

```
[oracle@strkc165 si]$ cp /oracle/base/12c/si/rdbms/admin/emremove.sql
/oracle/base/11204/si/dbs/


SQL> @emremove
old  69:     IF (upper('&LOGGING') = 'VERBOSE')
new  69:     IF (upper('VERBOSE') = 'VERBOSE')
SQL>PL/SQL procedure successfully completed
```

To remove the warning about DBMS_LDAP, Application Express is removed from the Oracle Database 11.2.0.4 database by using Oracle Support Notes ID 558340.1 and 1231863.1 and the following scripts:

```
SQL> @../apex/apxremov
...Removing Application Express
old   1: alter session set current_schema = &APPUN
new   1: alter session set current_schema = APEX_030200
old   2:     if '&UPGRADE' = '1' then
new   2:     if '1' = '1' then
old   1: drop user &APPUN cascade
new   1: drop user APEX_030200 cascade
old   2:     if '&UPGRADE' = '1' then
new   2:     if '1' = '1' then
old   5:     if '&UPGRADE' = '1' then
new   5:     if '1' = '1' then
old   2:     if '&UPGRADE' = '1' then
new   2:     if '1' = '1' then
...Application Express Removed

SQL> drop package htmldb_system;
SQL> drop public synonym htmldb_system;
```

Finally, before you rerun the `preupgrd.sql` script, purge the recycle bin by running the following command:

```
SQL> EXECUTE dbms_preup.purge_recyclebin_fixup;
```

The `preupgrd.sql` script is rerun and produce one information message:

```
INFORMATION: --> Older Timezone in use

     Database is using a time zone file older than version 18.
     After the upgrade, it is recommended that DBMS_DST package
     be used to upgrade the 11.2.0.4.0 database time zone version
     to the latest version which comes with the new release.
     Please refer to My Oracle Support note number 977512.1 for details.
```

This message is resolved on the Oracle Database 12c instance after the database is upgraded.

The `preupgrd.sql` output also contains a recommendation to `Please gather dictionary statistics 24 hours prior to upgrading the database.` This was done by running the following command:

```
SQL> exec dbms_stats.gather_dictionary_stats;
PL/SQL procedure successfully completed.
```

Depending on the particular situation of the database to be upgraded, there are other items, such as the invalid objects, that are described in Section 2.5.2 of the *Oracle Database Upgrade Guide 12c* that might need to be addressed.

7.3 Database Upgrade Assistant

After the preparatory work in 7.2, “Pre-upgrade” on page 142 is done, the Oracle Database 11.2.0.4 database is ready to be upgraded. The remainder of this chapter describes using the Database Upgrade Assistant (DBUA) to upgrade the database to Oracle Database 12c. The DBUA is in the `/oracle/base/12c/si/bin` directory. After you run **dbua**, the window that is shown in Figure 7-2 opens.

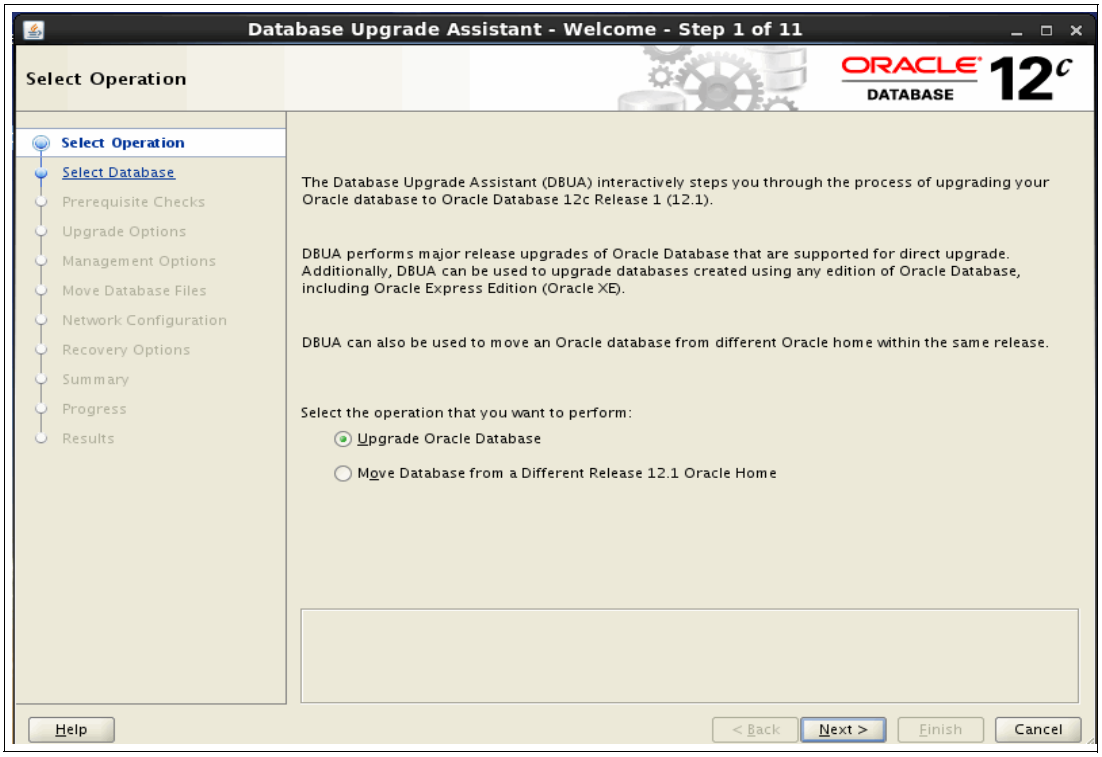


Figure 7-2 First DBUA window

To upgrade Oracle Database by using the DBUA, complete the following steps:

1. Select **Upgrade Oracle Database** and then click **Next**. The window that is shown in Figure 7-3 opens.

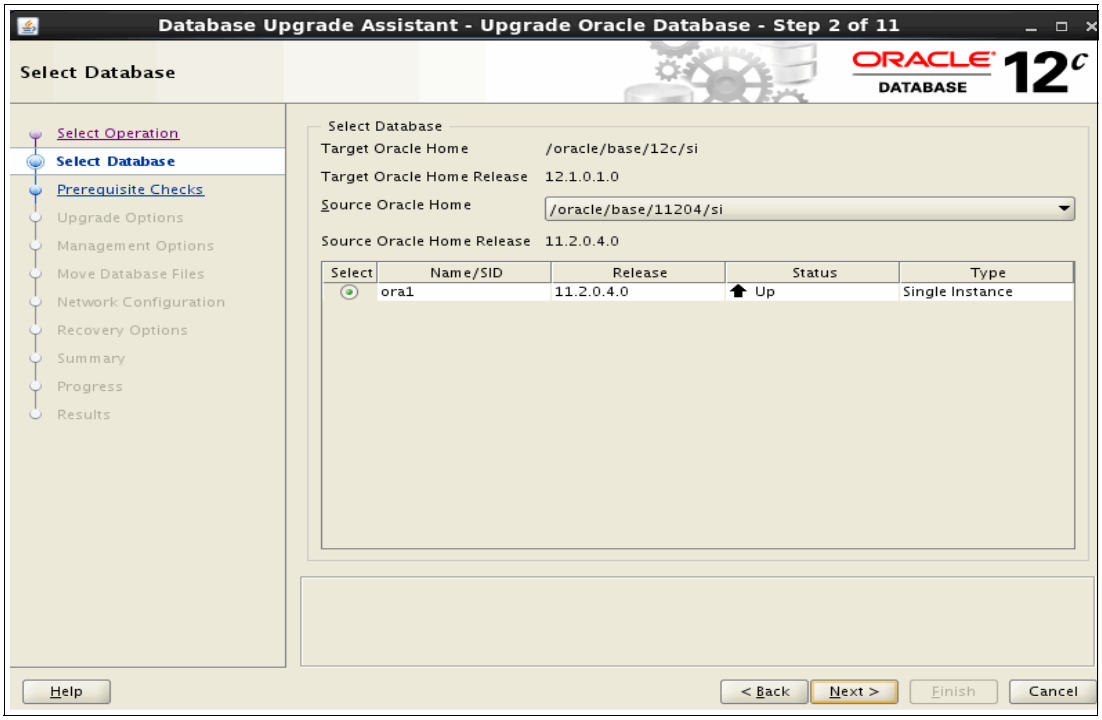


Figure 7-3 The Oracle Database 11.2.0.4 source database to upgrade

For this example, there is only a single database that is available to be upgraded and it is selected by default. Click **Next** to continue.

2. Figure 7-4 shows DBUA running prerequisite checks before doing the database upgrade.

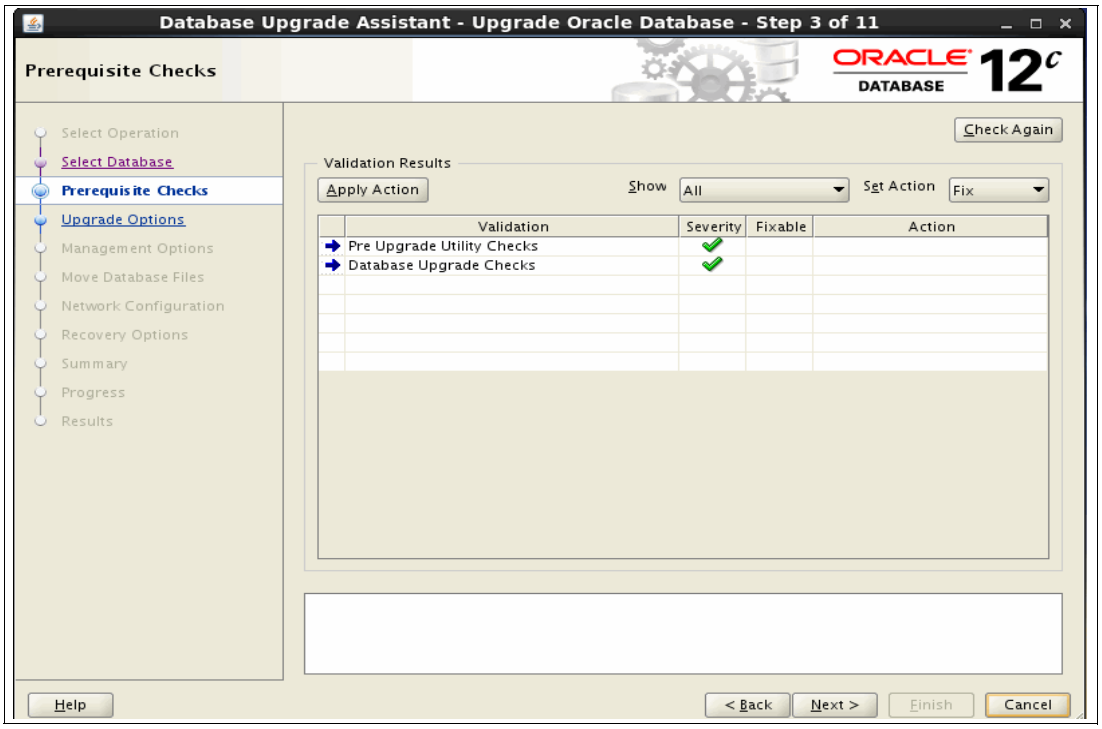


Figure 7-4 DBUA Prerequisite Checks

DBUA reruns the pre-upgrade check, which is the same one we ran manually. The earlier run had no warnings or errors, so there should not be any warnings or errors now. When the pre-upgrade checks are complete, click **Next** to continue. The window shown in Figure 7-5 opens.

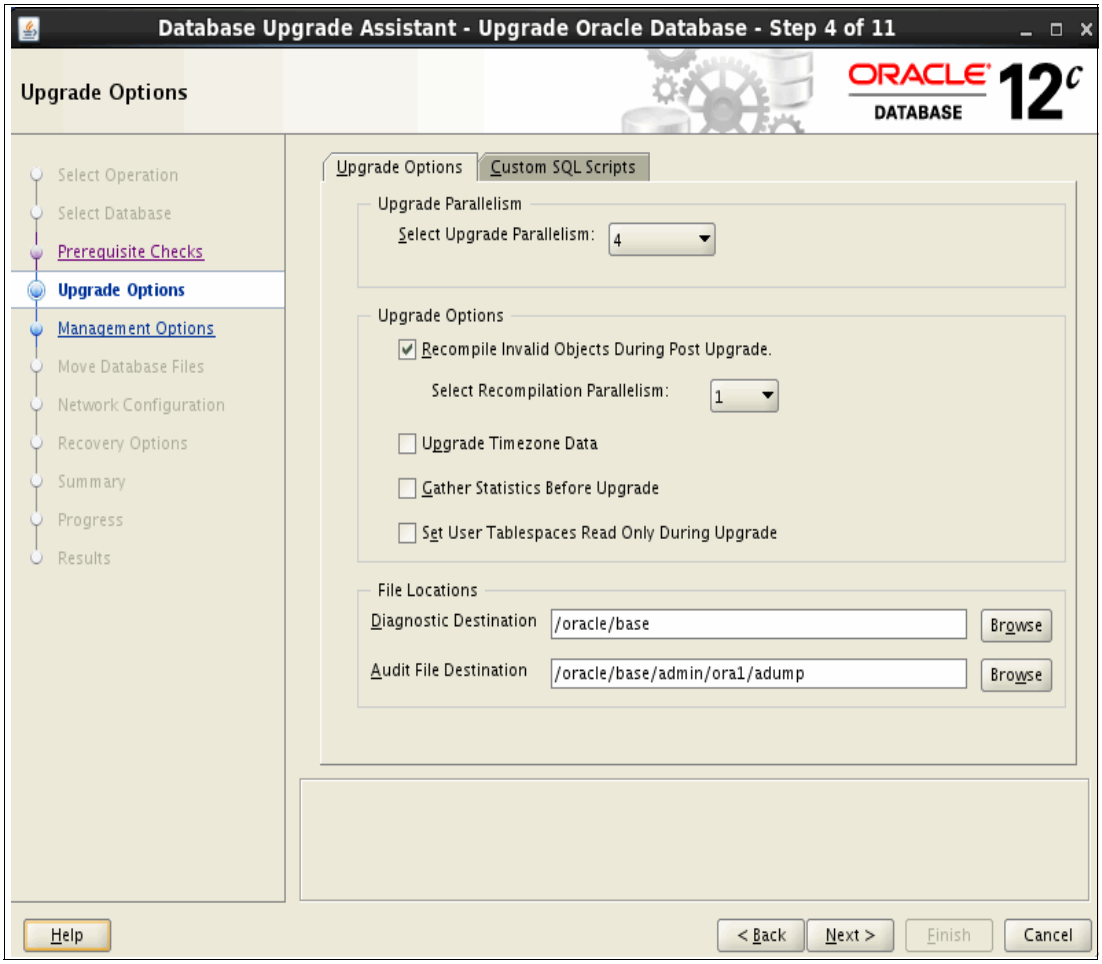


Figure 7-5 DBUA parameters and configuration

3. Select the upgrade options and file locations and click **Next** to proceed. The window shown in Figure 7-6 opens.

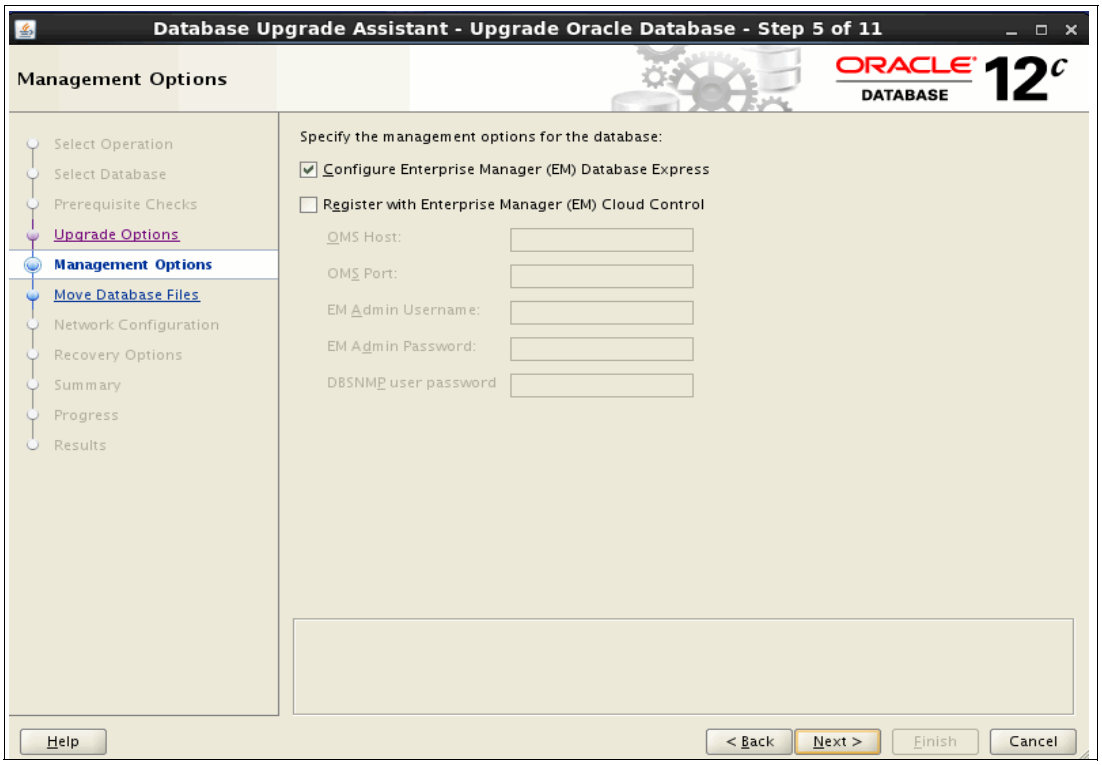


Figure 7-6 Configure the usage of Enterprise Manager Database Express on Oracle Database 12c

Select **Configure Enterprise Manager (EM) Database Express** to manage the new Oracle Database 12c database and click **Next**. In our example, we do not move the database files, as shown in Figure 7-7, but you might want to move them in your own case.

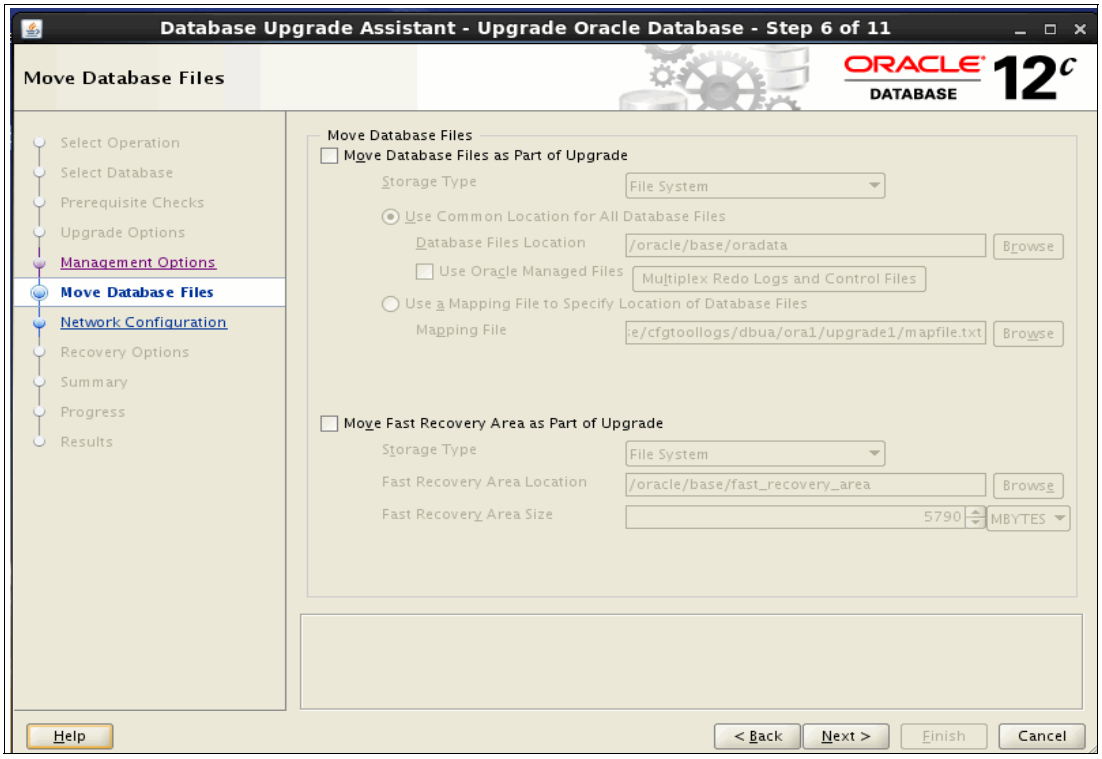


Figure 7-7 Do not move database files

4. Here, we migrate the Oracle Database 11.2.0.4 listener, as shown in Figure 7-8.

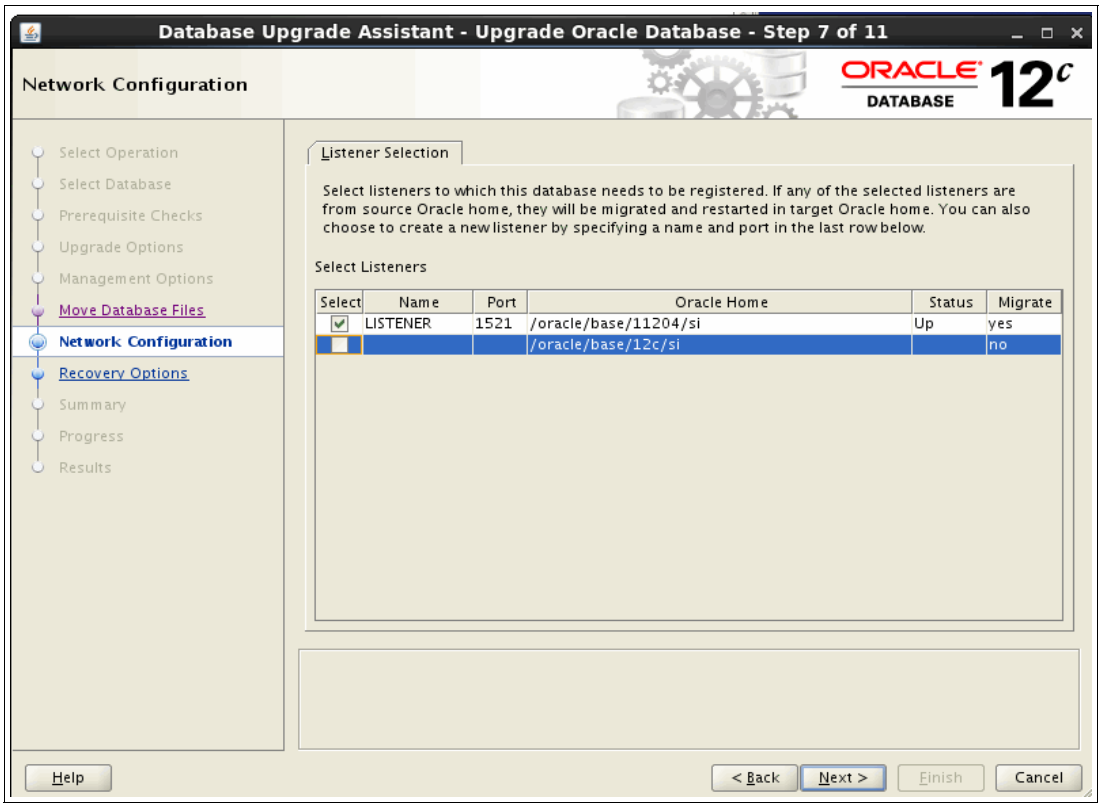


Figure 7-8 Migrate the Oracle Database 11.2.0.4 listener

Select the listener and click **Next**.

5. Create an RMAN backup, as shown in Figure 7-9, so a downgrade can be done if necessary to revert back to the Oracle Database 11.2.0.4 database.

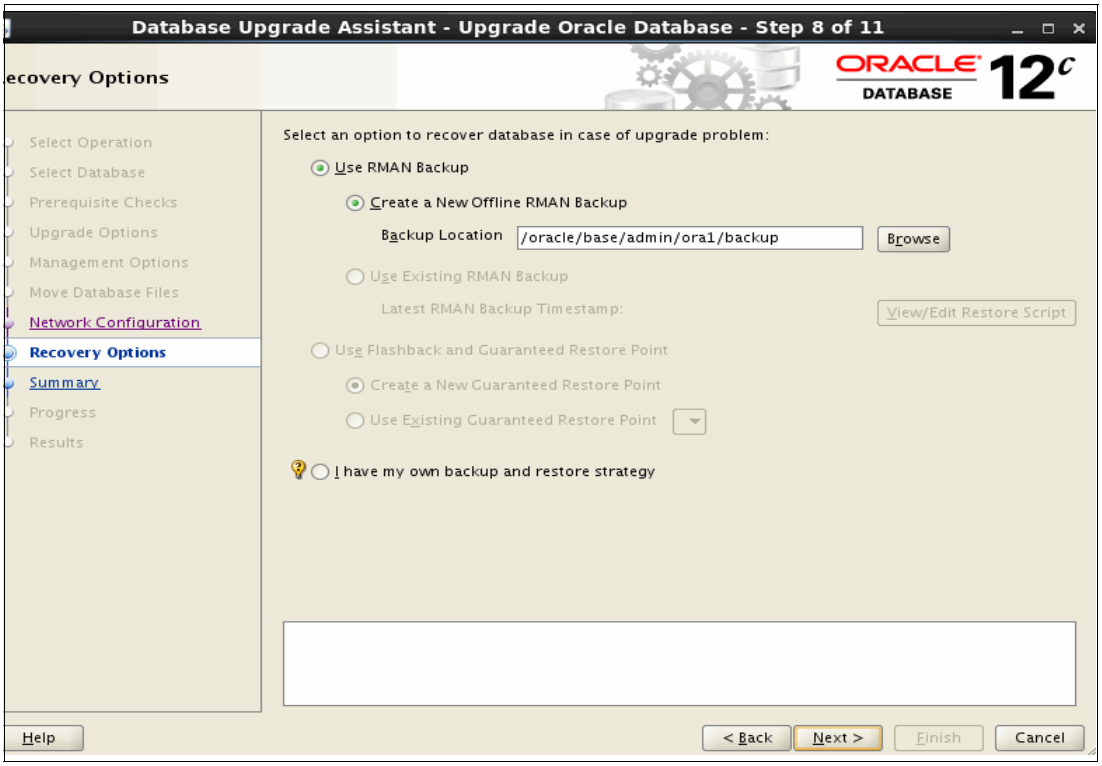


Figure 7-9 RMAN offline backup

As noted in 7.2, “Pre-upgrade” on page 142, to recover Oracle Database 11.2.0.4 DB Control in a downgrade, the `emdwgrd` script in the Oracle Database 12c directory `/oracle/base/12c/si/bin` must be run before running **`emremove.sql`** to save the DB Control files and configuration.

Note: If you did not run the `emdwgrd` script in the Oracle Database 12c directory `/oracle/base/12c/si/bin` before running **`emremove.sql`**, you cannot recover Oracle Database 11.2.0.4 DB Control. The Oracle Database 11.2.0.4 instance is using DB Control and DB Control is not available in Oracle Database 12c. In Oracle Database 12c, the function in DB Control is now in Oracle Enterprise Manager 12c Cloud and Enterprise Manager Database Express.

Click **Next** to continue. The information message about time zones from the `preupgrd.sql` script is shown as a warning in Figure 7-10 on page 153.

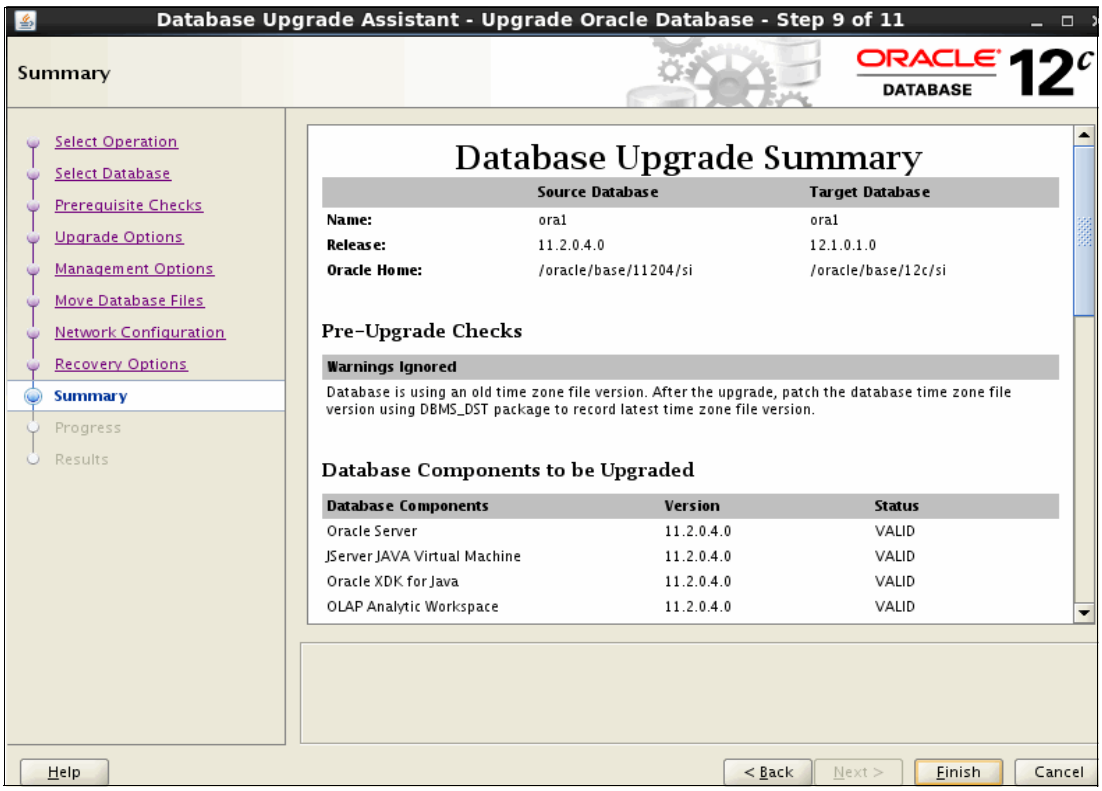


Figure 7-10 DBUA Summary

6. After verifying that the upgrade summary is correct, click **Finish** to perform the database upgrade. Figure 7-11 shows that the upgrade is complete.

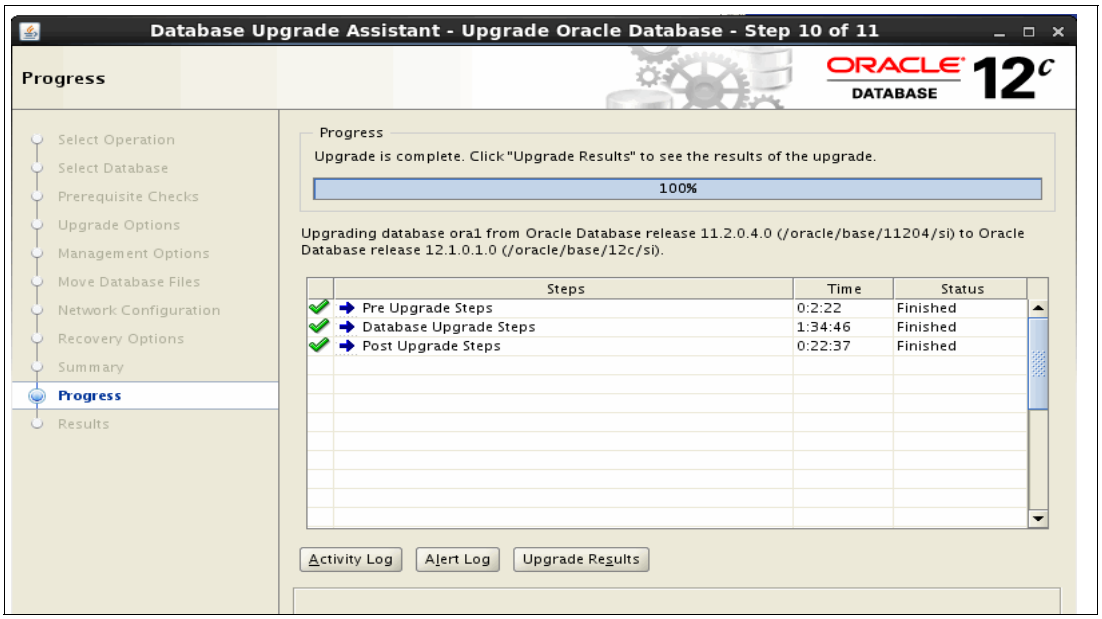


Figure 7-11 DBUA complete

The upgrade using DBUA took some time for a small database, so performance is another area where careful consideration must be given to the database upgrade process. Also, this is a good time to do a full database backup.

7.4 Post-upgrade tasks

After your database is upgraded and open in normal mode, you must run `rdbms/admin/catuppst.sql`, which runs several required tasks and completes the upgrade process. Then, run `rdbms/admin/utlrp.sql`, and then run `.rdbms/admin/utluiobj.sql` to compare invalid objects before and after the upgrade.

In our example, we ran the `catuppst.sql` script on the Oracle Database 12c instance. Because it generated several pages of output, it is not reproduced here. However, the log that was created is shown here:

```
[oracle@strkc165 si]$ cat
/oracle/base/12c/si/cfgtoollogs/catbundle/catbundle_PSU_ORA1_APPLY_2013Nov25_11_52
_40.log
SQL> exec dbms_registry.set_session_namespace('SERVER')

PL/SQL procedure successfully completed.

SQL> ALTER SESSION SET current_schema = SYS;

Session altered.

SQL> PROMPT Updating registry...
Updating registry...
SQL> INSERT INTO registry$history
  2    (action_time, action,
  3     namespace, version, id,
  4     bundle_series, comments)
  5  VALUES
  6    (SYSTIMESTAMP, 'APPLY',
  7     SYS_CONTEXT('REGISTRY$CTX','NAMESPACE'),
  8     '12.1.0.1',
  9     0,
 10     'PSU',
 11     'Patchset 12.1.0.0.0');

1 row created.

SQL> COMMIT;

Commit complete.

SQL> SPOOL off
```

As there are no invalid objects, the outputs of scripts `utlrp.sql` and `utluiobj.sql` are not shown.

The time zone file was upgraded to Version 18 on Oracle Database 12c by using the instructions in Oracle support note, *Updating the RDBMS DST version in 12c Release 1 (12.1.0.1 and up) using DBMS_DST*, ID 1509653.1. Here you can see the process to update the time zone file

```
SQL> SELECT VERSION FROM v$timezone_file;

   VERSION
----------
        18
```

7.5 Converting a non-CDB to a PDB

Using the information in the “Direct adoption of a 12.1 non-CDB as a PDB” section of the *Oracle Multitenant* white paper, found at http://www.oracle.com/technetwork/database/multitenant/overview/index.html, covert the upgraded database to a PDB database. Chapter 4, “Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database” on page 47 describes how to create a Oracle Database 12c multitenant database (CDB), so the details are not repeated here. However, an empty CDB (ora1cdb) instance is now available, as is the upgraded non-CDB (ora1) instance.

On the ora1 instance, run the following script to prepare the non-CBD for cloning as a PDB in a CDB instance. Then, start the instance in exclusive mode and open the database in read-only mode. Then, create an XML file for use in the clone process. Finally, shut down the non-CDB instance.

```
SQL> startup pfile=initora1.ora mount exclusive
ORACLE instance started.
Total System Global Area 5010685952 bytes
Fixed Size                  2374920 bytes
Variable Size            1040188152 bytes
Database Buffers         3959422976 bytes
Redo Buffers                8699904 bytes
Database mounted.

SQL> alter database open read only;
Database altered.

SQL> exec dbms_pdb.describe(pdb_descr_file => '/oracle/base/12c/ora1noncdb.xml');

PL/SQL procedure successfully completed.
```

Start the CDB instance (ora1cdb) and the cloning process by running the following command:

```
SQL> create pluggable database ora1pdb as clone using
'/oracle/base/12c/ora1noncdb.xml'
file_name_convert=('/oracle/base/oradata/ora1','/oracle/base/oradata/ora1pdb')
copy;
Pluggable database created.
SQL> show con_name
CON_NAME
------------------------------
CDB$ROOT
```

```
SQL> select name,open_mode from v$containers;

NAME                           OPEN_MODE
------------------------------ ----------
CDB$ROOT                       READ WRITE
PDB$SEED                       READ ONLY
ORA1PDB                        MOUNTED
```

Open and close the new pluggable database to complete the clone process by running the following commands. Also, now there is a service name of ora1pdb registered with the local listener.

```
SQL> alter pluggable database ora1pdb open;
Pluggable database altered.

SQL> alter pluggable database ora1pdb close;
Pluggable database altered.
```

The message `Warning: PDB altered with errors` was displayed when ora1pdb opened. The message disappeared after the `noncdb_to_pdb.sql` script was run to remove superfluous non-CDB data from the PDB data dictionary:

```
SQL> @../rdbms/admin/noncdb_to_pdb
```

This script produces several pages of output and is not reproduced here. The script also took about 20 minutes to run.

The original 11204 ora1 database is now a Oracle Database 12c PDB named ora1pdb. Connect with “sys” to ora1pdb and set up an administrator for the PDB by running the following commands:

```
SQL> show con_name
CON_NAME
------------------------------
CDB$ROOT

SQL> connect sys/Oracle_01@localhost:1521/ora1pdb as sysdba
Connected.
SQL> show con_name
CON_NAME
------------------------------
ORA1PDB

SQL> create user pdbadmin identified by Oracle_01 account unlock;
User created.

SQL> grant pdb_dba to pdbadmin;
Grant succeeded.

SQL> connect pdbadmin/Oracle_01@localhost:1521/ora1pdb
Connected.

SQL> show con_name
CON_NAME
------------------------------
ORA1PDB
```

8

Upgrading a Oracle Real Application Cluster 11.2.0.4 database to version 12c R1

This chapter describes the steps to upgrade an Oracle Real Application Cluster (RAC) 11.2.0.4 database to an Oracle RAC 12c multitenant (CDB) database. Here are the overall steps:

- Performing an out-of-place upgrade of the Oracle Grid Infrastructure 11.2.0.4 (CRS/ASM)
- Installing the Oracle RAC 12c software
- Migrating a test table space with Data Pump export/import.

Note the following items:

- There are no active users during the export.
- The Linux guests that are used in this chapter are on different nodes from the ones that are used in previous chapters.
- The SCAN IP is strkc164167-r.

8.1 Upgrading the Oracle Grid Infrastructure

The home directory for the grid infrastructure for the Oracle RAC 11.2.0.4 crs/asm that will be upgraded is `/oracle/crs`. The home directory for the out-of-place upgrade for Oracle RAC 12c is `/oracle2/grid`. The cluster verify utility is run to check the readiness of the Oracle RAC 11.2.0.4 grid infrastructure to be upgraded to Oracle RAC 12c. There is a verbose option if more output is wanted from cluster verify. Run runcluvfy.sh from the Oracle RACE 12c extracted `clusterware` directory, as shown in Example 8-1.

Example 8-1 Running the cluster verify utility (runcluvfy)

```
runcluvfy.sh stage -pre crsinst -upgrade -n strkc164,strkc165 -src_crshome
/oracle/crs -dest_crshome /oracle2/grid -dest_version 12.1.0.1.0.1 -fixup

Performing pre-checks for cluster services setup

Checking node reachability...
Node reachability check passed from node "strkc164"

Checking user equivalence...
User equivalence check passed for user "oracle"

Checking CRS user consistency
CRS user consistency check successful
Checking ASM disk size consistency
All ASM disks are correctly sized
Checking if default discovery string is being used by ASM
ASM discovery string "/dev/mapper/lun*, /dev/asm40*" is not the default discovery
string

Checking node connectivity...
Checking hosts config file...

Verification of the hosts config file successful

Check: Node connectivity using interfaces on subnet "130.35.40.0"
Node connectivity passed for subnet "130.35.40.0" with node(s) strkc165,strkc164
TCP connectivity check passed for subnet "130.35.40.0"


Check: Node connectivity using interfaces on subnet "10.10.3.0"
Node connectivity passed for subnet "10.10.3.0" with node(s) strkc164,strkc165
TCP connectivity check passed for subnet "10.10.3.0"

Checking subnet mask consistency...
Subnet mask consistency check passed for subnet "130.35.40.0".
Subnet mask consistency check passed for subnet "10.10.3.0".
Subnet mask consistency check passed.
Node connectivity check passed

Checking multicast communication...

Checking subnet "10.10.3.0" for multicast communication with multicast group
"224.0.0.251"...
```

```
Check of subnet "10.10.3.0" for multicast communication with multicast group
"224.0.0.251" passed.

Check of multicast communication passed.
Task ASM Integrity check started...

Starting check to see if ASM is running on all cluster nodes...

ASM Running check passed. ASM is running on all specified nodes

Starting Disk Groups check to see if at least one Disk Group configured...
Disk Group Check passed. At least one Disk Group configured

Task ASM Integrity check passed...

Checking OCR integrity...

OCR integrity check passed
Total memory check passed
Available memory check passed
Swap space check passed
Free disk space check passed for
"strkc165:/usr,strkc165:/var,strkc165:/etc,strkc165:/sbin,strkc165:/tmp"
Free disk space check passed for
"strkc164:/usr,strkc164:/var,strkc164:/etc,strkc164:/sbin,strkc164:/tmp"
Free disk space check passed for "strkc165:/oracle/crs"
Free disk space check passed for "strkc164:/oracle/crs"
Check for multiple users with UID value 500 passed
User existence check passed for "oracle"
Group existence check passed for "oinstall"
Group existence check passed for "dba"
Membership check for user "oracle" in group "oinstall" [as Primary] passed
Membership check for user "oracle" in group "dba" passed
Run level check passed
Hard limits check passed for "maximum open file descriptors"
Soft limits check passed for "maximum open file descriptors"
Hard limits check passed for "maximum user processes"
Soft limits check passed for "maximum user processes"
There are no oracle patches required for home "/oracle/crs".
There are no oracle patches required for home "/oracle/crs".
Source home "/oracle/crs" is suitable for upgrading to version "12.1.0.1.0".
System architecture check passed
Kernel version check passed
Kernel parameter check passed for "semmsl"
Kernel parameter check passed for "semmns"
Kernel parameter check passed for "semopm"
Kernel parameter check passed for "semmni"
Kernel parameter check passed for "shmmax"
Kernel parameter check passed for "file-max"
Kernel parameter check passed for "ip_local_port_range"
Kernel parameter check passed for "rmem_default"
Kernel parameter check passed for "rmem_max"
Kernel parameter check passed for "wmem_default"
Kernel parameter check passed for "wmem_max"
Kernel parameter check passed for "aio-max-nr"
```

```
Package existence check passed for "binutils"
Package existence check passed for "compat-libstdc++-33(s390x)"
Package existence check passed for "libgcc(s390x)"
Package existence check passed for "libstdc++(s390x)"
Package existence check passed for "libstdc++-devel(s390x)"
Package existence check passed for "sysstat"
Package existence check passed for "gcc"
Package existence check passed for "gcc-c++"
Package existence check passed for "ksh"
Package existence check passed for "make"
Package existence check passed for "glibc(s390x)"
Package existence check passed for "glibc-devel(s390x)"
Package existence check passed for "libaio(s390x)"
Package existence check passed for "libaio-devel(s390x)"
Check for multiple users with UID value 0 passed
Current group ID check passed

Starting check for consistency of primary group of root user

Check for consistency of root user's primary group passed
Package existence check passed for "cvuqdisk"

Starting Clock synchronization checks using Network Time Protocol(NTP)...

NTP Configuration file check started...
NTP Configuration file check passed

Checking daemon liveness...
Liveness check passed for "ntpd"
Check for NTP daemon or service alive passed on all nodes

NTP common Time Server Check started...
Check of common NTP Time Server passed

Clock time offset check from NTP Time Server started...
Clock time offset check passed

Clock synchronization check using Network Time Protocol(NTP) passed

Core file name pattern consistency check passed.

User "oracle" is not part of "root" group. Check passed
Default user file creation mask check passed
Checking integrity of file "/etc/resolv.conf" across nodes

"domain" and "search" entries do not coexist in any  "/etc/resolv.conf" file
All nodes have same "search" order defined in file "/etc/resolv.conf"
The DNS response time for an unreachable node is within acceptable limit on all
nodes
Check for integrity of file "/etc/resolv.conf" passed

UDev attributes check for OCR locations started...
UDev attributes check passed for OCR locations

UDev attributes check for Voting Disk locations started...
```

```
UDev attributes check passed for Voting Disk locations

Time zone consistency check passed
Checking VIP configuration.
Checking VIP Subnet configuration.
Check for VIP Subnet configuration passed.
Checking VIP reachability
Check for VIP reachability passed.

Checking Oracle Cluster Voting Disk configuration...

Oracle Cluster Voting Disk configuration check passed

Clusterware version consistency passed.

Checking integrity of name service switch configuration file "/etc/nsswitch.conf"
...
All nodes have same "hosts" entry defined in file "/etc/nsswitch.conf"
Check for integrity of name service switch configuration file "/etc/nsswitch.conf"
passed


Checking daemon "avahi-daemon" is not configured and running
Daemon not configured check passed for process "avahi-daemon"
Daemon not running check passed for process "avahi-daemon"

Starting check for /dev/shm mounted as temporary file system ...

Check for /dev/shm mounted as temporary file system passed
```

Note: There are *no* fixable verification failures to fix.

The pre-check for the cluster services setup is successful.

The upgrade checks were met. The Oracle Database 11.2.0.4 system is up and RAC is running on both nodes. Run a check to ensure that there are no Oracle environmental variables set and that an Oracle `bin` directory is not included in the $PATH variable before starting runInstaller. To run this check, run the following command:

```
[root@strkc164 ~]# /oracle/crs/bin/crsctl query crs activeversion
Oracle Clusterware active version on the cluster is [11.2.0.4.0]
```

8.2 Upgrading Oracle Grid Infrastructure through the GUI

Running **runInstaller** from the extracted `clusterware` directory opens the GUI window that is shown in Figure 8-1. You use this window to start the upgrade process. The captions of Figure 8-1 through Figure 8-13 on page 173 tell the steps that we followed.

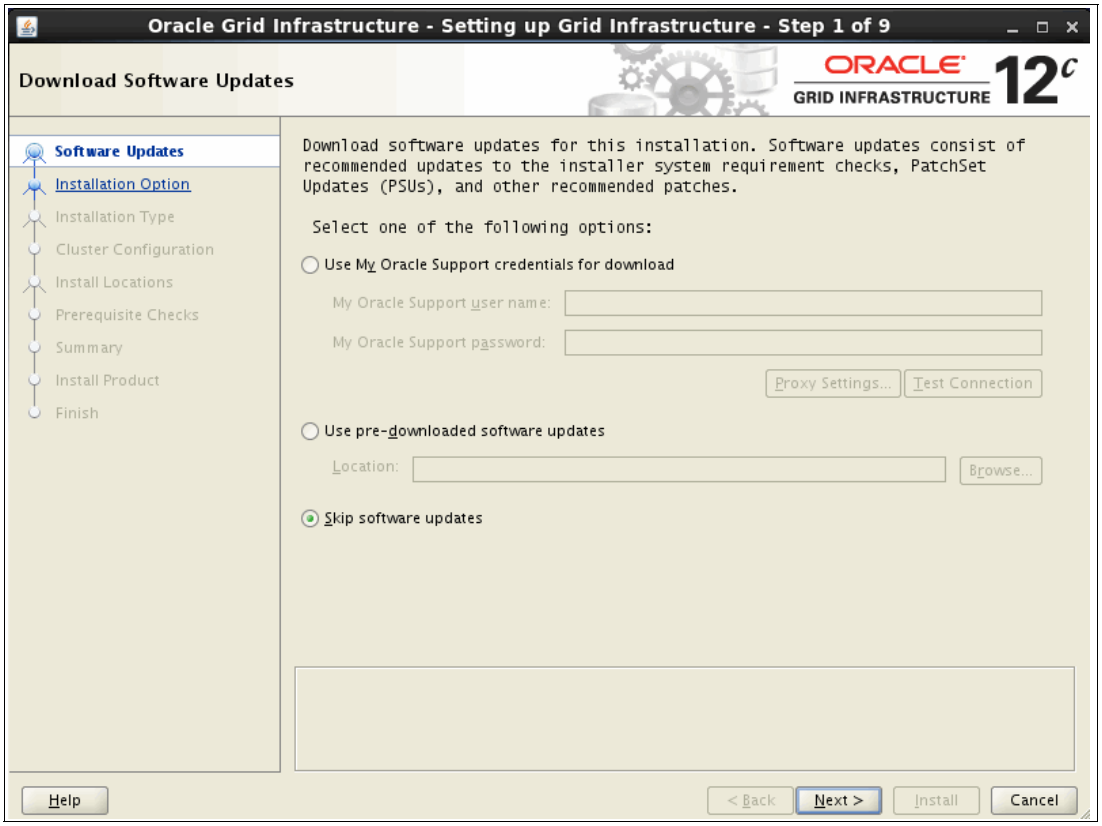


Figure 8-1 Skip software updates

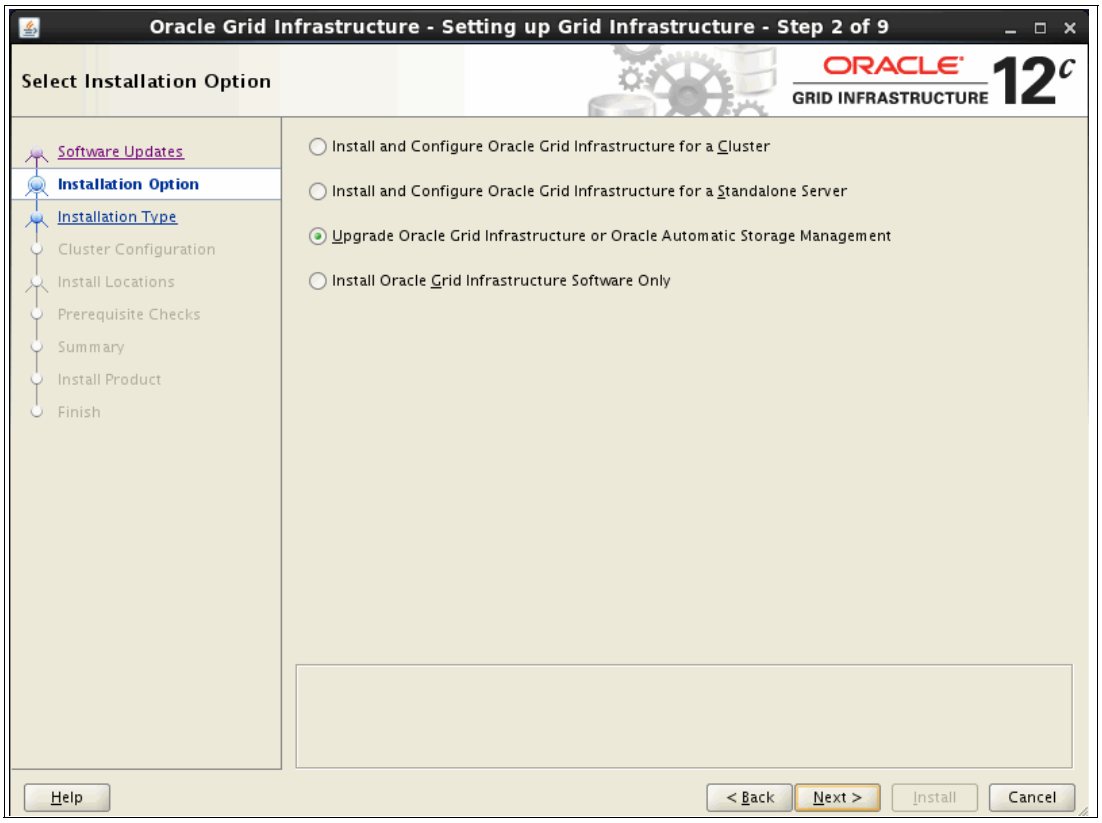


Figure 8-2 Upgrade Oracle Grid Infrastructure 11.2.0.4

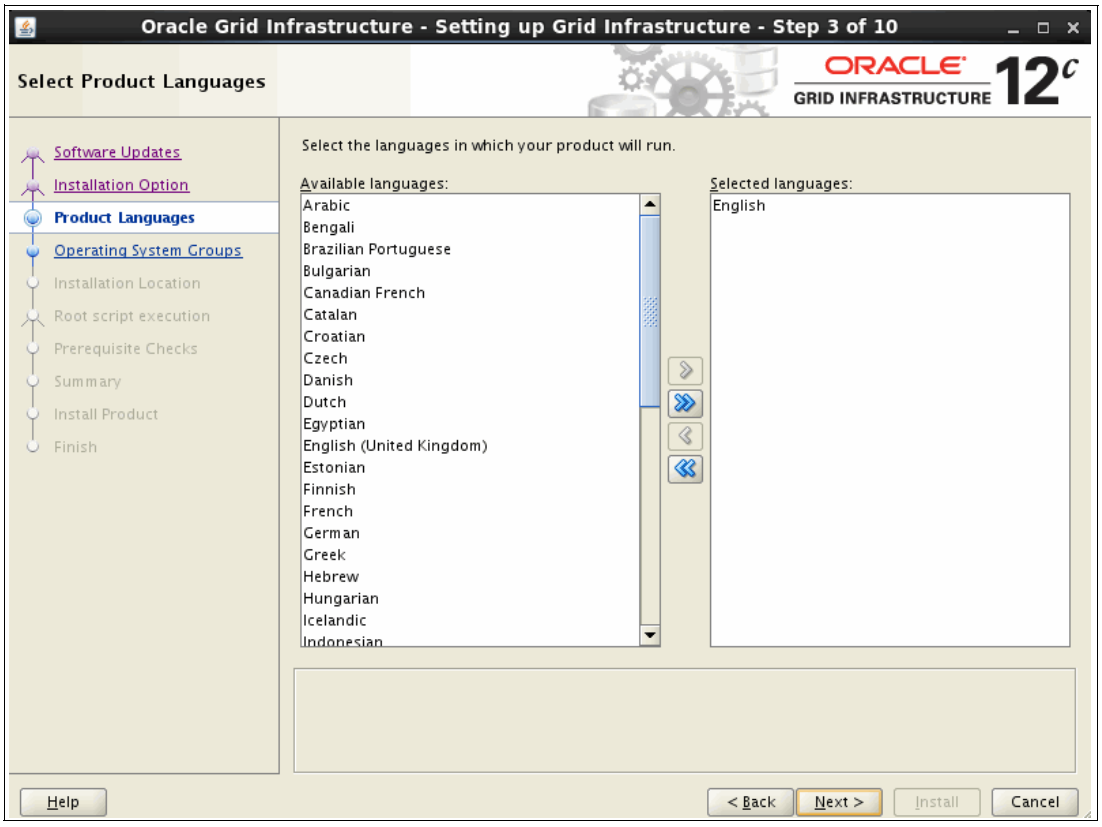


Figure 8-3 Select English as the only language

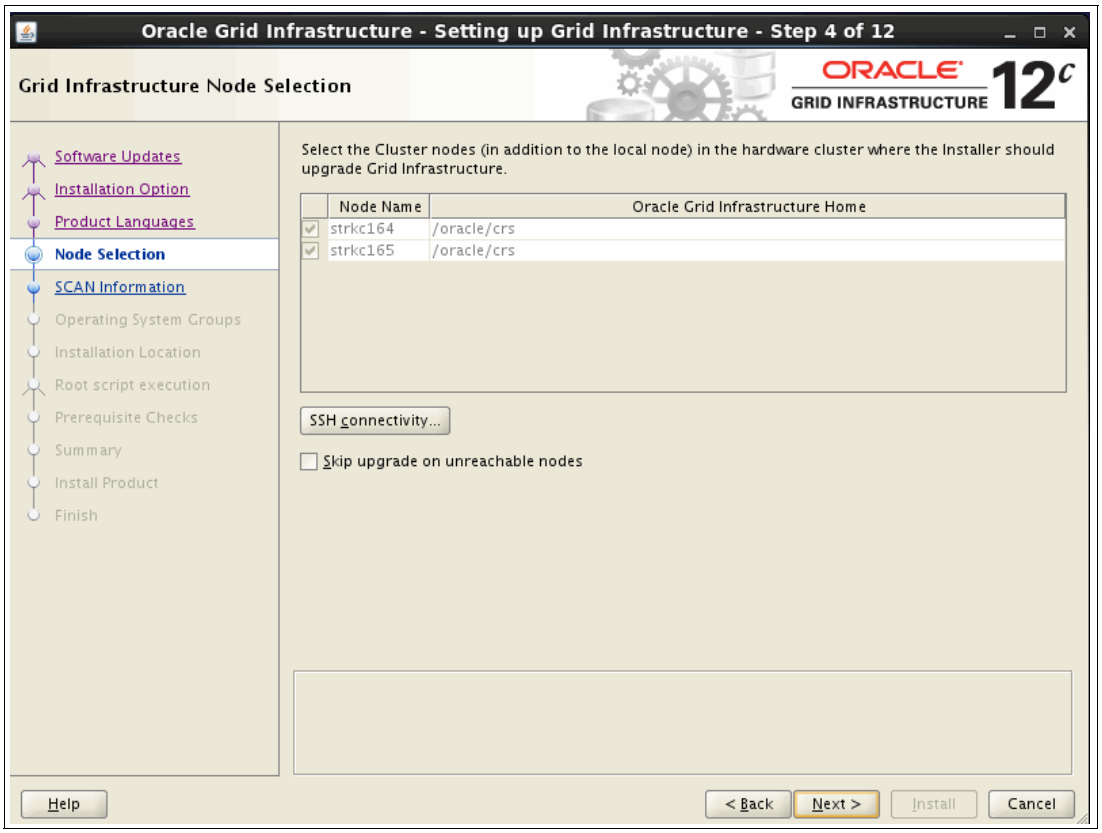


Figure 8-4 Upgrade the Oracle Grid Infrastructure on both nodes

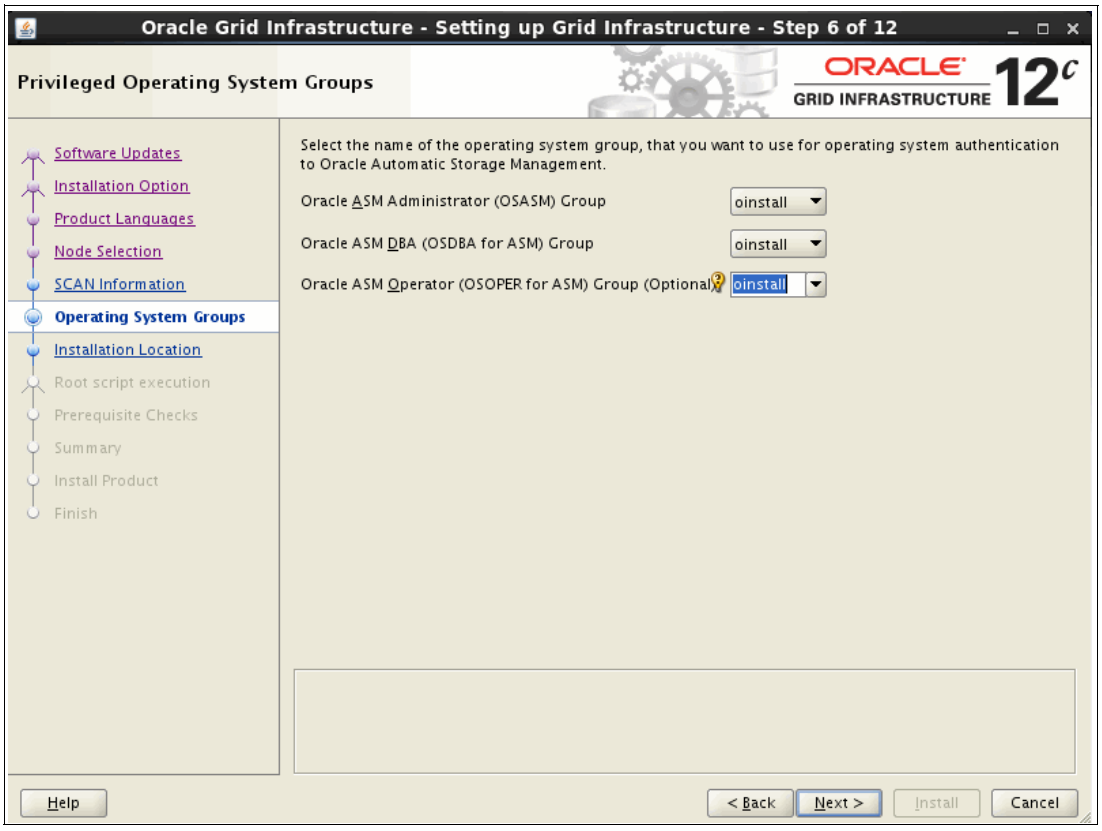


Figure 8-5 Use Oinstall group for everything

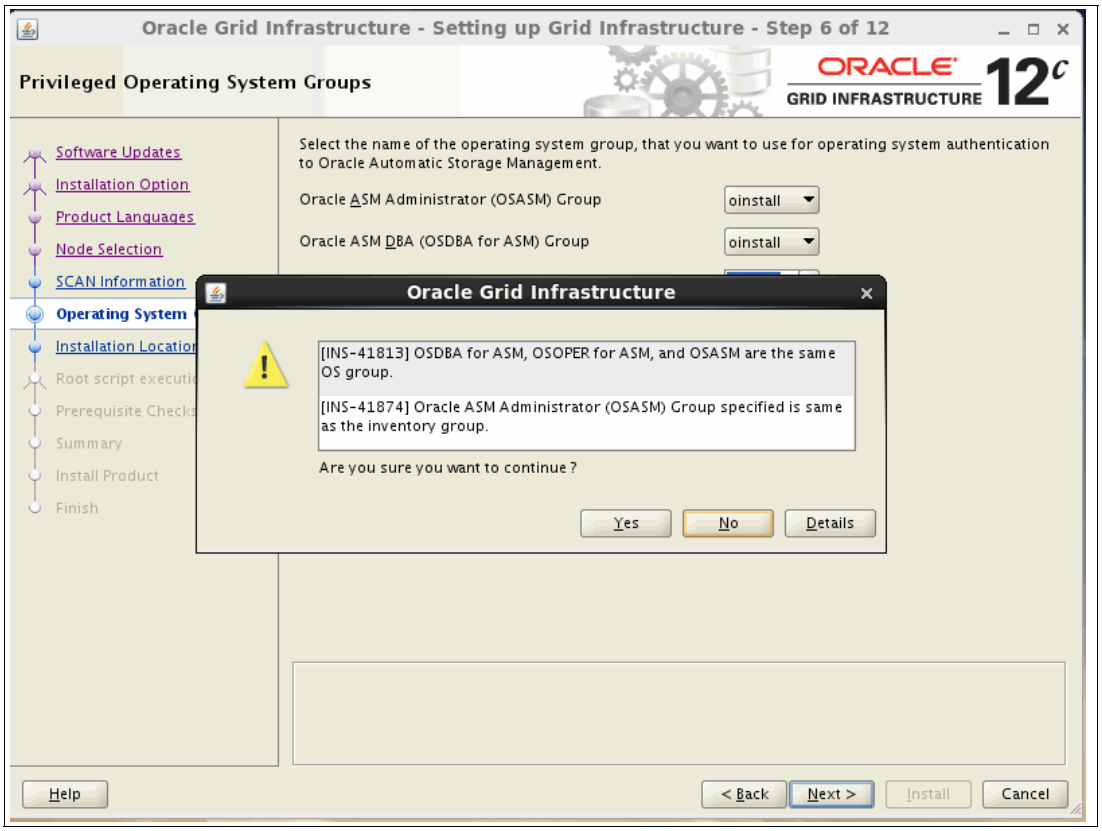


Figure 8-6 Ignore the information message

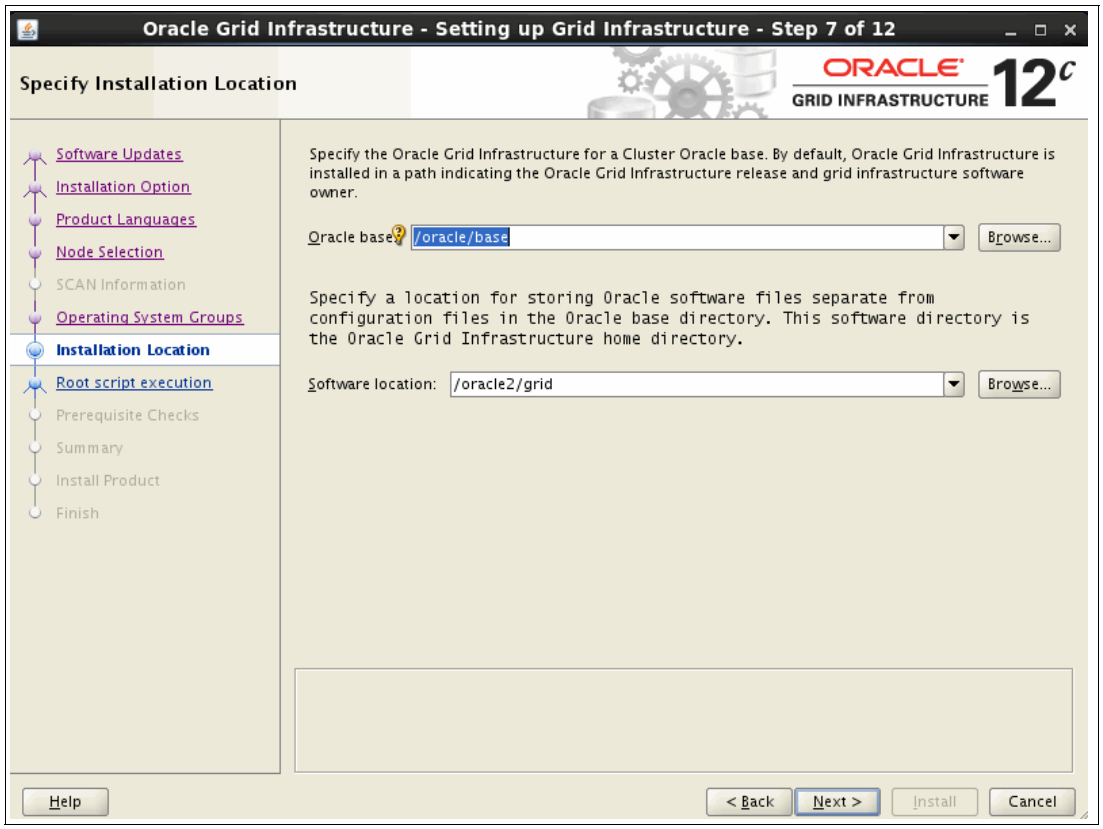


Figure 8-7 Out-of-place new grid home

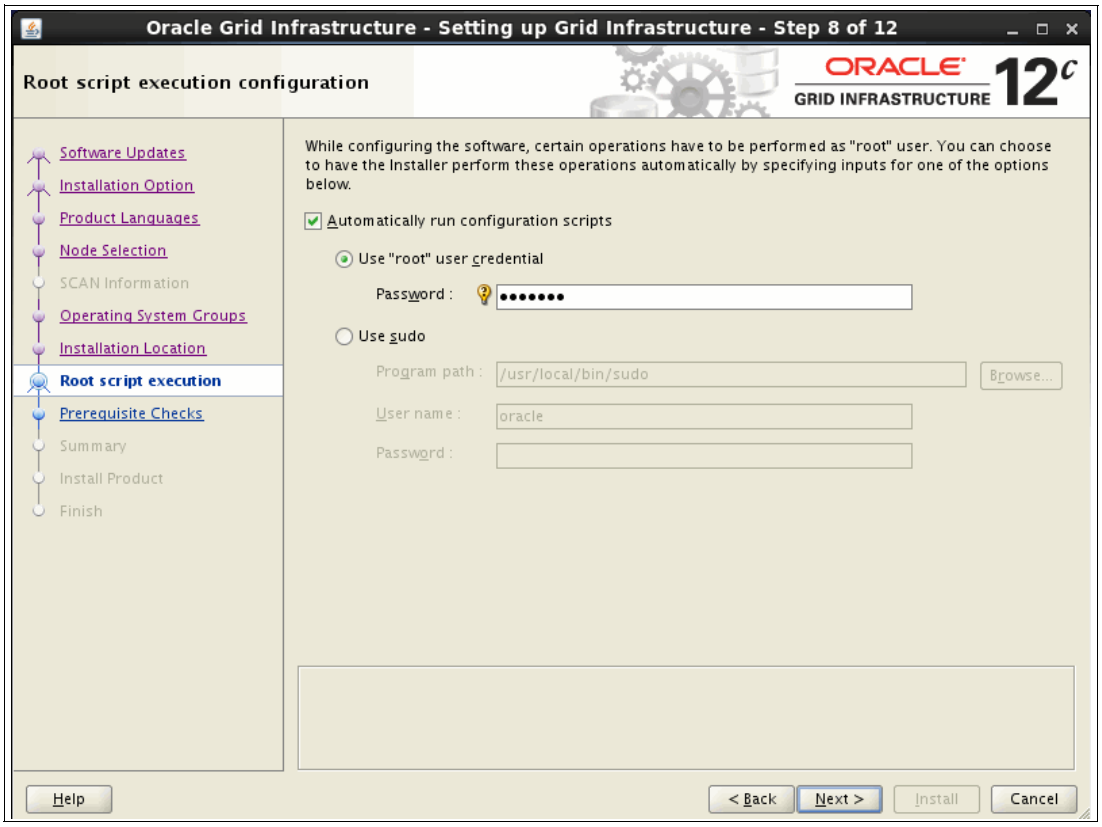


Figure 8-8 Automatically run the root configuration scripts

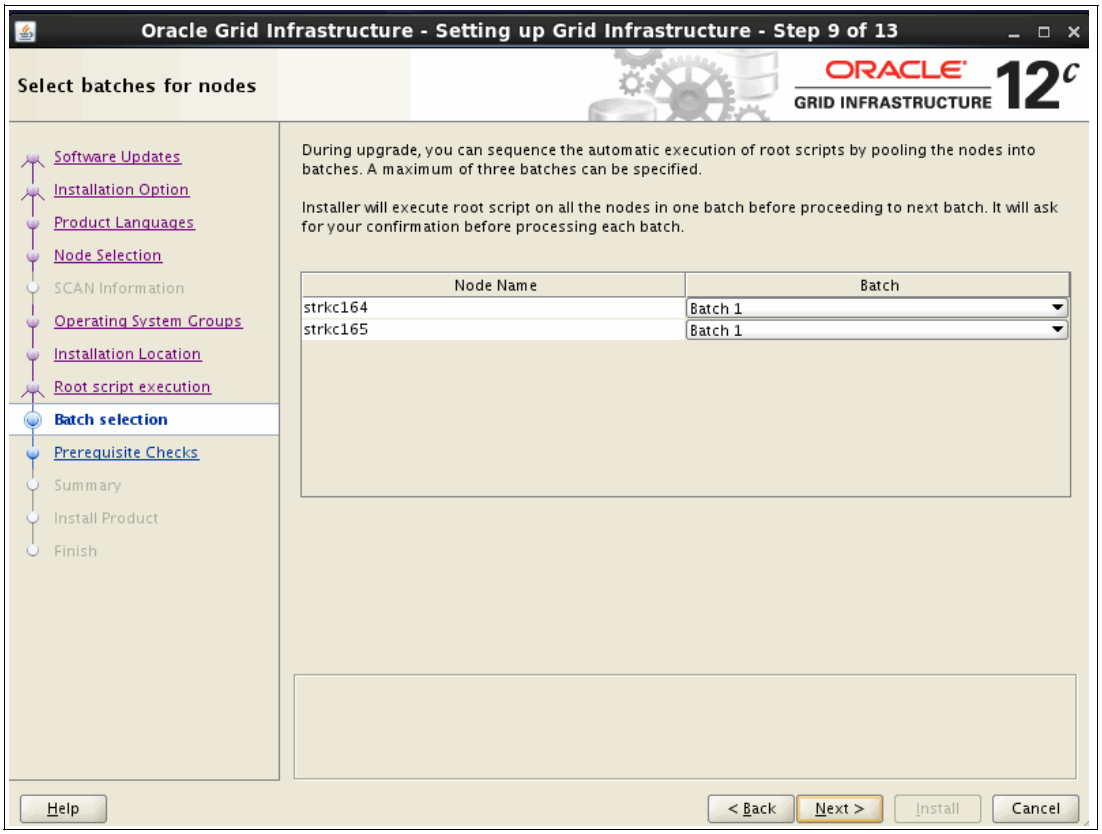


Figure 8-9 Use the two-node default sequence to run the root scripts

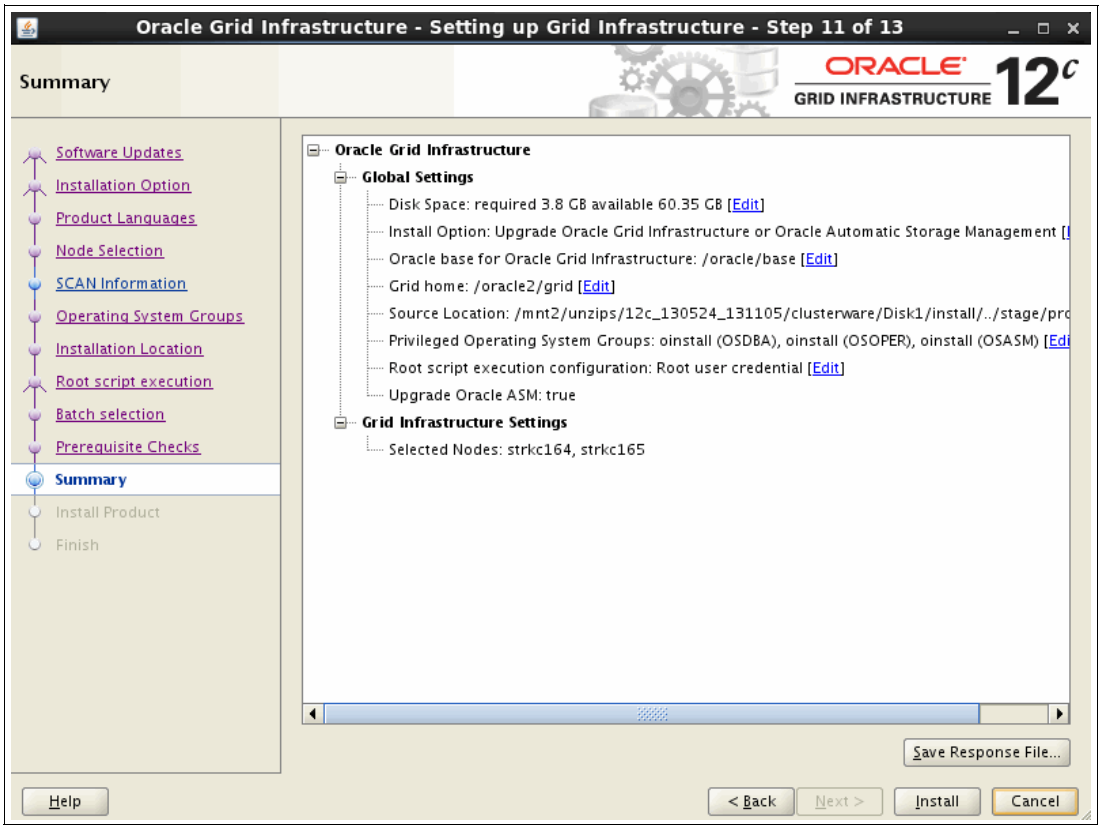


Figure 8-10 Oracle Grid Infrastructure upgrade summary

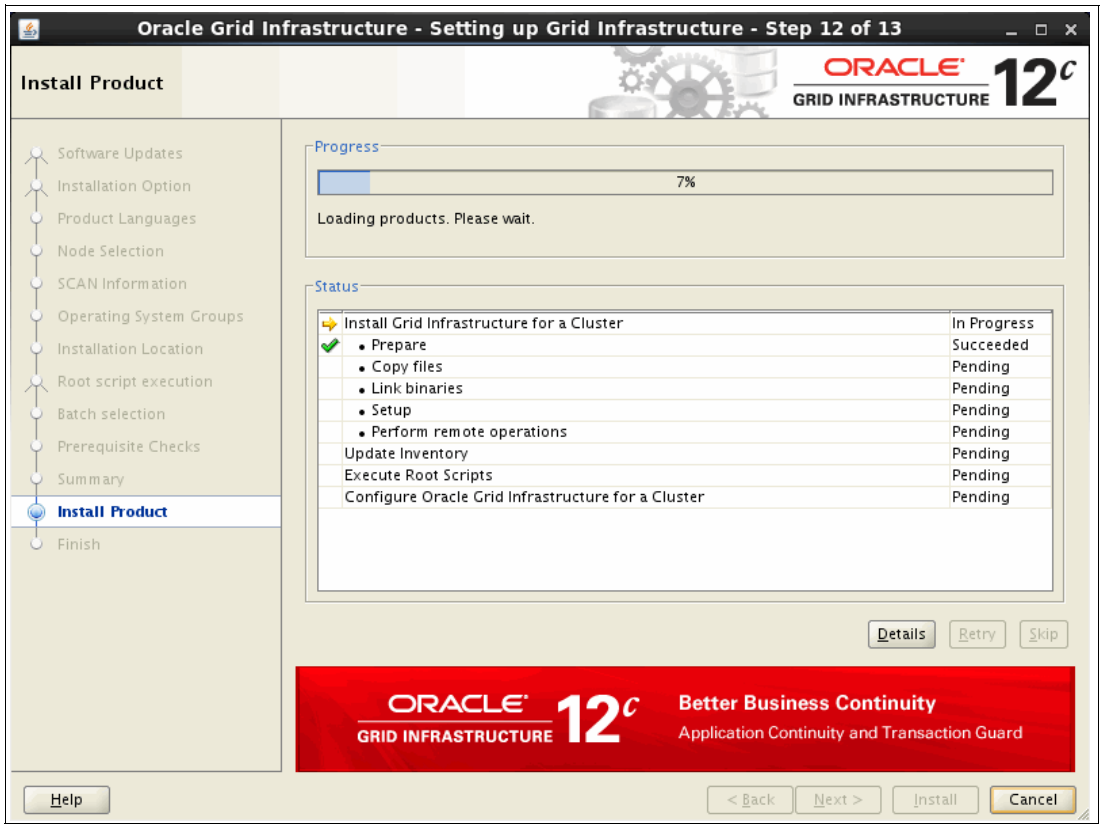


Figure 8-11 Oracle Grid Infrastructure upgrade progress

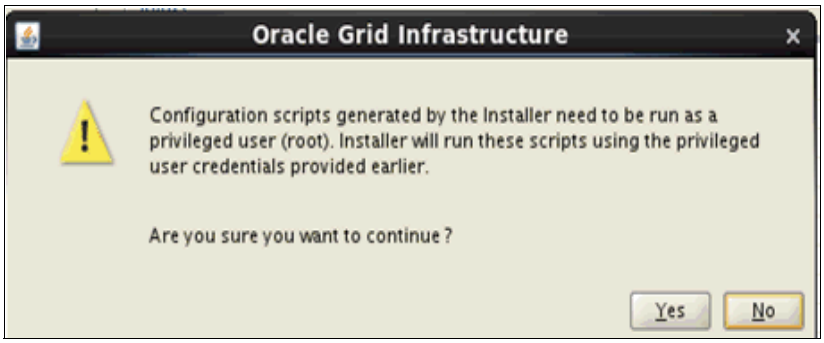


Figure 8-12 Select Yes to run the root configuration scripts

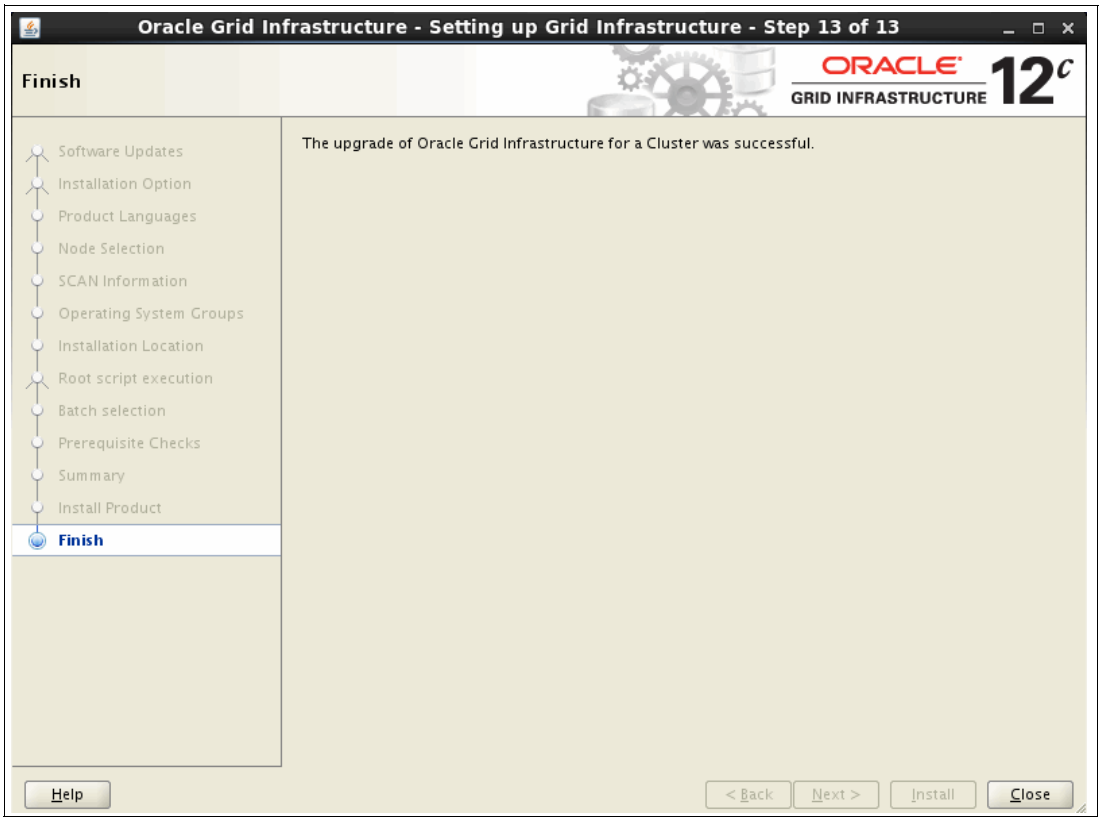


Figure 8-13 Oracle Grid Infrastructure 11.2.0.4 is upgraded to Oracle Grid Infrastructure 12.1.0.1

The Oracle Grid Infrastructure is upgraded to Version 12.1.0.1.0 and the Oracle RAC 11.2.0.4.0 system is running with the new infrastructure.

A check of the status of **crs** shows that it is now Version 12.1.0.1.0:

```
[root@strkc164 ~]# /oracle2/grid/bin/crsctl query crs activeversion
Oracle Clusterware active version on the cluster is [12.1.0.1.0]
```

Similarly, a check of **ASM** shows it is now Version 12.1.0.1.0:

```
[oracle@strkc164 ~]$ sqlplus / as sysasm
SQL*Plus: Release 12.1.0.1.0 Production on Thu Dec 5 07:19:06 2013
Copyright (c) 1982, 2013, Oracle.  All rights reserved.
Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.1.0 - 64bit Production
With the Real Application Clusters and Automatic Storage Management options
```

Because Oracle RAC is not upgraded, it is still at Version 11.2.0.4.0, as shown by running the following command:

```
[oracle@strkc164 dbs]$ sqlplus / as sysdba
SQL*Plus: Release 11.2.0.4.0 Production on Thu Dec 5 07:21:54 2013
Copyright (c) 1982, 2013, Oracle.  All rights reserved.
Connected to:
Oracle Database 11g Enterprise Edition Release 11.2.0.4.0 - 64bit Production
With the Partitioning, Real Application Clusters, Automatic Storage Management,
OLAP,
Data Mining and Real Application Testing options
```

A quick check of the sample data shows that it is still available on Oracle RAC 11.2.0.4.0 after ASM has been upgraded to Version 12.1.0.1.0:

```
SQL> connect scott/tiger@strkc164167-r/rac
Connected.
SQL> select * from dept;

    DEPTNO DNAME          LOC
---------- -------------- -------------
        10 ACCOUNTING     NEW YORK
        20 RESEARCH       DALLAS
        30 SALES          CHICAGO
        40 OPERATIONS     BOSTON
```

8.3 Data pump export of an Oracle RAC 11.2.0.4 table space

The data pump export feature is used to unload the swingbench table space (SOE) into an external dump file. The following SQL shows the creation of data pump export directories for the external dump file and the log:

```
SQL> CREATE or REPLACE DIRECTORY dpump_dir as '+DATA/';
Directory created.

SQL> CREATE or REPLACE DIRECTORY dpump_log as '/oracle2/nfs_share/';
Directory created
```

Here is the data pump export parameter file:

```
[oracle@strkc164 ~]$ cat /oracle2/nfs_share/exp_parfile_11g_soe
DIRECTORY=dpump_dir
LOGFILE=dpump_log:export_11g_soe.log
DUMPFILE=export_soe%U.dmp
TABLESPACES=soe
#
```

Example 8-2 shows the data pump export command and its output.

Example 8-2 Output of data pump export command

```
[oracle@strkc164 dbs]$ expdp system/manager
parfile=/oracle2/nfs_share/exp_parfile_11g_soe
Export: Release 11.2.0.4.0 - Production on Sun Dec 29 17:36:26 2013
Copyright (c) 1982, 2011, Oracle and/or its affiliates.  All rights reserved.
Connected to: Oracle Database 11g Enterprise Edition Release 11.2.0.4.0 - 64bit
Production
With the Partitioning, Real Application Clusters, Automatic Storage Management,
OLAP,
Data Mining and Real Application Testing options
Starting "SYSTEM"."SYS_EXPORT_TABLESPACE_01":  system/********
parfile=/oracle2/nfs_share/exp_parfile_11g_soe
Estimate in progress using BLOCKS method...
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
Total estimation using BLOCKS method: 9.675 GB
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/INDEX/INDEX
Processing object type TABLE_EXPORT/TABLE/INDEX/FUNCTIONAL_INDEX/INDEX
```

```
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/CONSTRAINT
Processing object type TABLE_EXPORT/TABLE/INDEX/STATISTICS/INDEX_STATISTICS
Processing object type
TABLE_EXPORT/TABLE/INDEX/STATISTICS/FUNCTIONAL_INDEX/INDEX_STATISTICS
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/REF_CONSTRAINT
Processing object type TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
. . exported "SOE"."ORDER_ITEMS"                          2.983 GB 134982884 rows
. . exported "SOE"."CUSTOMERS"                            2.454 GB 40000000 rows
. . exported "SOE"."ORDERS"                               2.215 GB 45000000 rows
. . exported "SOE"."LOGON"                                161.9 MB 10000000 rows
. . exported "SOE"."INVENTORIES"                          15.25 MB  900965 rows
. . exported "SOE"."ORDERENTRY_METADATA"                  5.539 KB       4 rows
. . exported "SOE"."PRODUCT_DESCRIPTIONS"                 221.5 KB    1000 rows
. . exported "SOE"."PRODUCT_INFORMATION"                  187.3 KB    1000 rows
. . exported "SOE"."WAREHOUSES"                           35.30 KB    1000 rows
Master table "SYSTEM"."SYS_EXPORT_TABLESPACE_01" successfully loaded/unloaded
******************************************************************************
Dump file set for SYSTEM.SYS_EXPORT_TABLESPACE_01 is:
  +DATA/export_soe01.dmp
Job "SYSTEM"."SYS_EXPORT_TABLESPACE_01" successfully completed at Sun Dec 29
17:39:42 2013 elapsed 0 00:03:13
```

8.4 Installing the Oracle RAC 12c software and creating a PDB

An installation of the Oracle RAC 12c RAC is described in Chapter 4, “Installing Oracle Database 12c Oracle Real Application Clusters and creating a multitenant database” on page 47. The RAC software is installed in the `/oracle/base/12c/rac` directory. In this section, the goal is to import the exported table space that is described in 8.3, “Data pump export of an Oracle RAC 11.2.0.4 table space” on page 174 in to a PDB, so you must create a PDB.

Section 4.4, “Creating a PDB in the CDB by using DBCA” on page 69 shows how to create a PDB, so only the configuration DBCA window is shown here in Figure 8-14. A new ASM disk group, DATA12C, was created to hold the PDB and imported data.

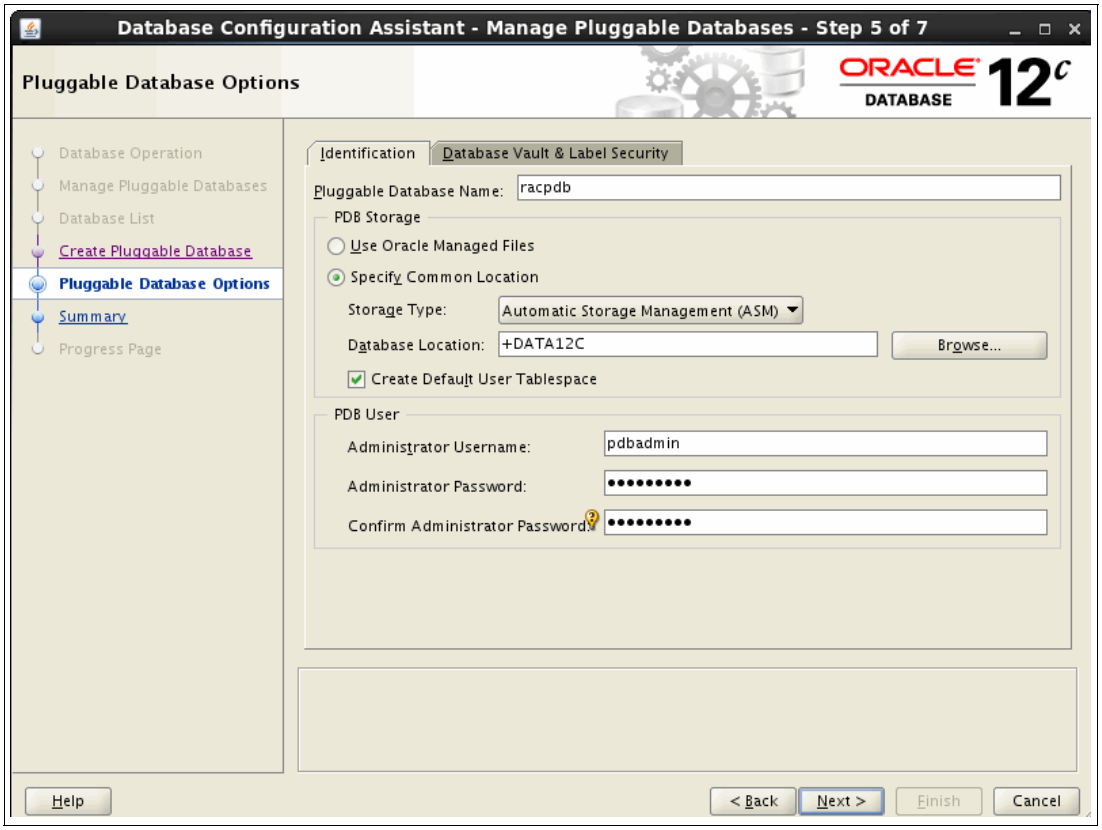


Figure 8-14 PDB for data pump import

The PDB is named racpdb. The PDB is created with pdbadmin as the administrator. Regarding checking privileges, pdbadmin has the PDB_DBA and CONNECT roles after the PDB is created. The roles cdb_dba and datapump_imp_full_database are granted to pdbadmin. Also, unlimited table space is granted to pdbadmin.

With the user name sys connected to the PDB, two directories are created for data pump import: One is for the external dump file and the other is to store the import log file, as shown in the following lines:

```
SQL> show user
USER is "SYS"

SQL> show con_name
CON_NAME
------------------------------
RACPDB

SQL> CREATE or REPLACE DIRECTORY dpump_dir as '+DATA/';
Directory created.

SQL> CREATE or REPLACE DIRECTORY dpump_log as '/oracle2/nfs_share/';
```

The directory names are the same as that are used for the export, but they do not have to be.

The first directory must point to +DATA/ because this is where the export dump file is. The second directory is for the import log. Its requirements are that the file must be accessible to both RAC nodes (as is the case for the export log file) and it cannot be in ASM.

Here is the import parameter file that is used by data pump import:

```
[oracle@strkc164 ~]$ cat /oracle2/nfs_share/imp_parfile_12c_soe
DIRECTORY=dpump_dir
LOGFILE=dpump_log:import_12c_soe.log
DUMPFILE=export_soe%U.dmp
TABLESPACES=soe
SKIP_UNUSABLE_INDEXES=YES
TABLE_EXISTS_ACTION=SKIP
EXCLUDE=STATISTICS
REMAP_DATAFILE="'+DATA_11G/soe.dbf':'+DATA12C/import/soe.dbf'"
```

Before you run the import, create the soe table space and soe user in the PDB as follows:

```
SQL> connect pdbadmin/Oracle_01@strkc164/racpdb
Connected.
SQL> create bigfile tablespace soe datafile '+data12c/import/soe.dbf' size 50G
autoextend on;
Tablespace created.
SQL> create user soe identified by soe account unlock;
User created.
SQL> grant unlimited tablespace to soe;
Grant succeeded.
SQL> grant pdb_dba to soe;
```

The data pump import into Version 12C and messages are shown here:

```
[oracle@strkc164 dbs]$ impdp pdbadmin/Oracle_01@strkc164/racpdb
PARFILE=/oracle2/nfs_share/imp_parfile_12c_soe
Import: Release 12.1.0.1.0 - Production on Sun Dec 29 18:07:18 2013
Copyright (c) 1982, 2013, Oracle and/or its affiliates.  All rights reserved.
Connected to: Oracle Database 12c Enterprise Edition Release 12.1.0.1.0 - 64bit
Production
With the Partitioning, Real Application Clusters, Automatic Storage Management,
OLAP,
Advanced Analytics and Real Application Testing options
Master table "PDBADMIN"."SYS_IMPORT_TABLESPACE_01" successfully loaded/unloaded
Starting "PDBADMIN"."SYS_IMPORT_TABLESPACE_01":  pdbadmin/********@strkc164/racpdb
PARFILE=/oracle2/nfs_share/imp_parfile_12c_soe
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
. . imported "SOE"."ORDER_ITEMS"                          2.983 GB 134982884 rows
. . imported "SOE"."CUSTOMERS"                            2.454 GB 40000000 rows
. . imported "SOE"."ORDERS"                               2.215 GB 45000000 rows
. . imported "SOE"."LOGON"                                161.9 MB 10000000 rows
. . imported "SOE"."INVENTORIES"                          15.25 MB  900965 rows
. . imported "SOE"."ORDERENTRY_METADATA"                  5.539 KB       4 rows
. . imported "SOE"."PRODUCT_DESCRIPTIONS"                 221.5 KB    1000 rows
. . imported "SOE"."PRODUCT_INFORMATION"                  187.3 KB    1000 rows
. . imported "SOE"."WAREHOUSES"                           35.30 KB    1000 rows
Processing object type TABLE_EXPORT/TABLE/INDEX/INDEX
Processing object type TABLE_EXPORT/TABLE/INDEX/FUNCTIONAL_INDEX/INDEX
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/CONSTRAINT
```

```
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/REF_CONSTRAINT
Job "PDBADMIN"."SYS_IMPORT_TABLESPACE_01" successfully completed at Sun Dec 29
20:00:04 2013 elapsed 0 01:52:41
```

Now that the Version 11.2.0.4 “test” table space is imported into a Version 12c PDB, here is an example of a connection with the testing user soe:

```
[oracle@strkc164 dbs]$ sqlplus soe/soe@strkc164167-r/racpdb
SQL*Plus: Release 12.1.0.1.0 Production on Mon Dec 30 06:33:16 2013
Copyright (c) 1982, 2013, Oracle.  All rights reserved.
Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.1.0 - 64bit Production
With the Partitioning, Real Application Clusters, Automatic Storage Management,
OLAP,
Advanced Analytics and Real Application Testing options

SQL> show user
USER is "SOE"
SQL> show con_name
CON_NAME
------------------------------
RACPDB
```

9

Performance management topics for IBM z/VM, Linux, and Oracle on IBM System z

This chapter contains performance management topics for Oracle on Linux on IBM System z, and uses data from zVPS from Velocity Software.[1] zVPS provides a full performance management capability for z/VM that now includes instrumentation for Oracle and Linux and other distributed servers. Each subsystem (Oracle, Linux, and z/VM) is described from a performance management perspective. Performance management is more than performance analysis. It includes the following aspects:

- Performance analysis: Performance analysis depends on the platform and application subsystem being analyzed. Instrumentation must be available to support analysis of all subsystems, hipervisors, and applications.
- Capacity planning: Capacity planning requires long-term information to trend usage and other performance metrics. zVPS maintains a full performance database with all the metrics, including Oracle metrics.
- Operational alerts: Operational alerts are required to alert staff about poor service levels or about issues that might potentially cause poor service levels. The objective is to detect problems before the users see them.
- Chargeback: Chargeback can be used to encourage users to design and code applications to reduce resource consumption, or to move workload to the optimal platform or time frame for processing. Chargeback is about running IT as a business, as part of the business. Valid resource consumption numbers are required.

Performance analysis requires platform and application knowledge. This chapter provides some of the knowledge for analyzing Oracle running on Linux under z/VM. The other three performance management topics are beyond the scope of this chapter.

[1] http://www.velocity-software.com/

9.1 zVPS

zVPS, the Velocity Performance Suite from Velocity Software, provides the function for full performance management. The requirements for continuous performance management include having low overhead, a full performance database, and complete metrics.

For data collection from z/VM, zVPS uses the CP Monitor. For data collection for Linux, network, and Oracle, zVPS is “agentless”, using the snmp daemon for data collection.

The snmp daemon is a lightweight function that uses less than 0.1% of one IFL per server, with one-minute data collection. Initial analysis of the Oracle data collection shows that with a few databases, the cost of collecting this data once a minute is within the 0.1% target.

9.1.1 Screens versus reports

zVPS uses the term *screen* for real-time information that is viewable with a 3270 emulator or browser, and uses the term *report* for data that is provided in report format from the performance database. Most screens and reports are identical in name, format, and metrics.

9.2 Oracle analysis with zVPS

Using snmp data to acquire data from the v$ tables, zVPS can provide an efficient collection mechanism to maintain historical data for trend analysis, and current pertinent data for understanding Oracle Database performance. From the systems programmer perspective, Oracle often has been a black box. Even the internal configuration settings must be provided by the Oracle administrator. With zVPS V4.2 collecting the data, storing the data, and then exposing the data, analysis can now be done by a centralized function rather than a group that includes all of the Oracle administrators.

Oracle administrators likely will find a use for this new function because data is automatically captured 24x7 at a one-minute granularity, providing full historical analysis to Oracle metrics. These metrics can then be used for trend analysis for capacity planning, and operational alerts can be set for potential performance problems.

There are four new Oracle reports that are provided by zVPS V4.2. Each report contains a prefix area, which identifies the Linux server, the database name, and the instance of the database, as shown in Figure 9-1.

```
Report: ESAORAG      Oracle
Monitor initialized: 12/20/
---------------------------
Node/
Date     <--DataBase ---->
Time     Name     Instance
-------- -------- --------
01/28/14
08:15:00
PAZXXT10 soedb    soedb
redhat6x db01     db01
sles11v2 db01     db01
```

Figure 9-1 Initialization report

The Oracle configuration report provides a high-level analysis showing the version. Figure 9-2 shows three servers:

- PAZXXT10 is Oracle Database 12c running on System z
- redhat6x is Oracle Database 11g running on System z
- sles11v2 is Oracle Database 12c running on IBM System x®.

High-level SGA and PGA information also is found in the configuration report. When you size a Linux server's storage size for running Oracle, the SGA and PGA maximum values are necessary input.

```
Report: ESAORAC      Oracle Database Configuration Report
-------------------------------------------------------------------------------
Node/    <------------Database Description----------> <------Database------->
Date                                                  <----Start----->
Time     DatabaseName     Instance         Version    Date       Time  Status
-------- ---------------- ---------------- ---------- ---------- ----- ------
01/28/14
08:15:00
PAZXXT10 soedb            soedb            12.1.0.1.0 2014/01/27 10:15 OPEN
redhat6x db01             db01             11.2.0.2.0 2013/12/19 14:42 OPEN
sles11v2 db01             db01             12.1.0.1.0 2013/11/08 13:20 OPEN

Report: ESAORAC               ZMAP 4.2.0 12/21/
-----------------------------------------------------
Node/    <---------<-------Storage Overview (MB)------>
Date              <-----SGA------->  <-------PGA----->
Time     Database  Max   Fixed Free  Size   Max  MaxMan
-------- --------------- ----- ----- ----- ----- ------
01/28/14
08:15:00
PAZXXT10 soedb      1598   2.3  557K 557.1 293.7 1040.0
redhat6x db01      399.6   2.2  139K 139.3 164.8  529.0
sles11v2 db01      334.4   2.2 32768 106.5 355.2  12950
```

Figure 9-2 Configuration report

The other reports are shown as part of storage and I/O analysis. When Oracle administrators refer to *SGA size*, they refer to the *Max SGA size*, in this case, 1.6 GB for PAZXXT10, 400 MB for Red Hat 6.x, and 334 MB for SLES 11v2. PAZXXT10 is the server that we highlight in this chapter.

9.3 Processor performance management

Performance management starts with some understanding of performance. With System z, expectations are to run at high usage. To meet these expectations, a workload must be managed and prioritized.

When they analyze delays, it is common for Linux or Oracle administrators to look at *steal time* from the Linux perspective. This value shows delays that are caused by resource queuing in virtual environments. Steal time is the time that Linux servers are waiting because another server (or LPAR) is using the CPU resource and Linux is not dispatched. It might also be caused by storage contention resulting in paging delays. This is the perfect example of the value of having higher-level information because knowing that there is a problem from the Linux perspective is not as valuable as knowing why there is a problem from the hypervisor perspective. From inside Linux, it is difficult to determine the total IFL consumption or paging problems that are causing the steal time.

9.3.1 Prioritizing work in a large virtualized system

At high processor usage with contention, workload prioritization can be used to ensure that optimal performance is consistent with business requirements. Given a specific number of IFL processors in one System z server, sharing of the IFL processors is across LPARs, then virtual machines within an LPAR, and then by process within Linux. The objective is to achieve high usage and get the most out of each IFL. When all IFLs are being consumed, the workload must be prioritized. Processor management consists of analyzing and prioritizing the following items:

1. LPAR usage: In our example, Linux servers under z/VM, which in turn runs in one of possibly many LPARs. How many resources is the LPAR getting, and are other LPARs impacting the LPAR where Oracle is operating? LPAR weights must be understood and set to manage contention from other LPARs.
2. Virtual server usage: From the z/VM perspective, virtual machines are prioritized based on share settings. When approaching high processor usage, the virtual machine “SET SHARE” settings are used to prioritize virtual servers to meet service requirements.
3. Virtual CPU usage: Defining too many virtual CPUs impacts performance, as does defining too few. As the virtual processors approach 100% usage, queuing occurs at the process level inside Linux. Each workload has an optimal number of virtual processors. Defining too many virtual processors allows low priority work to compete at the LPAR level, and defining too few virtual processors might limit a workload’s ability to use existing processor power.
4. Linux process usage:” At the lowest level, Linux also has a prioritization mechanism. From a Linux perspective, a processor resource is assigned to processes. Processes may be Oracle processes, kernel processes, infrastructure processes, or other applications. Processes may be prioritized to ensure that some processes are dispatched first. “Nicing” processes lower (negative) results in giving them higher access to the processors.

None of the processor tuning matters much at low usage. Only at higher usage when there is contention is it up to the installation to decide what processes, virtual machines, and LPARs are allowed access to the real processors.

Without going into a full description of the z/VM scheduler, it is enough to say that “share settings” are used to control CPU distribution, and can be either absolute or relative. There are two rules to follow in setting share for virtual servers:

- There is a choice between absolute shares and relative shares. Both relative shares and absolute shares are “normalized” based on the load on the system in terms of logged on servers. The “normalized share” is used by the scheduler to schedule servers requesting service. Relative shares are shares that are provided to servers that provide a share of the processing power relative to other servers; that share drops as more servers log on to the system. Absolute shares are fixed and independent of the load on one LPAR; as more servers log on to a system, the algorithm increases the server’s share of the CPU resources as compared to “relative” servers. Servers where service requirements go up as load goes up should be “absolute”. Servers that should compete for CPU resource should be “relative”. Most Linux servers should be relative; TCP/IP and IBM RACF® should be absolute.
- Shares are divided by the number of virtual processors that are defined to the server. Thus, a default relative share of 100 for a virtual server with two virtual servers provides both virtual processors a relative share of 50. Thus, each processor has a normalized share of 50% of the default. To keep all work at the same share, use the following calculation: if there are two virtual processors, then the relative share should be 200; if there are four virtual processors, then the relative share should be set to 400. Changing shares should be in *small* increments; large shares have significant drawbacks and negatively impact performance.

9.3.2 CPU performance analysis

In this section, the CPU performance analysis for Linux and z/VM is described.

LPAR and processor usage analysis

Performance analysis for the processor starts at the LPAR level. When there are multiple LPARs, as shown in Figure 9-3, the graphs (provided by zVPS) show the total IFL usage and the total general-purpose processor usage. The general-purpose processors are approaching capacity, and the Linux IFLs are less than 50% used.

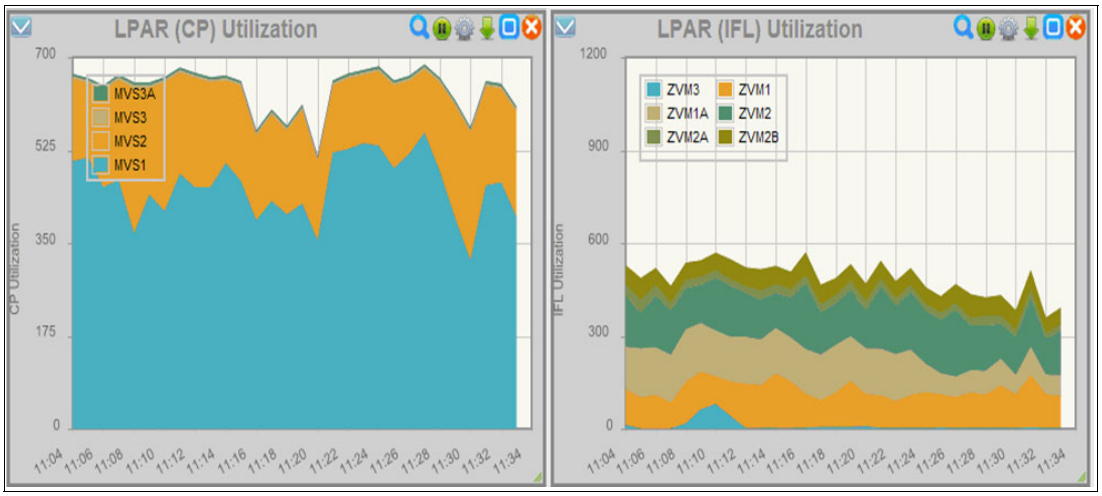


Figure 9-3 LPAR level view

When processor usage becomes high, LPAR weights must be used to prioritize the LPARs. A preferred practice is that an LPAR should not have excessive logical CPUs that are defined because the weight is spread between logical CPUs. The ratio of logical CPUs that are defined to physical CPUs is proportional to the LPAR impact.

In z/VM V6.3, if too many virtual CPUs are defined in the LPAR for the workload, z/VM “parks” one or more virtual CPUs and distributes the weight across fewer virtual CPUs.

z/VM CPU analysis

When you are analyzing workloads, where there might be a few hundred servers, it is important to define a few meaningful groups so that the human mind can comprehend the information. Looking at 100 different servers is far more difficult to comprehend than looking at a smaller number of groups. zVPS uses the term *user class* for this grouping.

In Figure 9-4, from zVPS, the virtual servers (virtual machines) are assigned to one of nine classes. It becomes easy to see that every 10 minutes that one of the servers that is assigned to the SUSE class has a cron job. Going from a spike at the system level to which server group has the spike makes the analysis process much quicker. This graph allows you to “zoom in” to determine which server is the cause of the 10 minute spike.

In this case, the Oracle class (in blue) is mostly quiesced.

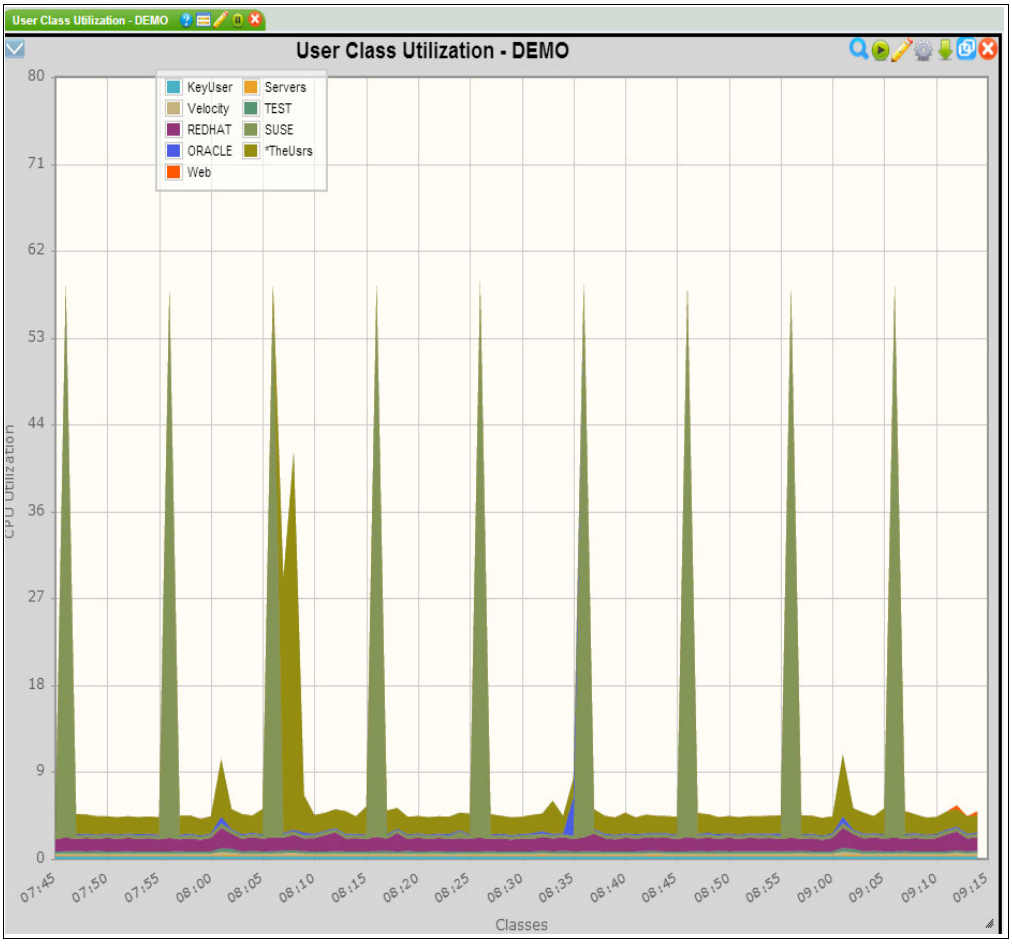


Figure 9-4 User class analysis

Linux analysis

The lowest level of analyzing the usage of the processor at the Linux level is knowing which processes of which servers are using the CPU resource. For example, when you look at the active processes, as shown Figure 9-5, you see that all of the active processes across the four Oracle servers are being used in some initial experiments.

```
Screen: ESALNXP  Velocity Software              ESAMON 4.124 12/20 22:33-22:34
1 of 3  VSI Linux Percent Usage by Process      NODE *               2828 314C7

                          <-Process Ident-> nice prty <-----CPU Percents----->
Time     Node     Name        ID  PPID   GRP valu valu  Tot sys  user syst usrt
-------- -------- -------- ----- ----- ----- ---- ---- ---- ---- ---- ---- ----
22:34:00 sles11v2 *Totals*     0     0     0    0    0  2.4  0.2  1.8  0.1  0.3
                  init         1     1     1    0   20  0.4    0    0  0.1  0.3
                  vmtoolsd  1492     1  1491    0   20  0.0  0.0    0    0    0
                  hald-add  1719  1590  1586    0   20  0.0  0.0    0    0    0
                  ora_psp0  3372     1  3372    0   20  0.0  0.0    0    0    0
                  ora_vktm  3374     1  3374    0   -2  0.7    0  0.7    0    0
                  ora_dia0  3388     1  3388    0   20  0.1    0  0.1    0    0
                  ora_lgwr  3392     1  3392    0   20  0.0    0  0.0    0    0
                  ora_mmon  3406     1  3406    0   20  0.1    0  0.1    0    0
                  ora_mmnl  3408     1  3408    0   20  0.0    0  0.0    0    0
                  ora_tt00  3428     1  3428    0   20  0.0    0  0.0    0    0
                  X         3671  3670  3671    0   20  0.1  0.0  0.1    0    0
                  gnome-se  3909     1  3909    0   20  0.4    0  0.4    0    0
                  gdm-simp  3922  3885  3885    0   20  0.1    0  0.1    0    0
                  snmpd     5757     1  5757    0   20  0.1  0.1  0.1    0    0
                  ora_vkrm 15344     1 15344    0   20  0.1    0  0.1    0    0
          sles11x2 *Totals*     0     0     0    0    0  0.1  0.0  0.0    0    0
                  snmpd     2430  2399  2430  -10   10  0.1  0.0  0.0    0    0
          RH5X161  *Totals*     0     0     0    0    0  0.1  0.0  0.0    0    0
                  snmpd     1191     1  1190  -10    5  0.1  0.0  0.0    0    0
          S11R2ORA *Totals*     0     0     0    0    0  1.0  0.3  0.5  0.1  0.1
                  init         1     1     1    0   20  0.2    0    0  0.1  0.1
                  oracle    3550     1  3550    0   -2  0.2  0.1  0.1    0    0
                  oracle    3645     1  3645    0   -2  0.2  0.1  0.1    0    0
```

Figure 9-5 ESALNXP - process performance

Figure 9-5 shows the node usage (*totals*) and the usage by each process. This screen shows all the processes that are using more than 0.1% of an IFL. The Oracle processes are idle.

The CPU Percents column shows the total for the process, which includes both the process system and user CPU time, but also the CPU time that is used by processes that were created and then terminated. Often, short-lived processes are not worth reporting, but their CPU consumption must be allocated. When a process terminates, Linux records its CPU consumption, which is then reported in this report as “syst” and “usrt” for the system and user CPU.

The ESALNXP report can also be used to select a single node for analysis or benchmarks. In our test run, Figure 9-6 shows the processes as the load increases in the Oracle test server. In the 15 minutes before 8:30, there was little activity. The next 15 minutes saw a significant increase in the Oracle workload.

```
SReport: ESALNXP      LINUX HOST Process Statistics Report
------------------------------------------------------------------
node/     <-Process Ident-> Nice PRTY <------CPU Percents---->
 Name     ID    PPID   GRP  Valu Valu  Tot  sys user syst usrt
--------- ----- ----- ----- ---- ---- ---- ---- ---- ---- ----
01/28/14
 08:30:00
PAZXXT10      0     0     0    0    0 6.59 2.03 2.64 0.66 1.26
 init         1     1     1    0   20 1.90 0.01 0.00 0.63 1.26
 ora_vktm  2940     1  2940    0   -2 1.86 1.04 0.82    0    0
 snmpd    15678 14338 15678  -10   10 0.88 0.50 0.38    0    0
08:45:00
PAZXXT10      0     0     0    0    0 55.9 7.47 46.1 0.77 1.56
 init         1     1     1    0   20 2.30 0.00    0 0.74 1.55
 ora_vktm  2940     1  2940    0   -2 1.29 0.72 0.57    0    0
 Xvnc      3508     1  3501    0   20 0.86 0.31 0.56    0    0
 snmpd    15678 14338 15678  -10   10 0.56 0.31 0.24    0    0
 java     17178 17162 17160    0   20 27.7 1.71 26.0    0    0
 oracle_1 17261     1 17261    0   20 1.02 0.15 0.87    0    0
 oracle_1 17263     1 17263    0   20 1.07 0.16 0.91    0    0
 oracle_1 17265     1 17265    0   20 0.88 0.14 0.75    0    0
 oracle_1 17267     1 17267    0   20 1.05 0.16 0.90    0    0
 oracle_1 17269     1 17269    0   20 1.07 0.16 0.91    0    0
 oracle_1 17271     1 17271    0   20 1.07 0.16 0.92    0    0
 oracle_1 17273     1 17273    0   20 1.04 0.16 0.89    0    0
 oracle_1 17275     1 17275    0   20 1.02 0.15 0.87    0    0
 oracle_1 17277     1 17277    0   20 0.86 0.13 0.72    0    0
 oracle_1 17279     1 17279    0   20 1.08 0.16 0.92    0    0
 oracle_1 17281     1 17281    0   20 1.05 0.15 0.90    0    0
 oracle_1 17283     1 17283    0   20 1.06 0.15 0.91    0    0
 oracle_1 17285     1 17285    0   20 0.87 0.13 0.74    0    0
 oracle_1 17287     1 17287    0   20 1.05 0.15 0.89    0    0
 oracle_1 17289     1 17289    0   20 1.00 0.15 0.85    0    0
 oracle_1 17291     1 17291    0   20 1.05 0.15 0.89    0    0
 oracle_1 17293     1 17293    0   20 0.88 0.13 0.75    0    0
 oracle_1 17295     1 17295    0   20 0.79 0.12 0.67    0    0
 oracle_1 17297     1 17297    0   20 0.79 0.12 0.67    0    0
 oracle_1 17299     1 17299    0   20 1.07 0.16 0.91    0    0
```

Figure 9-6 ESALNXP - processor performance

The Java process is the largest process, consuming about half of the total for this workload. When the CPU is at capacity, knowing which process of which application is causing this load allows for tuning and proper prioritization.

Linux application CPU analysis

Applications can be evaluated for a server or by user class. Often, applications run across multiple servers, and with proper server classification, can be analyzed as an application. In the ESALNXA application report, there is a class of servers that are named PAZXX that in theory can include several Oracle servers. In our test case, there is only one server that is defined in the class, so the data from the class of servers is identical to the data from just our test server.

Applications are defined to include all processes that are started by a certain process. Thus, if one process that is named xterm is responsible for starting Java, then Java is recorded as part of the xterm application. Several processes with a parent ID of 1 and the same name are also combined, so all of the oracle_1 processes are combined and reported as one application. Oracle processes have a parent process ID of 1,

Figure 9-7 shows that there are 12 active “oracle_1” processes that make up the workload. The Java process is recorded under the process that started it, that is, xterm. On average, during the 15 minute interval, there were 164.9 total processes running, with 42.5 average active processes.

```
Report: ESALNXA LINUX HOST Application Report ZMAP 4.2.0 01/28/14 Page 160
--------------------------------------------------------------------------------
Node/    Process/    <---Processor Percent---> <---CPU Seconds---> <Process->
Date     Application       <Process><Children> <Process><Children> <-Counts->
Time     name        Total sys  user syst usrt sys  user syst usrt Total Actv
-------- ----------- ----- ---- ---- ---- ---- ---- ---- ---- ---- ----- ----
01/28/14
08:45:00
***Node Groups***
PAZXX    *Totals*     55.9  7.5 46.1  0.8  1.6 67.2  415  7.0 14.0 164.9 42.5
         init          2.3  0.0    0  0.7  1.6  0.0    0  6.7 14.0   1.0  0.2
         ora_vktm      1.3  0.7  0.6    0    0  6.5  5.1    0    0   1.0  1.0
         oracle_1     19.8  2.9 16.8    0    0 26.3  152    0    0  12.0 12.0
         sshd          0.6  0.3  0.2    0    0  2.8  2.2    0    0   9.0  1.0
         xterm        27.8  1.7 26.1    0    0 15.4  234    0    0   3.3  1.0
         Xvnc          0.9  0.3  0.6    0    0  2.8  5.0    0    0   0.7  0.7
*** Nodes *******
PAZXXT10 *Totals*     55.9  7.5 46.1  0.8  1.6 67.2  415  7.0 14.0 164.9 42.5
         init          2.3  0.0    0  0.7  1.6  0.0    0  6.7 14.0   1.0  0.2
         ora_vktm      1.3  0.7  0.6    0    0  6.5  5.1    0    0   1.0  1.0
         oracle_1     19.8  2.9 16.8    0    0 26.3  152    0    0  12.0 12.0
         sshd          0.6  0.3  0.2    0    0  2.8  2.2    0    0   9.0  1.0
         xterm        27.8  1.7 26.1    0    0 15.4  234    0    0   3.3  1.0
         Xvnc          0.9  0.3  0.6    0    0  2.8  5.0    0    0   0.7  0.7
```

Figure 9-7 ESALNXA application analysis

Linux virtual CPU analysis

When analyzing Linux processor usage, the new ESALNXS report breaks down the loads by virtual CPU. In Figure 9-8, our test case server increases its activity to use 90% of its capacity, with most of the time spent in I/O wait. The processors are only about 30% busy (4.8 + 25.3).

```
Report: ESALNXS      LINUX VSI System Analysis Report         Velocity Software
Monitor initialized: 01/28/14 at 08:00:00 on 2094 serial 53E5D     First record
--------------------------------------------------------------------------------
Node/    <---Load Numbers--> CPU <Processor Pct Util> NICE <CPU Overhead%> IO
Time     Users Procs MaxProc NBR Total Syst User Idle Time Krnl IRQ  Steal Wait
-------- ----- ----- ------- --- ----- ---- ---- ---- ---- ---- ---- ----- ----
01/28/14
08:30:00
PAZXXT10     3   152       0 Tot   6.2  2.6  2.4  193    0  0.7  0.1   0.7  0.3
                             1   4.7  2.2  1.5 94.9    0  0.7  0.1   0.4  0.2
                             2   1.5  0.4  0.9 98.2    0  0.0  0.0   0.2  0.2
--------------------------------------------------------------------------------
08:45:00
PAZXXT10     3   152       0 Tot  98.3  7.2 44.5 81.6    0  0.9  1.0  20.0 44.6
                             1  49.3  4.3 22.0 40.5    0  0.7  0.5  10.2 21.8
                             2  49.0  3.0 22.5 41.1    0  0.2  0.5   9.9 22.8
--------------------------------------------------------------------------------
09:00:00
PAZXXT10     3   152       0 Tot 178.8 10.5 53.1 15.7    0  1.1  1.9   5.4  112
                             1  90.7  4.8 25.3  6.3    0  0.3  1.1   2.9 59.1
                             2  88.1  5.7 27.8  9.4    0  0.8  0.8   2.5 53.0
```

Figure 9-8 ESALNXS - system analysis

9.3.3 Processor summary

Processor usage can be analyzed by LPAR, by user class, by virtual machine, by application, and down to the process, allowing Oracle applications to be analyzed with many levels of granularity.

9.4 Storage and memory performance management

The storage and memory performance architecture for Linux and z/VM is described in this section.

9.4.1 z/VM architecture

The z/VM LPAR is allocated physical storage that is then shared between the virtual servers. When storage is over-allocated and all the servers do not fit in to storage, then the storage resource is “overcommitted”. The level of overcommitment impacts paging and performance. When storage is overcommitted, pages are paged to the paging subsystem on expanded storage or on disk. In z/VM V6.3, with significant changes in storage management, it is likely that expanded storage cannot provide a significant benefit to the paging subsystem that there was in earlier releases.

Storage is assigned to different functions. The ESASTR1 report from zVPS in Figure 9-9 shows the major categories. In this case, this LPAR has 3,670,016 pages, of which 99.6% are accounted for (capture ratio). Pages should belong to users, and be counted in “user resident”. If the overcommit ratio is less than 1, then there is no storage contention and the vdisks remain resident. In this case, 2,017,000 pages belong to virtual machines, with 345,000 pages belonging to the virtual disks. To determine which virtual disks are consuming the storage, the ESAVDSK report can be evaluated. Analyzing the ESASTR1 report and understanding where storage is being used is the first step of understanding memory performance management.

```
Report: ESASTR1                                                      PPg  287
Monitor initialized:
------------------------------------------------------------------------------
         Users <-------Pages-------------------------> Over
         Loggd System   <Available> Systm  User  VDISKg Commit    Capt-
Time        On Storage  <2gb  >2gb  ExSpc Resdnt Rsdnt  Ratio     Ratio
-------- ----- -------  ----- ----- ----- ------ ------ -----     -----

05:30:00   101 3670016   213K 1238K  1265  2017K 345653 0.903     0.996
05:45:00   103 3670016   213K 1236K  1268  2019K 345674 0.912     0.996
06:00:00   103 3670016   213K 1236K  1269  2019K 345671 0.912     0.996
06:15:00   103 3670016   212K 1235K  1269  2020K 345729 0.911     0.996
```

Figure 9-9 Main storage analysis

The capture ratio is reported, meaning that of the 3,670,016 pages on this system, 99.6% of the pages are identified. This is a result of adding up all the user data, virtual disk data, and the rest of the users that are identified in the CP monitor. Knowing the capture ratio increases your ability to rely on the accuracy of the data.

VM analysis

Preferred practices for managing many Linux servers include classifying those servers into user classes and understanding storage requirements by application or function. In an earlier environment where we were cloning up to 100 servers, the ESAUSPG report in Figure 9-10 shows nine user classes plus the system-wide total. Normally, the Velocity Software servers are classified as “Velocity”. In this analysis, because we were worried about how much storage was going to be used when we started 100 servers, it was important to watch how much storage was being used by ORACloud to avoid having the whole system abend from a lack of resources (our paging subsystem was only 8 GB).

```
Screen: ESAUSPG  ITSO                              ESAMON 4.110 10/18 15:47-15:4
1 of 2  User Storage Analysis                      CLASS *              2827 4B8

                 <---Storage occupancy in pages--->  Pages <Address Spaces>
         UserID  <---Main Storage---> <--Paging--->  Moved <Pages Resident>
Time     /Class   Total  >2GB   <2GB   Xstor  DASD    <2GB VirtDisk AddSpce
-------- -------- ------ ------ ------ ------ ------ ------ -------- -------
15:48:00 System:   6112K  5627K 484943  20512     41      0   132629       0
         ORACloud  1785K  1638K 146861    108     40      0    73520       0
         Cluster1  1527K  1408K 119215  10460      0      0    31154       0
         Cluster2  1463K  1349K 114295    422      0      0     9369       0
         StnAlone  1197K  1102K  94453      0      0      0    16721       0
         OthLinux  60550  55613   4937      0      1      0     1838       0
         TheUsrs   42611  39452   3159   1657      0      0        0       0
         Servers   21280  20739    541   5278      0      0        0       0
         Velocity  11806  11085    721    745      0      0       27       0
         KeyUser    4323   3562    761   1842      0      0        0       0
```

Figure 9-10 User storage analysis

With hundreds of servers on the LPAR, it is more important to understand resource requirements by workload rather than by server. After the workload can be analyzed, as shown in Figure 9-10, the next step was to look at the cloud workload specifically. By zooming into the ORACLOUD workload, all the servers in that workload display. This experiment was to clone 100 servers (about 60 minutes), and then log them on. This pushed storage requirements up fast, as shown in Figure 9-11 on page 191.

```
Screen: ESAUSPG  ITSO                                ESAMON 4.110 10/18 15:50-15:5
1 of 2  User Storage Analysis                        CLASS ORACLOUD USER  2827 4B8

                 <---Storage occupancy in pages--->  Pages <Address Spaces>
         UserID  <---Main Storage---> <--Paging--->  Moved <Pages Resident>
Time     /Class   Total  >2GB   <2GB   Xstor  DASD    <2GB VirtDisk AddSpce
-------- -------- ------ ------ ------ ------ ------ ------ -------- -------
15:51:00 S11OR001  51071  46895   4176      0      1      0     1838       0
         S11OR003  49872  45831   4041      0      1      0     1838       0
         S11OR002  49794  45718   4076      0      1      0     1838       0
         S11OR025  49602  45543   4059      0      1      0     1838       0
         S11OR039  49542  45185   4357      0      1      0     1838       0
         S11OR040  49541  45729   3812      0      1      0     1838       0
         S11OR022  49518  45243   4275      0      1      0     1838       0
         S11OR030  49512  45337   4175      0      1      0     1838       0
         S11OR024  49506  45204   4302      0      1      0     1838       0
         S11OR032  49506  45590   3916      0      1      0     1838       0
         S11OR013  49423  45561   3862      0      1      0     1838       0
         S11OR018  49401  45508   3893      0      1      0     1838       0
```

Figure 9-11 User storage analysis for ORACLOUD

9.4.2 Linux storage

Now, you need to understand the Linux and Oracle storage requirements. When the Oracle SGA/PGA does not fit into Linux storage, then Linux storage management moves pages to the swapping subsystem. When swapping occurs to the virtual disk, overall storage requirements increase. It is important to find a balance between virtual machine sizes and swapping requirements.

From a Linux perspective, you measure the following storage:

- Kernel, including page structure tables
- Available, which is immediately usable by any Linux process
- Page cache, where data and programs and the Oracle SGA are
- Write buffer, where Linux buffers output
- Anonymous storage, including short-term working storage and page tables

Minimizing storage requirements in this shared storage environment means more storage that is available for other servers and other work. In the System z environment, a much higher I/O bandwidth is supported and expected than distributed environments, which allows Linux on System z to reduce the cache size at the expense of more I/O. With the objective of maximizing throughput, oversizing storage reduces any configuration's work potential.

Linux analysis

In analyzing storage, the ESAUCD2 example in Figure 9-12 shows three Oracle servers and their storage layouts from the Linux perspective. Understanding the storage layout highlights the issues and the opportunities. In this example, the node lnxsa3 is a 4GB server, with about 80 MB that is used for kernel and page structure tables (4096 minus 4015.7). The swap space has few pages, so at one time this server used all its storage, likely during the Oracle installation. The write buffer is 75 MB, and the page cache is 2,800 MB. Knowing the storage layout of all the servers then shows you where to focus at a system level.

```
Screen: ESAUCD2  ITSO                          ESAMON 4.110 10/17 13:55
1 of 2  LINUX UCD Memory Analysis Report       CLASS THEUSRS NODE * 282
                  <------------------Storage sizes in MegaBytes ------->
         Node/    <--Real Storage--> Over  <-----SWAP Storage----> Total
Time     Group    Total  Avail Used   head Total Avail Used  MIN   Avail
-------- -------- ------ ----- ----- ----- ----- ----- ----- ----- -----
13:56:00 lnxsa3   4015.7 892.9  3123 248.1 253.9 253.8   0.1  15.6  1147
         lnxsa1    996.5 502.6 493.9  94.9 253.9 219.0  34.9  15.6 721.6
         lnxcl2n1 4015.7  1222  2793 400.7  7296  7296     0  15.6  8519

Screen: ESAUCD2  ITSO                          ESAMON 4.110 10/17 14:51-
2 of 2  LINUX UCD Memory Analysis Report       CLASS THEUSRS NODE * 2827
                  <------------------Storage sizes (in Megabytes) ------>
         Node/    <--Real Storage--> <--Storage in Use-> Error
Time     Group    Total  Avail Used  Shared Buffer Cache Message
-------- -------- ------ ----- ----- ------ ------ ----- ----------------
14:52:00 lnxsa3   4015.7 892.7  3123    0.0   75.2  2800
         lnxsa1    996.5 502.0 494.5    0.0   30.9 368.5
         lnxcl2n1 4015.7  1219  2796    0.0   40.7  2354
```

Figure 9-12 ESAUCD2 screen 1

To understand where the Linux storage is allocated, both the Linux storage and the process storage should be evaluated. Figure 9-13 on page 193 shows an example from Oracle Database 11g experiments. The LNXCL2N1 node is selected with the ESAUCD2 screen showing the Linux perspective, and the ESALNXP showing the resident storage size (RSS) for the active processes. Linux storage management shares many of the pages between processes. Thus, the Oracle processes may each show 40 MB and 39 MB; the overlap between the two might be most of it. The “shared” metric is not implemented in Linux currently, so it is not possible to know the overlap between these processes. In this case, the Java process is using considerably more storage than all the Oracle processes combined. This scenario highlights that just because a server is an Oracle Database, you should not assume how the storage resource is being consumed.

```
 Screen: ESALNXP  ITSO                              ESAMON 4.110 10/18 13:54-13:55
 2 of 3  VSI Linux Percent Usage by Process      NODE LNXCL2N1 DEVICE 2827

                             <-Process Ident-> <--Memory-> <--Faults/Second-->
 Time     Node     Name          ID  PPID   GRP  Size   RSS  min  maj mint majt
 -------- -------- --------- ----- ----- ----- ----- ----- ---- ---- ---- ----
 13:52:00 lnxcl2n1 *Totals*      0     0     0   69G 1901M   98    0  785    0
                   init          1     1     1 2538K  893K    0    0  301    0
                   snmpd      2610     1  2609   27M 9744K   21    0    0    0
                   ohasd.bi   2688     1  2688  222M   40M    0    0    0    0
                   oraagent   3039     1  3039  269M   39M    7    0   49    0
                   oracle     3207     1  3207  479M   15M    0    0    0    0
                   oracle     5126     1  5126 1925M   17M    0    0    0    0
                   java      26947 26902 26902  453M  162M   68    0  429    0
==============================================================================>
 Screen: ESAUCD2  ITSO                              ESAMON 4.110 10/18 13:54-13:55
 2 of 2  LINUX UCD Memory Analysis Report        CLASS THEUSRS NODE L 2827

                   <------------------Storage sizes (in Megabytes) ------>
          Node/    <--Real Storage--> <--Storage in Use-> Error
 Time     Group    Total  Avail Used  Shared Buffer Cache Message
 -------- -------- ------ ----- ----- ------ ------ ----- ----------------
 13:55:00 lnxcl2n1 4015.7  79.4  3936    0.0  144.2  3167
```

Figure 9-13 Linux storage and active processes

In our test case, with Oracle Database 12g, when the Oracle workload increases, we see the available storage decrease and both the page cache and the anonymous (overhead) increase, with the write buffer forced to write the data content out to disk to make room for the workload. At the 09:00 interval, this node is starting to be constrained. The available storage has gone from over 0.5 GB to 21 MB. The write buffer started at 367 MB, and is now 86 MB.

```
Report: ESAUCD2      LINUX UCD Memory Analysis Report    ZMAP 4.2.0 01/29/14
------------------------------------------------------------------------------
Node/    <---------------------Storage Sizes (in MegaBytes)---------->
Time/    <--Real Storage-->  <-SWAP Storage-> Total <-Storage in Use->
Date     Total  Avail Used  Total Avail Used  Avail Buffer Cache Ovrhd
-------- ------ ----- ----- ----- ----- ----- ----- ------ ----- -----
08:30:00
*** Nodes *******
PAZXXT10 3885.3 593.3  3292     0     0     0 593.3  366.8  2582  343.6
08:45:00
*** Nodes *******
PAZXXT10 3885.3 260.5  3625     0     0     0 260.5  302.0  2751 571.4
09:00:00
*** Nodes *******
PAZXXT10 3885.3  21.1  3864     0     0     0  21.1   86.0  3022 756.3
```

Figure 9-14 ESAUCD2 screen 2

To understand how the storage is allocated, the page cache went up by 440 MB and the anonymous/overhead went up by another 430 MB. From a systems perspective, programs are loaded into the page cache, which explains part of the increase in page cache. The SGA might grow, but the PGA will have large growth as more processes are started. As processes start, they require page table requirements to support them. Most of the increase in anonymous/overhead can be explained by page tables.

From the high-level Linux perspective, the next step is to look at the process storage requirements, and then the Oracle perspective.

Linux process storage analysis

Many storage metrics are provided for each active process on the ESALNXP report. Each process has shared storage and non-shared. In this case, much of the RSS is shared, as are the data and the executables. With Oracle Database, significant performance improvements are reported when using Large Page support. In this sample with 20 Oracle processes (not all shown), shown in Figure 9-15, there is over 300 MB consumed with just these Oracle process page tables (PTbl). Much of this consumed memory is freed if you use large page support.

```
Report: ESALNXP      LINUX H    Velocity Software Corporate   ZMAP 4.2.0 01
--------------------------------------------------------------------------------
node/     <-Process Ident-> <---------------Storage Metrics (MB)---------->
 Name     ID    PPID   GRP   Size RSS Peak Swap Data Stk  EXEC Lib Lck PTbl
--------- ----- ----- ----- ---- ---- ---- ---- ---- ---- ---- --- --- ----
01/28/14
08:45:00
PAZXXT10      0     0     0 110K 3766 1.6M    0  50K  216 198K 37K   0  765
 init         1     1     1    3    2 47.6    0 4.98  1.3  2.3  38   0 0.21
 ora_vktm  2940     1  2940 1888   20  28K    0 44.5  1.3 3561 256   0 6.68
 Xvnc      3508     1  3501   31   20  298    0  156  0.9 21.7  86   0 0.78
 snmpd    15678 14338 15678  166   19 2428    0 80.8  1.9  0.4  2K   0 1.96
 java     17178 17162 17160 2443  236  24K    0  23K  0.9  0.0  1K   0 6.13
 oracle_1 17261     1 17261 1891  135  17K    0 27.9  1.6 2136 154   0 15.9
 oracle_1 17263     1 17263 1892  145  17K    0 27.9  2.3 2136 154   0 16.1
 oracle_1 17265     1 17265 1891  138  17K    0 27.9  2.1 2136 154   0 16.0
 oracle_1 17267     1 17267 1892  137  17K    0 27.9  1.6 2136 154   0 16.0
 oracle_1 17269     1 17269 1892  149  17K    0 27.9  2.8 2136 154   0 16.3
 oracle_1 17271     1 17271 1891  145  17K    0 27.9  2.6 2136 154   0 16.1
 oracle_1 17273     1 17273 1893  143  17K    0 27.9  2.6 2136 154   0 16.1
 oracle_1 17275     1 17275 1891  142  17K    0 27.9  2.6 2136 154   0 16.1
 oracle_1 17277     1 17277 1891  141  17K    0 27.9  2.6 2136 154   0 16.2
 oracle_1 17279     1 17279 1891  139  17K    0 27.9  2.6 2136 154   0 16.0

09:00:00
PAZXXT10      0     0     0 142K 9003 2.1M    0  70K  261 255K 43K   0 1145
 init         1     1     1    3    1 47.6    0 4.98  1.3  2.3  38   0 0.21
 ora_vktm 2940     1  2940 1888   20  28K    0 44.5  1.3 3561 256   0 6.68
 ora_dbw0 2956     1  2956 1896  553  28K    0  138  1.3 3561 256   0 27.0
 ora_lg00 2962     1  2962 1888   27  28K    0 44.5  1.3 3561 256   0 7.21
 Xvnc     3508     1  3501   31   20  447    0  234  1.3 32.5 130   0 1.17
 java    17178 17162 17160 2492  270  37K    0  35K  1.3  0.1  2K   0 10.8
 oracle_1 17261     1 17261 1891  313  28K    0 46.5  2.9 3561 257   0 29.9
 oracle_1 17263     1 17263 1893  323  28K    0 46.5  3.9 3561 257   0 30.3
```

Figure 9-15 ESALNXP report

9.4.3 Oracle storage

With the new ESAORAG report, both the SGA and the PGA have metrics collected every minute for each database that is registered for collection. This feature allows users to see how the workload is using the storage resources from the Oracle perspective,

When we look at the ESAORAG report for our test case, as the workload increases (Figure 9-16), the SGA shows a 16 MB change in the cache, with a 96 MB increase in allocated storage in the PGA.

```
Report: ESAORAG    SGA/PGA Analysis Report                Velocity Software
Monitor initializ/14 at 08:00:00 on 2094 serial 53E5D     First record anal
--------------------------------------------------------------------------
Node/              <------------Shared Global Area (SGA) in Megabytes----->
Date     <--Data  Max   Fixed Redo Buffer     <------Pool sizes---------->
Time     Name     Size  Size Buffr Cache Free Shrd Large Java Stream ShrIO
-------- -------- ----- ---- ----- ----- ---- ---- ----- ---- ------ -----
01/28/14
08:30:00
PAZXXT10 soedb     1598  2.3   6.9 655.4 557K  295  32.8 16.4   32.8   49.2
--------------------------------------------------------------------------
08:45:00
PAZXXT10 soedb     1598  2.3   6.9 658.6 557K  295  32.8 16.4   29.5  49.2
--------------------------------------------------------------------------
09:00:00
PAZXXT10 soedb     1598  2.3   6.9 671.7 557K  295  32.8 16.4   16.4  49.2

Report: ESAORAG                ZMAP 4.2.0 01/28/14
Monitor initializlyzed: 01/28/14 08:00:00
-------------------------------------------------
Node/              <--PGA Data (in Megabytes)-->
Date     <--Data  <-Target-> InUse Alloc Free
Time     Name     Parm Auto              -able
-------- -------- ---- ---- ----- -----  -----
01/28/14
08:30:00
PAZXXT10 soedb     557  451  56.8  84.1   17.5
-------------------------------------------------
08:45:00
PAZXXT10 soedb     557  426  84.2 128.9   30.4
-------------------------------------------------
09:00:00
PAZXXT10 soedb     557  404 109.4 170.3   43.6
```

Figure 9-16 ESAORAG report

In conclusion regarding storage requirements, the workload increased, consuming about 870 MB (page cache plus overhead). Of this workload, the PGA went up by 96 MB, page tables by 320 MB, and Java used about 270 MB. The Oracle_1 processes consumed at least 320 MB (RSS). The original Java and Oracle process storage were not measured, but now there is the technology to show exactly where the storage is being used by a workload.

9.5 Disk I/O performance

DASD performance is also important to a database application's performance. There are several items to consider:

- ECKD versus FCP
- Disk size or LUN size
- HiperPAV or PAV
- FCX/HPF High Performance IBM FICON®
- LVM, striped or non-striped, stripe size
- Linux I/O Scheduler
- DIRECT I/O versus buffered

Different technologies differ in cost, performance, and management capabilities.

9.5.1 ECKD versus FCP

Here are the primary considerations for choosing the disk technology:

- Size of the database: For very large databases, FCP is the most reasonable in terms of cost and manageability. When database sizes are measured in terabytes or petabytes, it is better to allocate disk space in terms of very large LUNs on FCP.
- Performance requirements: When the ability to manage performance is required, data should be on ECKD because ECKD has extensive performance reporting capability. This includes *all* system devices and binary files.
- Overall, FCP offers better throughput and performance, but ECKD uses less CPU per transaction.

9.5.2 Disk size or LUN size

The size of the allocated unit has performance implications. For traditional 3390 DASD, with a choice of 3390-3, 3390-9, or 3390-27 models, the question is bandwidth. If higher bandwidth (I/Os per second (IOPS)) is required, the options are to have smaller devices and more of them supporting higher I/O rates, or to use PAV or HiperPAV.

- Parallel Access Volumes (PAVs) is an older technology that allows multiple device exposures to be defined for one real device, increasing the number of concurrent I/O to the base exposure.
- HiperPAV is a newer and more dynamic technology that allows alias devices to be configured as needed for base devices when base devices require concurrent I/O.

9.5.3 FCX/HPF

FICON Channel Extension or High Performance FICON are two names for the same feature. This feature increases data transmission rates on FICON channels for the software that supports it.

9.5.4 z/VM preferred practices

ECKD should be used for all CP system devices and other data that are important for performance. Ensure that there are enough devices so that device usage is less than 20% device busy.

For more information about disk I/O and Oracle, see *Oracle Database on Linux on System z – Disk I/O Connectivity Study*, found at:

http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102234

This study provides guidelines for disk configuration and tuning hints about ECKD and FCP disk devices. It specifically covers the Oracle stand-alone database using a transactional workload (OLTP) in an LPAR from an IBM zEnterprise 196.

9.5.5 Measuring Oracle I/O activity

The subsystem report for Oracle from zVPS (Figure 9-17) contains high-level activity information, allowing correlation between times of high I/O to activities. The report also contains the I/O activity metrics with read/write activity.

```
Report: ESAORAS      Oracle Subsystem Analysis Report
-------------------------------------------------------
Node/    <---Database----> <-User Activity-> <--CPU--->
Date                       <Rate per second> Sess Re-
Time     Name    Instance  Calls Comm Rollbk -ion  Cur
-------- -------- -------- ----- ----- ----- ----- -----
08:15:00
PAZXXT10 soedb   soedb      0.2    2.9   4.3   0.1     0
-------------------------------------------------------
08:30:00
PAZXXT10 soedb   soedb      0.2    2.3   3.8   0.0     0
-------------------------------------------------------
08:45:00
PAZXXT10 soedb   soedb      0.2  241.2  73.1  22.0   0.0
-------------------------------------------------------
09:00:00
PAZXXT10 soedb   soedb      0.2  569.5 168.2  52.4   0.11
```

Figure 9-17 Oracle Subsystem Analysis Report

The Oracle I/O activity for our test case is shown in Figure 9-18, as measured by Oracle. At the peak, the writes were 276 per second, with 9.7 million cache hits (CHits) per second.

```
Report: ESAORA           Velocity Software Corporate   ZMAP 4.2.0 12/21/13
-------------------------------------------------------------------------
Node/         <----Physical Reads Activty---> <-Physical Write Activity-->
Date          <------Rate per second--------> <----Rate per second------->
Time     Name  Rds  Hits  Direct   I/O Bytes Writs CHits Dirct  I/O  Bytes
-------- ----- ----- ----- ----- ----- ----- ----- ----- ------ ----- ----
08:15:00
PAZXXT10 soedb   0.9   0.2   0.1   0.1     0   0.1 694.5   1.0   1.0   0.0
-------------------------------------------------------------------------
08:30:00
PAZXXT10 soedb   0.8   0.2   0.2   0.2     0   0.1  1415   0.3   0.2   0.1
-------------------------------------------------------------------------
08:45:00
PAZXXT10 soedb   18.1  8.3 172.8 172.8     0 172.2 8715K  42.8  42.3   0.5
-------------------------------------------------------------------------
09:00:00
PAZXXT10 soedb   36.5 13.8 279.9 279.9     0 276.6 9733K 178.6 178.6   0.1
```

Figure 9-18 Oracle I/O activity

There are other reports that show the I/O from the Linux system perspective (ESAUCD4), and from the z/VM perspective (ESADSD2 for ECKD and ESASCSI for FCP devices).

9.5.6 Oracle Application Profile

zVPS provides information about profile application delays on the Linux Host Application report (ESALNXA). As the workload increases, the Oracle Log write and the database writer are waiting for I/O, as shown in Figure 9-19. Further analysis of the I/O subsystem supporting this workload should be the next step. This report can be used to evaluate the impacts of I/O subsystem tuning.

```
RReport: ESALNXA      LINUX HOST Application Report     Velocity Software   ZMAP 4.2.0
-------------------------------------------------------------------------------------
Node/    Process/    <---Processor Percent--->  <Process-> <---Percent Process Status-->
Date     Application       <Process><Children>  <-Counts-> Run- Sleep Zom Disk Page Stop
Time     name        Total sys  user syst usrt  Total Actv ing  -ing  bie Wait Wait
-------- ----------- ----- ---- ---- ---- ----  ----- ---- ---- ---- ---- ---- ---- ----
01/28/14
08:30:00
PAZXXT10 *Totals*      6.6  2.0  2.6  0.7  1.3  149.0 24.5  0.7 99.3    0    0    0    0
         init          1.9  0.0  0.0  0.6  1.3    1.0  0.3    0  100    0    0    0    0
         ora_vktm      1.9  1.0  0.8    0    0    1.0  1.0    0  100    0    0    0    0
         sshd          0.9  0.5  0.4    0    0    9.0  1.1 11.1 88.9    0    0    0    0
-------------------------------------------------------------------------------------
08:45:00
PAZXXT10 *Totals*     55.9  7.5 46.1  0.8  1.6  164.9 42.5  1.9 94.7    0  3.4    0    0
         init          2.3  0.0    0  0.7  1.6    1.0  0.2    0  100    0    0    0    0
         ora_vktm      1.3  0.7  0.6    0    0    1.0  1.0    0  100    0    0    0    0
         oracle_1     19.8  2.9 16.8    0    0   12.0 12.0 15.0 48.3    0 36.7    0    0
         sshd          0.6  0.3  0.2    0    0    9.0  1.0 11.1 88.9    0    0    0    0
         xterm        27.8  1.7 26.1    0    0    3.3  1.0    0  100    0    0    0    0
         Xvnc          0.9  0.3  0.6    0    0    0.7  0.7    0  100    0    0    0    0
-------------------------------------------------------------------------------------
09:00:00
PAZXXT10 *Totals*     69.4 11.1 56.9  0.5  0.9  181.6 57.7  1.8 95.1    0  3.1    0    0
         init          1.3  0.0  0.0  0.5  0.8    1.0  0.3    0  100    0    0    0    0
         ora_dbw0      2.2  1.5  0.7    0    0    1.0  1.0  6.7    0    0 93.3    0    0
         ora_lg00      0.7  0.4  0.2    0    0    1.0  1.0    0 46.7    0 53.3    0    0
         ora_vktm      1.2  0.7  0.5    0    0    1.0  1.0    0  100    0    0    0    0
         oracle_1     43.5  5.0 38.5    0    0   20.0 20.0  8.0 73.7    0 18.3    0    0
         sshd          0.5  0.3  0.2    0    0    9.0  1.1 11.1 88.9    0    0    0    0
         xterm        15.7  1.6 14.2    0    0    5.0  1.3    0  100    0    0    0    0
         Xvnc          1.3  0.5  0.8    0    0    1.0  1.0  6.7 93.3    0    0    0    0
```

Figure 9-19 Linux Host Application Report

9.6 Oracle Database 11g experiences

Oracle -specific aspects are in detail in *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104, and are not repeated here.

9.7 Summary

This is a constantly evolving subject. The latest information about this topic is presented at the SHARE User Group Conferences and in IBM and Oracle Webinars. The presentations are posted at http://www.zseriesoraclesig.org and at http://www.share.org.

A

Details about the new IBM System z

This appendix describes the latest information about the IBM hardware that is used to host Oracle solutions running on Linux on System z. This appendix is taken from *IBM zEnterprise System Technical Introduction*, SG24-8050.

A.1 IBM zEnterprise EC12

The IBM zEnterprise EC12 (zEC12) builds on the strengths of its predecessor, the IBM zEnterprise 196. It is designed to help overcome problems in today's IT infrastructures and provide a foundation for the future. The zEC12 continues the evolution of integrated hybrid systems, introducing the zEnterprise BladeCenter Extension (zBX) Model 003, and an updated zEnterprise Unified Resource Manager.

The zEC12 has a redesigned zEnterprise chip. It is the first six-core chip in mainframe history, and operates at an industry-leading, high frequency 5.5 GHz. The zEC12 is a scalable symmetric multiprocessor (SMP) that can be configured with up to 101 processors that run concurrent production tasks with up to 3 TB of memory.

The zEC12 introduces several PCIe I/O features, such as the usage of Storage Class Memory through the Flash Express feature. It also introduces technologies such as the IBM System z Advanced Workload Analysis Reporter (IBM zAware). This appliance has cutting-edge pattern recognition analytics that use heuristic techniques, and represents the next generation of system health monitoring.

The zEC12 goes beyond previous designs while continuing to enhance the traditional mainframe qualities, delivering unprecedented performance and capacity growth. The zEC12 has a balanced general-purpose design that allows it to be equally at ease with compute-intensive and I/O-intensive workloads.

A.2 zEC12 elements

zEC12 continues the integration with heterogeneous platforms, which are based on IBM BladeCenter technology. The zEC12 introduces the IBM zEnterprise BladeCenter Extension (zBX) Model 003. Similar to its predecessor, the zBX Model 002, the zBX Model 003 houses up to 112 general-purpose IBM POWER7® and System x blades, and specialized solutions such as the IBM WebSphere DataPower® XI50 for zEnterprise.

The other key element is the zEnterprise Unified Resource Manager firmware, which has updated hypervisor firmware. The zEC12, when managed by the Unified Resource Manager, constitutes a node in an ensemble, with or without a zBX attached.

An ensemble is a collection of up to eight highly virtualized heterogeneous zEC12 or zEnterprise nodes. It has dedicated networks for system management and data transfer across the virtualized system images. The ensemble is managed as a single logical entity by the Unified Resource Manager functions, where diverse workloads can be deployed.

Workloads continue to change. Multitier application architectures and their deployment on heterogeneous infrastructures are common today. But what is uncommon is the infrastructure setup that is needed to provide the high qualities of service that are required by mission-critical applications.

Creating and maintaining these high-level qualities of service while using a large collection of distributed components takes a great amount of knowledge and effort. It implies the acquisition and installation of extra equipment and software to ensure availability, security, monitoring, and managing. Additional manpower is required to configure, administer, troubleshoot, and tune such a complex set of separate and diverse environments. Because of platform functional differences, the resulting infrastructure is not uniform regarding those qualities of service and serviceability.

The zEC12 directly addresses those infrastructure problems. The zEC12 design can simultaneously support many diverse workloads while also providing the highest qualities of service.

The IBM holistic approach to System z design includes hardware, software, and procedures. It takes into account a wide range of factors, including compatibility and investment protection, thus ensuring a tighter fit with the IT requirements of the entire enterprise.

A.2.1 zEC12 highlights

This section contains some of the highlights of the IBM zEC12 system.

Processor and memory

IBM continues its technology leadership with the zEC12. The zEC12 is built by using the IBM modular multibook design that supports one to four books per central processor complex (CPC). Each book contains a multiple chip module (MCM), which hosts the redesigned CMOS 13S[1] processor units, storage control chips, and connectors for I/O. The superscalar processor has enhanced out-of-order instruction execution, redesigned caches, and an expanded instruction set that includes a Transactional Execution facility, for better performance.

Depending on the model, the zEC12 can support from a minimum of 32 GB to a maximum of 3040 GB of usable memory, with up to 768 GB per book. In addition, a fixed amount of 32 GB is reserved for the hardware system area (HSA) and is not part of customer-purchased memory. Memory is implemented as a redundant array of independent memory (RAIM). To use the RAIM function, up to 960 GB are installed per book, for a system total of 3840 GB.

Capacity and performance

The zEC12 provides increased capacity over its predecessor, the z196 system. This capacity is achieved both by increasing the performance of the individual processor units and by increasing the number of processor units (PUs) per system. The increased performance and the total system capacity available, along with possible energy savings, allow you to consolidate diverse applications on a single platform, with real financial savings. The introduction of new technologies and features help ensure that the zEC12 is an innovative, security-rich platform. It is designed to maximize resource usage, and with the ability to integrate applications and data across the enterprise IT infrastructure. zEC12 has five model offerings with 1 - 101 configurable PUs. The first four models (H20, H43, H66, and H89) have 27 PUs per book, and the high capacity model (the HA1) has four 30 PU books. Model HA1 is estimated to provide up to 50% more total system capacity than the z196 Model M80 with the same memory and power requirements. This comparison is based on the Large Systems Performance Reference (LSPR) mixed workload analysis.

The zEC12 expands the subcapacity settings offer with three subcapacity levels for the first 20 processors. This configuration gives a total of 161 distinct capacity settings in the system, and provides a range of over 1:320 in processing power. The zEC12 delivers scalability and granularity to meet the needs of medium-sized enterprises, while also satisfying the requirements of large enterprises that have demanding, mission-critical transaction and data processing requirements. The zEC12 continues to offer all the specialty engines available on previous System z systems.

[1] CMOS 13S is a 32-nanometer CMOS logic fabrication process.

I/O subsystem and I/O features

The zEC12 supports a PCIe I/O and InfiniBand infrastructure. PCIe features are installed in PCIe I/O drawers. When you upgrade from a z196 or IBM z10 EC, up to two I/O drawers that were introduced with the IBM z10 BC, and one traditional I/O cage are also supported. There are up to 48 high-performance fanouts for data communications between the server and the peripheral environment. The multiple channel subsystem (CSS) architecture allows up to four CSSs, each with 256 channels.

For I/O constraint relief, three subchannel sets are available per CSS, allowing access to a larger number of logical volumes. For improved device connectivity for parallel access volumes (PAVs), PPRC secondaries, and IBM FlashCopy® devices, this third subchannel set allows you to extend the amount of addressable external storage. The zEC12 allows you to perform an IPL from subchannel set 1 (SS1) or subchannel set 2 (SS2), in addition to subchannel set 0. In addition, the system I/O buses take advantage of the PCIe technology and of InfiniBand technology, which is also used in coupling links.

Virtualization

IBM Processor Resource/Systems Manager™ (PR/SM™) manages all the installed and enabled resources (processors and memory) as a single large SMP system. It enables the configuration and operation of up to 60 logical partitions, which have processors, memory, and I/O resources that are assigned from the installed books.

zEC12 provides improvements to the PR/SM HiperDispatch function. HiperDispatch provides work alignment to logical processors, and alignment of logical processors to physical processors. This alignment optimizes cache usage, minimizes inter-book communication, and optimizes IBM z/OS® work dispatching, with the result of increasing throughput. zEC12 provides for the definition of up to 32 IBM HiperSockets. HiperSockets provide for memory communication across logical partitions without the need of any I/O adapters, and have VLAN capability. HiperSockets are extended to bridge to an ensemble internode data network.

Increased flexibility with z/VM-mode logical partition

The zEC12 provides for the definition of a z/VM-mode logical partition (LPAR) containing a mix of processor types. These types include CPs and specialty processors such as IFLs, zIIPs, zAAPs, and ICFs.

z/VM V5R4 and later support this capability, which increases flexibility and simplifies system management. In a single LPAR, z/VM can run these tasks:

- Manage guests that use Linux on System z on IFLs, IBM z/VSE®, z/TPF, and z/OS on CPs
- Run designated z/OS workloads, such as parts of IBM DB2 DRDA® processing and XML, on zIIPs
- Provide an economical Java execution environment under z/OS on zAAPs

zAware mode logical partition

The zEC12 introduces the zAware mode logical partition. This special partition is defined for the sole purpose of running the zAware code. It is a licensing requirement. Either CPs or IFLs can be configured to the partition. The partition can be used exclusively by the IBM System z Advanced Workload Analysis Reporter (IBM zAware) offering.

Reliability, availability, and serviceability

System reliability, availability, and serviceability (RAS) are areas of continuous IBM focus. The objective is to reduce, or eliminate if possible, all sources of planned and unplanned outages, with the objective of keeping the system running. It is a design objective to provide higher availability with a focus on reducing outages. With a properly configured zEC12, further reduction of outages can be attained through improved nondisruptive replace, repair, and upgrade functions for memory, books, and I/O adapters. In addition, you have extended nondisruptive capability to download Licensed Internal Code (LIC) updates.

Enhancements include removing pre-planning requirements with the fixed 32 GB HSA. You no longer must worry about using your purchased memory when you define your I/O configurations with reserved capacity or new I/O features. Maximums can be configured and IPLed so that later insertion can be dynamic, and not require a power-on reset of the server.

This approach provides many high-availability and nondisruptive operations capabilities that differentiate it in the marketplace. The ability to cluster multiple systems in an IBM Parallel Sysplex® takes the commercial strengths of the z/OS platform to higher levels of system management, competitive price/performance, scalable growth, and continuous availability.

Flash Express

Flash Express is an innovative optional feature that is introduced with the zEC12. It is intended to provide performance improvements and better availability for critical business workloads that cannot afford any hits to service levels. Flash Express is easy to configure, requires no special skills, and provides rapid time to value.

Flash Express implements storage-class memory (SCM) in a PCIe card form factor. Each Flash Express card implements an internal NAND Flash solid-state drive (SSD), and has a capacity of 1.4 TB of usable storage. Cards are installed in pairs, which provides mirrored data to ensure a high level of availability and redundancy. A maximum of four pairs of cards can be installed on a zEC12, for a maximum capacity of 5.6 TB of storage. The Flash Express feature is designed to allow each logical partition to be configured with its own SCM address space. It is used for paging. With Flash Express, 1 MB pages are pageable.

Hardware encryption is included to improve data security. Data security is ensured through a unique key that is stored on the Support Element (SE) hard disk drive. It is mirrored for redundancy. Data on the Flash Express feature is protected with this key, and is only usable on the system with the key that encrypted it. The Secure Key Store is implemented by using a smart card that is installed in the Support Element. The smart card (one pair, so you have one for each SE) contains the following items:

- A unique key that is personalized for each system
- A small cryptographic engine that can run a limited set of security functions within the smart card

Flash Express is supported by z/OS 1.13 (at minimum) for handling z/OS paging activity and IBM SAN Volume Controller memory dumps. Additional functions of Flash Express are expected to be introduced later, including 2 GB page support and dynamic reconfiguration for Flash Express.

IBM System z Advanced Workload Analysis Reporter

IBM System z Advanced Workload Analysis Reporter (IBM zAware) is a feature that was introduced with the zEC12 that embodies the next generation of system monitoring. IBM zAware is designed to offer a near real-time, continuous learning, diagnostic tests, and monitoring capability. This function helps pinpoint and resolve potential problems quickly enough to minimize their effects on your business.

The ability to tolerate service disruptions is diminishing. In a continuously available environment, any disruption can have grave consequences. This negative effect is especially true when the disruption lasts days or even hours. But, increased system complexity makes it more probable that errors occur, and those errors are also increasingly complex. Some incidents' early symptoms go undetected for long periods and can grow to large problems. Systems often experience “soft failures” (sick but not dead), which are much more difficult or unusual to detect. IBM zAware is designed to help in those circumstances.

A.3 IBM zEnterprise BladeCenter Extension (zBX)

The IBM zEnterprise BladeCenter Extension (zBX) is the infrastructure for extending the System z qualities of service and management capabilities across a set of heterogeneous compute elements in an ensemble.

A.3.1 Statement of Direction

The IBM zEnterprise EC12 is the last server to support connections to an STP Mixed CTN, including the Sysplex Timer (9037). After zEC12, servers that require time synchronization, such as to support a base or Parallel Sysplex, require Server Time Protocol (STP). In addition, all servers in that network must be configured in STP-only mode.

The zBX is available as an optional system to work along with the zEC12 server and consists of the following components:

- Up to four IBM 42U Enterprise racks.
- Up to eight BladeCenter chassis with up to 14 blades, each with up to two chassis per rack.
- Up to 1125 blades.
- INMN top of rack (TOR) switches. The INMN provides connectivity between the zEC12 Support Elements and the zBX, for management purposes.
- IEDN TOR switches. The IEDN is used for data paths between the zEC12 and the zBX, and the other ensemble members, and also for customer data access.
- 8 Gbps Fibre Channel switch modules for connectivity to a SAN.
- Advanced management modules (AMMs) for monitoring and management functions for all the components in the BladeCenter.
- Power Distribution Units (PDUs) and cooling fans.
- Optional acoustic rear door or optional rear door heat exchanger.

The zBX is configured with redundant hardware infrastructure to provide qualities of service similar to those of System z, such as the capability for concurrent upgrades and repairs.

A.3.2 Blades

There are two types of blades that can be installed and operated in the IBM zEnterprise BladeCenter Extension (zBX):

- Optimizer Blades: IBM WebSphere DataPower Integration Appliance XI50 for zEnterprise blades.
- IBM blades:
  - A selected subset of IBM POWER7 blades
  - A selected subset of IBM BladeCenter HX5 blades

These blades have been thoroughly tested to ensure compatibility and manageability in the IBM zEnterprise System environment:

- IBM POWER7 blades that are virtualized by PowerVM® Enterprise Edition, and the virtual servers that run the IBM AIX operating system.
- IBM BladeCenter HX5 blades that are virtualized by using an integrated hypervisor for System x and the virtual servers that run Linux on System x (Red Hat Enterprise Linux (RHEL) and SUSE Linux Enterprise Server (SLES) operating systems. Enablement for the blades is specified with an entitlement feature code to be configured on the zEC12s.

The maximum number of blades varies according to the blade type and blade function.

A.3.3 Unified Resource Manager

zEnterprise Unified Resource Manager is the integrated management fabric that runs on the HMC and SE. Unified Resource Manager consists of six management areas.

- Operational controls (Operations): Includes extensive operational controls for various management functions.
- Virtual server lifecycle management (Virtual servers): Enables directed and dynamic virtual server provisioning across hypervisors from a single point of control.
- Hypervisor management (Hypervisors): Enables the management of hypervisors and support for application deployment.
- Energy management (Energy): Provides energy monitoring and management capabilities that can be used to better understand the power and cooling demands of the zEnterprise System.
- Network management (Networks): Creates and manages virtual networks, including access control, that allow virtual servers to be connected together.
- Workload Awareness and platform performance management (Performance): Management of processor resource across virtual servers that are hosted in the same hypervisor instance to achieve workload performance policy objectives. The Unified Resource Manager provides energy monitoring and management, goal-oriented policy management, increased security, virtual networking, and storage configuration management for the physical and logical resources of an ensemble.

A.3.4 Hardware Management Consoles and Support Elements

The Hardware Management Consoles (HMCs) and Support Elements (SEs) are appliances that together provide hardware platform management for ensemble nodes. The HMC is used to manage, monitor, and operate one or more zEnterprise central processor complexes (CPCs) and their associated logical partitions and zBXs. The HMC6 has a global (ensemble) management scope, and the SE has (local) node management responsibility. When tasks are performed on the HMC, the commands are sent to one or more SEs, which then issue commands to their zEnterprise CPCs and zBXs. To promote high availability, an ensemble configuration requires a pair of HMCs in primary and alternate roles.

A.4 zBC12

The IBM zEnterprise BC12 (zBC12) server is the successor to the IBM zEnterprise 114 and is the fourth member of the zEnterprise CPC family. Similar to the IBM zEnterprise EC12 (zEC12), the zBC12 was designed to help overcome problems in today's IT infrastructure and provide a foundation for the future. Together with the zEC12, it continues the evolution of integrated hybrid systems, introducing the zEnterprise BladeCenter Extension (zBX) Model 003, and an updated zEnterprise Unified Resource Manager.

The zBC12, when managed by the Unified Resource Manager, with or without a zBX attached, constitutes a node in a zEnterprise ensemble. An ensemble is a collection of up to eight highly virtualized heterogeneous zEnterprise nodes. It has dedicated networks for management and data transfer across the virtualized system images. The ensemble is managed as a single logical entity by the Unified Resource Manager functions, and multiple diverse workloads can be deployed across its resources.

The zBC12 CPC has the same newly designed six-core chip of the zEC12, operating at a clock speed of 4.2 GHz. The zBC12 is a scalable symmetric multiprocessor (SMP) that can be configured with up to 13 processors running concurrent production tasks, and with up to 512 GB of memory.

Introduced with the zBC12, and also available on the zEC12, are several PCIe I/O features, such as data compression and decompression acceleration, and Remote Direct Memory Access over Converged Ethernet. The zBC12 also supports previously announced technologies, such as the usage of Storage Class Memory through the Flash Express feature, and the IBM System z Advanced Workload Analysis Reporter (IBM zAware). This appliance has leading-edge pattern recognition analytics that use heuristic techniques, and represents the next generation of system health monitoring.

The zBC12 goes beyond previous designs while continuing to enhance the traditional mainframe qualities, delivering unprecedented performance and capacity growth. The zBC12 has a balanced general-purpose design that allows it to be equally at ease with compute-intensive and I/O-intensive workloads.

Workloads continue to change. Multitier application architectures and their deployment on heterogeneous infrastructures are common today. But, what is uncommon is the infrastructure setup that is needed to provide the high quality of service that is required by mission-critical applications.

Creating and maintaining these high-level qualities of service while using a large collection of distributed components takes a great amount of knowledge and effort. It implies the acquisition and installation of extra equipment and software to ensure availability and security, monitoring, and management. Additional staff is required to configure, administer, troubleshoot, and tune such a complex set of separate and diverse environments. Because of platform functional differences, the resulting infrastructure is not uniform regarding those qualities of service or serviceability.

Although undeniably being a key piece of the IT infrastructure, it is also the place of choice for a large and diversified stack of software which, complemented with services, places the zBC12 at the heart of leading-edge solution offerings, including mobility-based and cloud-enabled applications, and big data. Its traditional strengths and characteristics, such as security, are increasingly recognized as indispensable for public acceptability of these new IT services. The IBM holistic approach to System z design includes hardware, software, and procedures. It takes into account a wide range of factors, including compatibility and investment protection, thus ensuring a tighter fit with the IT requirements of the entire enterprise.

A.5 z/VM

IBM z/VM V6.3 extends the mainframe virtualization platform to help you reshape and derive more value from your experiences. z/VM V6.3 is designed to offer the following benefits:

- Improved economies of scale with z/VM support for 1 TB of real memory
- Better performance for larger virtual machines
- Quadrupled memory scalability while continuing to maintain nearly 100% resource usage
- Reduced LPAR sprawl for additional horizontal scalability
- Considerably more virtual machines can be consolidated into a single LPAR, depending on workload characteristics
- Reduced administrative expense for managing a smaller number of large capacity z/VM host servers
- Improved performance with HiperDispatch
- More efficient usage of CPU hardware resources underneath multiple layers of virtualization running multiple and diverse workloads

Today's z/VM provides a highly secure and scalable enterprise cloud infrastructure and an environment for efficiently running multiple diverse critical applications with support for more virtual servers than any other platform in a single footprint. Enhancements that provide improved scalability and better price performance strengthen z/VM as a foundation for optimized workload deployment with reduced costs per virtual server.

The IT industry is in the midst of an important technological shift driving growth and innovation that is built on the confluence of large amounts of data, cloud, mobile devices, and social business. This environment presents an opportunity for organizations to reshape the value they deliver through the customer experience.

Workloads continue to grow in size, putting significant pressure on the resource requirements of individual virtual machines. To address pressure on memory resources, z/VM V6.3 supports 1 TB of real memory, which can increase server consolidation ratios and continues to provide support for more virtual servers than any other platform in a single footprint. With the introduction of new functions to increase memory scalability limits, z/VM V6.3 provides the capability to scale with efficiency both horizontally and vertically, supporting your growing demands.

To address your increasing workload demands for processor cycles and for quicker access to memory, z/VM V6.3 delivers the HiperDispatch function, which can improve workload throughput by optimizing processor cache usage. HiperDispatch attempts to redispatch a virtual server repeatedly on the same physical CPU, or on a collection of physically adjacent CPUs, to increase the chances of obtaining data from the processor cache, instead of incurring time delays by having to go to main memory for data.

Strengthening the affinity between dispatched work and logical and physical processors increases the probability of cache hits and improved performance. As processor configurations become larger, this enhancement mitigates the performance loss of large-scale configurations by reducing the random dispersal of work across unrelated processors.

HiperDispatch is expected to deliver a CPU performance boost depending on a workload's characteristics. Memory-intensive workloads, running on many physical processors (16 - 32), are most likely to achieve the highest performance gains.

These select highlights of z/VM V6.3 contribute to the foundation of a highly secure and scalable enterprise cloud infrastructure and an environment for efficiently running multiple critical applications. Here are examples of new solutions that are suited for this environment:

- Intelligent Operations Center for IBM Smarter Cities®, providing integrated city management with maximum flexibility and scalability on zEnterprise
- IBM Smarter Infrastructure for Social Services, ensuring protection for citizen information with a single source of secure data and flexibility in deployment
- IBM IT Asset Management for Government, helping government agencies improve the productivity and efficiency of their critical assets

For the most current information about z/VM V6.3, see the z/VM website at the following address:

http://www.vm.ibm.com/zvm630/

Related publications

The publications that are listed in this section are considered suitable for a more detailed discussion of the topics that are covered in this book.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Some publications referenced in this list might be available in softcopy only.

- *Experiences with Oracle 11gR2 on Linux on System z*, SG24-8104
- *Experiences with Oracle Solutions on Linux for IBM System z*, SG24-7634
- *Installing Oracle 11gR2 RAC on Linux on System z*, REDP-4788
- *IBM zEnterprise EC12 Configuration Setup*, SG24-8034
- *IBM zEnterprise EC12 Technical Guide*, SG24-8049
- *IBM zEnterprise System Technical Introduction*, SG24-8050
- *An Introduction to z/VM Single System Image (SSI) and Live Guest Relocation (LGR)*, SG24-8006
- *Linux on IBM System z: Performance Measurement and Tuning*, SG24-6926*Optimizing Your Oracle Investment with IBM Storage Solutions*, REDP-4421
- *Sharing and Maintaining Linux under z/VM*, REDP-4322
- *Silent Installation Experiences with Oracle Database 11gR2 Real Application Clusters on Linux on System z*, REDP-9131
- *Using IBM Virtualization to Manage Cost and Efficiency*, REDP-4527
- *Using z/VM v 6.2 Single System Image (SSI) and Live Guest Relocation (LGR)*, SG24-8039
- *The Virtualization Cookbook for IBM z/VM 6.3, RHEL 6.4, and SLES 11 SP3*, SG24-8147

You can search for, view, download, or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

www.ibm.com/redbooks

Oracle publications

These publications are also relevant as further information sources:

The Oracle installation guides are at http://docs.oracle.com

- *Oracle Grid Infrastructure Installation Guide 12c Release 1 (12.1) for Linux*, E17888
- *Oracle Database Administrator's Guide12c Release 1 (12.1)*, E17636
- *Oracle Database Client Quick Installation Guide 12c Release 1 (12.1) for IBM: Linux on System z,* E18444
- *Oracle Database Installation Guide 12c Release 1 (12.1) for Linux*, E17720

- *Oracle Database Quick Installation Guide 12c Release 1 (12.1) for IBM: Linux on System z,* E18443
- *Oracle Database Release Notes 12c Release 1 (12.1) for Linux*, E17734

For Oracle Real Application Cluster installation, we used these installation guides as well:

- *Oracle Automatic Storage Management Administrator's Guide 12c Release 1 (12.1),* E17612
- *Oracle Clusterware Administration and Deployment Guide 12c Release 1 (12.1),* E17886
- *Oracle Real Application Clusters Administration and Deployment Guide 12c Release1(12.1)*, E17887
- *Oracle Real Application Clusters Installation Guide 12c Release 1 (12.1) for Linux and UNIX,* E17889

List of recommended Oracle My Oracle Support notes

My Oracle Support (MOS) notes can be accessed by going to the Oracle support site (a support ID is required) at `https://support.oracle.com` and entering the corresponding document note number in the search box. Here is the current list of MOS notes that are related to Oracle on Linux on System z:

- *Getting Started - 12c Release 1 Grid Infrastructure, Oracle Database - IBM: Linux on System z (s390x)*, Doc ID 1574412.1
- *Requirements for Installing Oracle Database 12c Release 1 on RHEL 6 on IBM: Linux on System z (s390x)*, Doc ID 1574413.1
- *Requirements for Installing Oracle Database 12c Release 1 on SLES 11 on IBM: Linux on System z (s390x)*, Doc ID 1574414.1

Here are other relevant notes:

- *Ensure you have prerequisite rpms to install Oracle Database and AS10g(midtier) on IBM: Linux on System z (s390x)*, Doc ID 1086769.1
- *Getting Started - 11gR2 Grid Infrastructure, SI (Single Instance), ASM and DB (IBM: Linux on System z)*, Doc ID 1306465.1
- *How to completely remove 11.2 Grid Infrastructure, CRS and/or Oracle Restart - IBM: Linux on System z*, Doc ID 1413787.1
- *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z Red Hat 5*, Doc ID 1351746.1
- *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z Red Hat 6*, Doc ID 1377392.1
- *How to Manually Configure Disk Storage devices for use with Oracle ASM 11.2 on IBM: Linux on System z SLES*, Doc ID 1350008.1
- *How to Upgrade Oracle Restart i.e. Single Node Grid Infrastructure/ASM from 11.2.0.2 to 11.2.0.3*, Doc ID 1400185.1
- *Oracle GoldenGate Best Practices: Instantiation from an Oracle Source Database*, Doc ID 1276058.1
- *Requirements for Installing Oracle 11gR2 on RHEL 5 on IBM: Linux on System z (s390x)*, Doc ID 1306889.1

- *Requirements for Installing Oracle 11gR2 on RHEL 6 on IBM: Linux on System z (s390x)*, Doc ID 1470834.1
- *Requirements for Installing Oracle 11gR2 on SLES 10 on IBM: Linux on System z (s390x)*, Doc ID 1308859.1
- *Requirements for Installing Oracle 11gR2 on SLES11 on IBM: Linux on System z (s390x)*, Doc ID 1290644.1*;* also review *OHASD fails to start on SuSE 11 SP2 on IBM: Linux on System z*, Doc ID 1476511.1
- *Where To Locate The Oracle RDBMS Installation Guides, Upgrade Guides and Release Notes*, Doc ID 605251.1

Online resources

These websites are also relevant as further information sources:

- Linux on System z

  `http://www.ibm.com/developerworks/linux/linux390/`
- Oracle Technology Network

  `http://otn.oracle.com`
- Oracle Support Webpage (My Oracle Support)

  `https://support.oracle.com`
- Special Interest Group of Oracle users on the mainframe

  `http://www.zseriesoraclesig.org`
- z/VM Performance & Tuning Tips, Capacity planning

  `http://www.vm.ibm.com/perf/tips`

Help from IBM

IBM Support and downloads

ibm.com/support

IBM Global Services

ibm.com/services

IBM Redbooks

Experiences with Oracle Database 12c Release 1 on Linux on System z

(0.2”spine)
0.17”<->0.473”
90<->249 pages

Experiences with Oracle Database 12c Release 1 on Linux on System z

Setting up Linux for Oracle DB 12c R1

Installing Oracle DB 12c R1 RAC

Upgrading to Oracle DB 12c R1

Oracle Database 12c Release 1 is now supported on Linux on IBM System z. This platform offers many advantages to customers who rely upon the IBM mainframe systems to run their businesses. Linux on System z takes advantage of the qualities of service in the System z hardware and in IBM z/VM, making it a robust industrial strength version of Linux. This provides an excellent platform for hosting Oracle solutions that run in an enterprise.

This IBM Redbooks publication shares experiences that are gained while installing and testing Oracle Database 12c Release 1:

- Recommendations about how to set up an infrastructure
- Installing an Oracle Grid Infrastructure
- Installing Oracle 12C R1 Real Application Clusters (RAC) and creating a RAC Database, including a multitenant database
- Using the Cloud Control Agent to manage Oracle Database 12c Release 1
- Installing Oracle WebLogic Server 12c
- Upgrading from an Oracle Database from 11gR2 to 12c Release 1

The audience for this publication includes database consultants, installers, administrators, and system programmers. This publication is not meant to replace Oracle documentation, but to supplement it with our experiences while installing and using Oracle products.

INTERNATIONAL TECHNICAL SUPPORT ORGANIZATION

BUILDING TECHNICAL INFORMATION BASED ON PRACTICAL EXPERIENCE

IBM Redbooks are developed by the IBM International Technical Support Organization. Experts from IBM, Customers and Partners from around the world create timely technical information based on realistic scenarios. Specific recommendations are provided to help you implement IT solutions more effectively in your environment.

For more information:
ibm.com/redbooks

SG24-8159-00 ISBN 073843938X