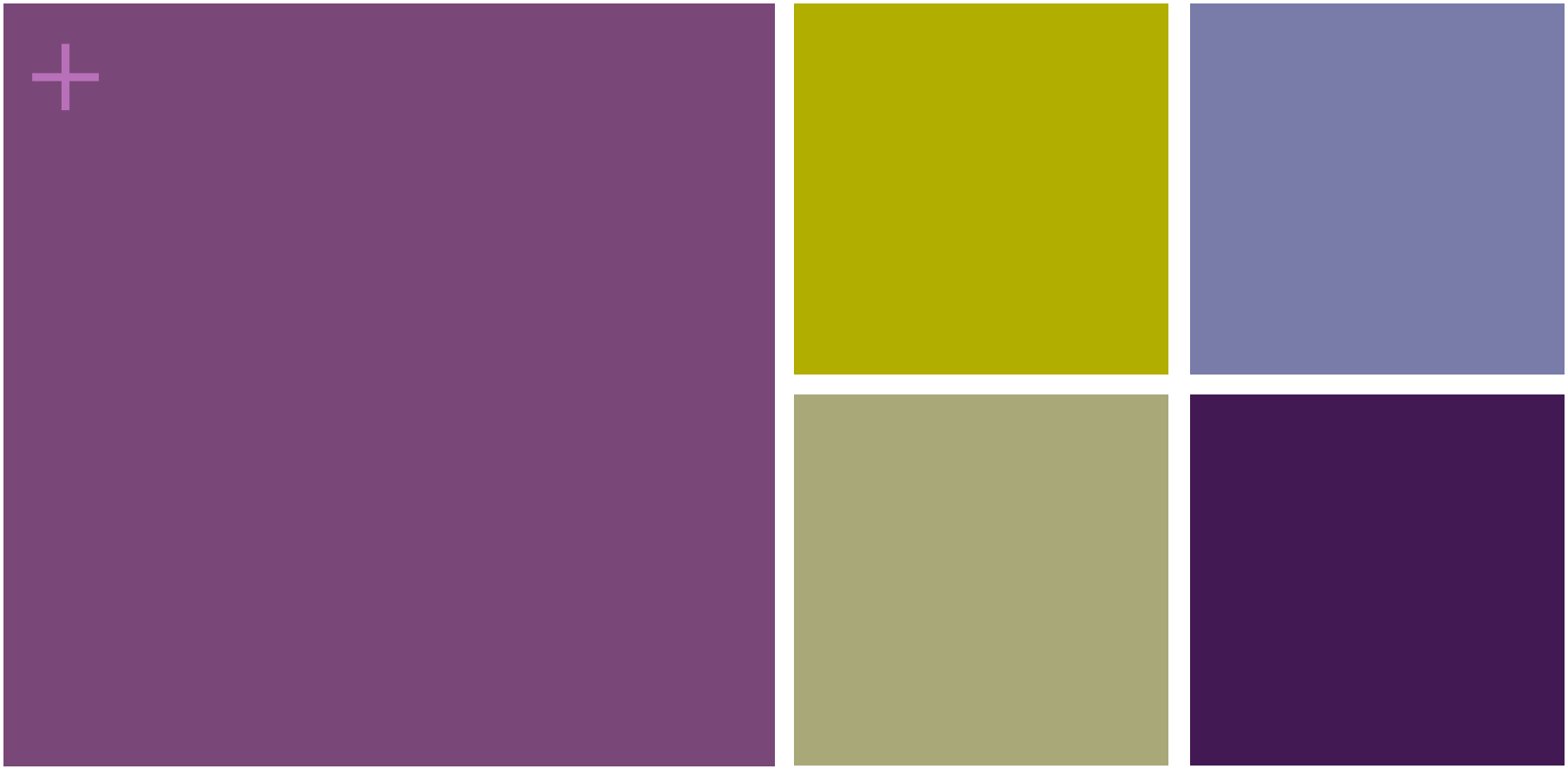

Database Security

Chapter 5

Database Installation 3: Oracle

Objectives

- Identify the considerations that an administrator must take into account prior to installation
- Install Oracle for Windows and UNIX-based operating systems
- Configure Oracle 2008 Services for Windows and UNIX-based platforms
- Secure the installation and configuration of Oracle

Planning for an Oracle Deployment

- Oracle Corporation has taken a comprehensive approach to offering business data solutions
  - Has progressed greatly over the past five years
  - Extended its primary database focus
  - Developed products that interact at each infrastructure layer
- Several different solutions can be purchased and integrated to create a robust business solution
  - Cost and complexity are important issues

Year	Version	Comments
1977		Software Development Laboratories founded
1979	Oracle 2	Was renamed Relational Software, Inc., and released their first database for VAX machines; included IBM's SQL and did not support transactions; OS support did not extend beyond Digital Equipment's -VAX/VMS
1982	Oracle 2.3	Renamed Oracle Corporation, and extended support of computers to include DEC VAX-11, PDP-11, and IBM mainframes
1983	Oracle 3	New version written in C language, supported COMMIT and ROLLBACK for transactions, included support for UNIX and any hardware with a C compiler
1984	Oracle 4	Read consistency support added, as well as a broader range of hardware and software compatibility

Table 5-1 History of Oracle
(continues)

Table 5-1 History of Oracle (cont'd.)

Year	Version	Comments
1985	Oracle 5	Support for client-server environments as well as the increased development of customized interfaces to support a variety of business needs; this includes its first spreadsheet application
1986	Oracle 5.1	Distributed query support and clustering were added to allow for larger environmental support
1988	Oracle 6	Relational Database Management System; supported PL/SQL within forms for more flexibility, added row/level locking and real-time backups; business support being developed to keep up with the growing commercial networks
1989	Oracle ERP	Oracle released its first ERP product and finds a place in the commercial world
1990	Oracle Applications release 8	Oracle business support applications are released, including its first client/server application and GUI support for PCs and Macs
1992	Oracle 7	Referential integrity, stored procedures, and triggers are added to the database as database administration features; application development tools and security components are offered
1994		Oracle introduces the first media server on the market, which included an array of tools for multimedia objects
1997	Orace 8	Support of object-oriented development and multimedia applications are integrated
1999	Oracle 8i	The *i* stands for Internet, Oracle's attempt at making the database better integrated with the Internet and online processing; Oracle JVM is included
2000	Oracle E-Business Suite 11i	Applications developed for enterprise organizations to support their business needs
2001	Oracle 9i	400 added features to support the Internet and business, including XML support, RAC, and clustering
2003	Oracle Database 10g	The *g* stands for grid computing and architecture that the current versions of Oracle are built upon
2005	Oracle 10 Release 2	Announces Oracle Enterprise Linux, also known as the unbreakable Linux project for improved support and reliability for enterprise environments
2007	Oracle 11g	Released for Linux and Microsoft Windows users
2009	Oracle Middleware 11g	Acquired BEA a year before, adds BEA products and introduces Oracle Fusion Middleware 11g
2010	Oracle 11g release 2	Oracle acquires Sun Micrososystems

Checking the Requirements

- Hardware requirements for 64-bit version platforms
  - AMD64 or EM64T processor
  - 5.22 GB hard drive space with 150MB available within the temporary directory
  - 1 GB of RAM
  - 2 GB of virtual memory, or double the RAM
- Hardware requirements for 32-bit version platforms
  - 550 MHz processor (800 MHz on Windows Vista)
  - 4.76 GB hard drive space with 200MB available within the temporary directory

Checking the Requirements (cont'd.)

- Hardware requirements for 32-bit version platforms (cont'd.)
  - 1 GB RAM
  - 2 GB virtual memory, or double the RAM
- These requirements are the lowest possible resources necessary to run basic application
  - Attempting to run Oracle using the minimum requirements will cause several services to fail

Checking the Requirements (cont'd.)

- Variables to consider when choosing hardware
  - Hard disk space
    - Difficult to determine need, as file sizes fluctuate
    - Good practice to overestimate
  - Main memory (RAM)
    - Used for user connections, query executions, and SQL statements reused by the system
  - CPU
    - Need determined by number of simultaneously used instances and applications at a given time

Edition	CPUs supported	Maximum addressable memory	Maximum database size
Oracle Express	1	1 GB	4 GB
Oracle Standard One	2 Sockets	OS maximum	No maximum
Oracle Standard	4 Sockets	OS maximum	No maximum
Oracle Enterprise	No maximum	OS maximum	No maximum

Table 5-2 Oracle editions and hardware limitations

Operating System Requirements

- Oracle supports a variety of operating systems
- Operating system determines features and optional components that can be deployed
- Platform choice should be considered carefully

64-bit and 32-bit

- Oracle Database is available in both 32- and 64-bit versions
  - For both Windows and UNIX-based systems
- 32-bit version
  - Can run on either 32-bit or 64-bit platforms
  - Running on 64-bit OS will result in limited capability
- 64-bit version
  - Can only run on 64-bit platform

Windows-based platforms	Linux-based platforms	Other UNIX-based platforms
32-bit • Windows 2000 with Service Pack 1 or later • Microsoft Windows 2000 • Windows Server 2003 • Windows Server 2003 • Windows XP Professional • Windows Vista (Business, Enterprise, and Ultimate) 64-bit • Windows Server 2003 (all x64 editions) • Windows Server 2003 (all x64 editions) • Windows XP Professional x64 • Windows Vista x64 (Business, Enterprise, and Ultimate)	32-bit • Asianux 2 SP2 • Asianux 3 • Oracle Enterprise Linux 4 • Oracle Enterprise Linux 5 • Red Hat Enterprise Linux 4 • Red Hat Enterprise Linux 5 • SUSE Enterprise Linux 10 64-bit • Asianux 2 SP2 • Asianux 3 • Oracle Enterprise Linux 4 • Oracle Enterprise Linux 5 • Red Hat Enterprise Linux 4 • Red Hat Enterprise Linux 5 • SUSE 10	Solaris • Solaris 9 Update 7 or later • Solaris 10 HP-UX • HP-UX 11i V1 (11.11) PA-RISC • HP-UX 11i v2 (11.23) • HP-UX 11i v3 (11.31) AIX • AIX 5L version 5.3, TL 05, Service Pack 06 • AIX 6L version 6.1, TL 00, Service Pack 04 or later

Table 5-3 Oracle supported platforms

Other Software Requirements

- Software requirements depend on operating system and any additional components chosen
- Administrator should check Oracle’ s supporting documentation for specific prerequisites

Network Resource Requirements

- Effectiveness of network communication will be determined by network hardware and software
- Changes to network hardware and software:
  - May be necessary to accommodate increased activity caused by implementing Oracle database server
  - Oracle requires TCP/IP with SSL and named pipes
- Environment should be tested to ensure it can handle amount of data traffic
  - Check network cards, switches, cables, and other devices

Preinstallation Decisions

- Choosing an edition
  - Oracle database is available in four main editions
  - Oracle has several optional features to meet specific environment needs
- Express Edition (XE)
  - Intended for beginners and first time database deployment
  - Easy, user-friendly approach to installation
  - No cost to the user

Choosing an Edition (cont'd.)

- Oracle Database Standard Edition One (SEO)
  - Appropriate for single-server environments
- Oracle Database Standard Edition (SE)
  - Full-featured database that offers support for all types of environments
- Enterprise Edition
  - Designed for high-volume, query intensive environments
  - Many additional features included that are not available with other editions

Oracle Extra-Cost Enterprise Edition Options

- Optional components available for Enterprise Edition
  - Oracle Real Application Clusters (RAC)
  - Oracle RAC One Nod
  - Oracle Advanced Compression
  - Advanced Security Option
  - Oracle Data Mining
  - Oracle Data Profiling and Quality
  - Database Vault
  - Label Security

Oracle Extra-Cost Enterprise Edition Options (cont'd.)

- Optional components available for Enterprise Edition (cont'd.)
  - Oracle In-Memory Database Cache
  - Oracle Partitioning
  - Oracle OLAP
  - Oracle Active Data guard
  - Oracle Real Application Testing
  - Oracle Total Recall
  - Oracle Spatial

Oracle Extra-Cost Enterprise Edition Options (cont'd.)

- Optional components available for Enterprise Edition (cont'd.)
  - Oracle Change Management Pack
  - Oracle Configuration Management Pack
  - Oracle Diagnostic Pack
  - Oracle Provisioning and Patch Automation Pack
  - Oracle Tuning Pack

Licensing Options

- Separate license required for each edition of Oracle database
  - Cost depends on number of users or number of processors
  - An edition can be licensed for a specific time period
- Express Edition (XE)
  - Free for use
  - Distributed on Windows or Linux platform
  - Restricted to using 4 GB of user data and 1 GB RAM
  - For servers using only one CPU

Edition	1-year license	2-year license	3-year license	4-year license	5-year license	Perpetual
Standard One	$36.00	$63.00	$90.00	$108.00	$126.00	$180.00
Standard	$70.00	$123.00	$175.00	$210.00	$245.00	$350.00
Enterprise	$190.00	$333.00	$475.00	$570.00	$665.00	$950.00

Table 5-4 Licensing cost per user

Edition	1-year license	2-year license	3-year license	4-year license	5-year license	Perpetual
Standard One	$1160.00	$2030.00	$2900.00	$3480.00	$4060.00	$5800.00
Standard	$3500.00	$6125.00	$8750.00	$10,500.00	$12,250.00	$17,500.00
Enterprise	$9500.00	$16,250.00	$23,750.00	$28,500.00	$33,250.00	$47,500.00

Table 5-5 Licensing cost per processor

Licensing Options (cont'd.)

- SEO developed for servers that use one or two processors
- SE developed for servers that use four processors or fewer
- Enterprise edition developed to run on servers that use four or more processors
  - Minimum 25 users to qualify for a license for this edition

Free Unlimited Downloads of Oracle

- Oracle offers free downloads of all editions of Oracle Database:
  - For educational, testing, or development purposes
  - Downloads permit unlimited usage of full software versions
  - Downloads can be found at *http://www.oracle.com/technology/software/index.html*

Locating Help

- Oracle has built a community of users, administrators, developers, and more
- Help resources
  - Technical support
  - Oracle community
  - Oracle University
  - Oracle’s Knowledge Center
  - Metalink
  - Bloggers
  - Twitter

Installation

- Once preinstallation decisions and requirements have been met:
  - Installation may begin
- If prerequisites have not been met:
  - Oracle will require updates prior to installation

The Oracle University Installer (OUI)

- Java-based application providing GUI to aid installation of complex deployments
- OUI guides administrator through installation using a step-by-step wizard
  - Records administrator's selections in response file
  - Enables silent installation
- Silent installation
  - Application installation that completes without prompting a user

Step-by-Step Installation for Windows

- Steps in this section intended for installing Enterprise Edition 64-bit edition server using OUI
  - DVDs or downloaded version of the DVD are needed
  - Oracle 11g Database steps illustrated here

1. From the directory where the downloaded files were unzipped:
   - Double-click the directory setup.exe file to start the OUI

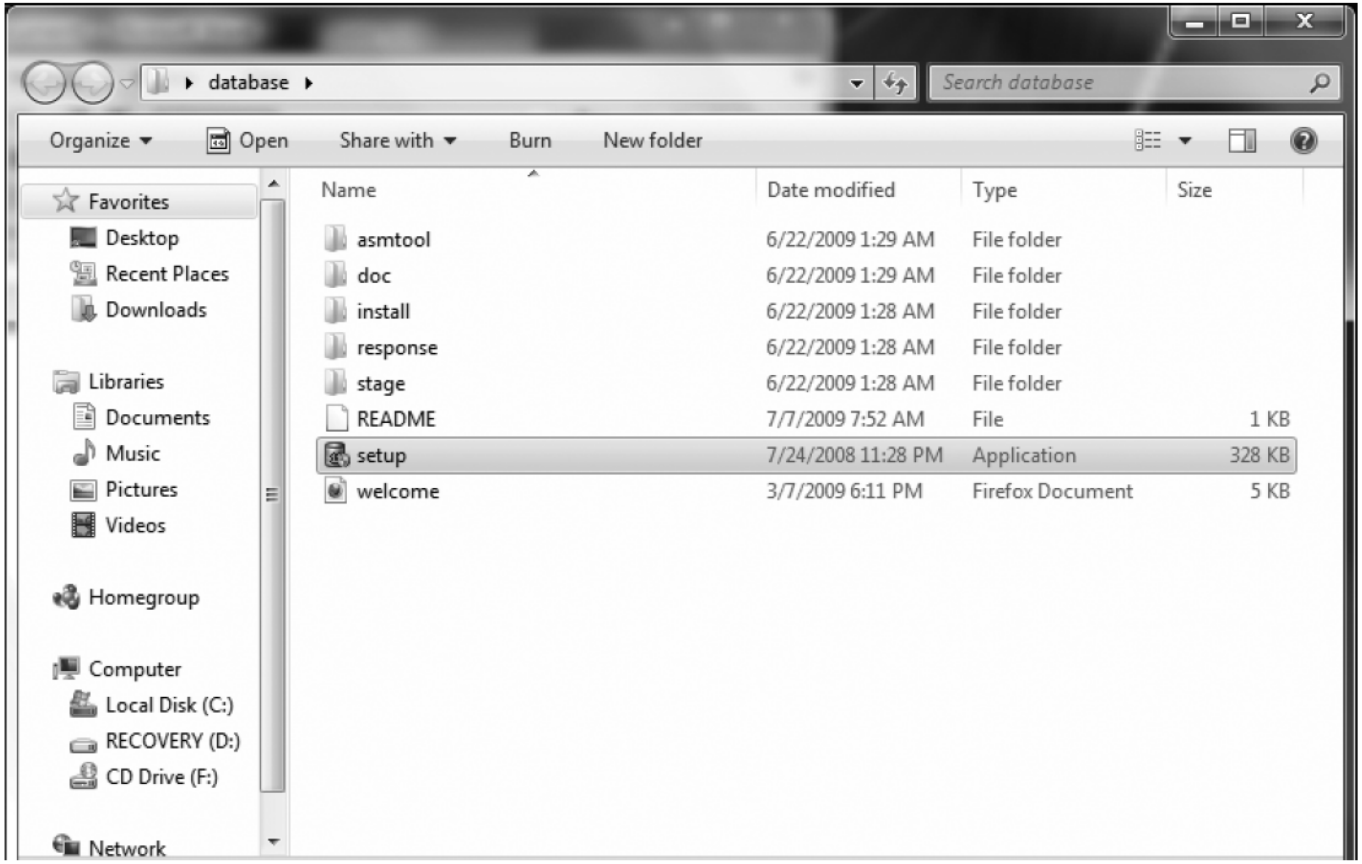

Figure 5-1 Locating the setup file

Step-by-Step Installation for Windows (cont'd.)

- Two different types of installations
  - Basic
    - Creates a default database quickly with minimal user involvement
  - Advanced
    - Custom installations that require specific software and database configurations

2. Choose Basic Installation on the OUI welcome screen
   - Enter a global name and password for the database

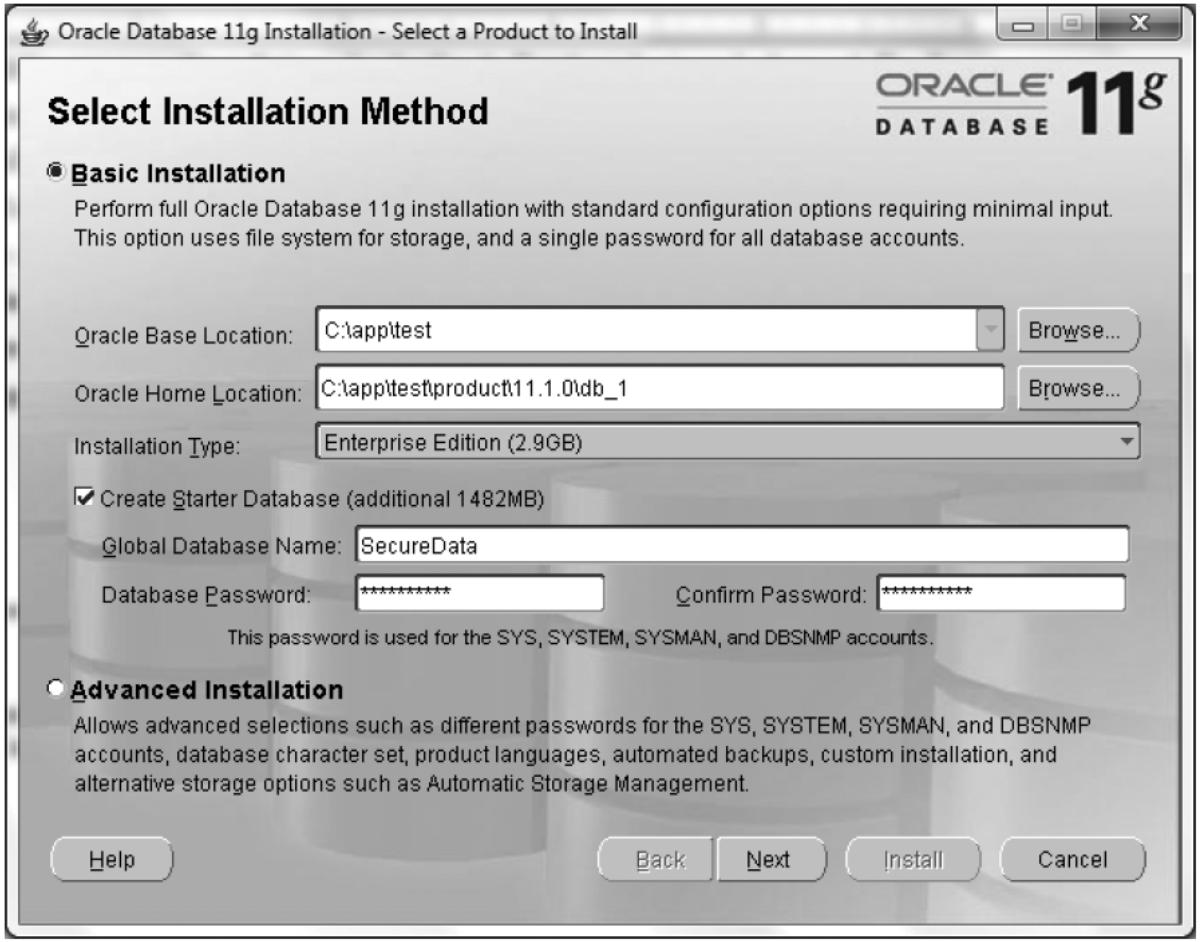

Figure 5-2 OUI welcome screen

Step-by-Step Installation for Windows (cont'd.)

3. Input information for obtaining and receiving configuration updates and alerts
   - And for creating a Metalink account
4. Oracle conducts a system check to ensure prerequisites are met
   - Indicates any errors found or warnings
   - Errors must be fixed before installation can continue
5. Enter option to have machine's configuration associated with a Metalink account
   - Click Next

Figure 5-3 Options for receiving alerts

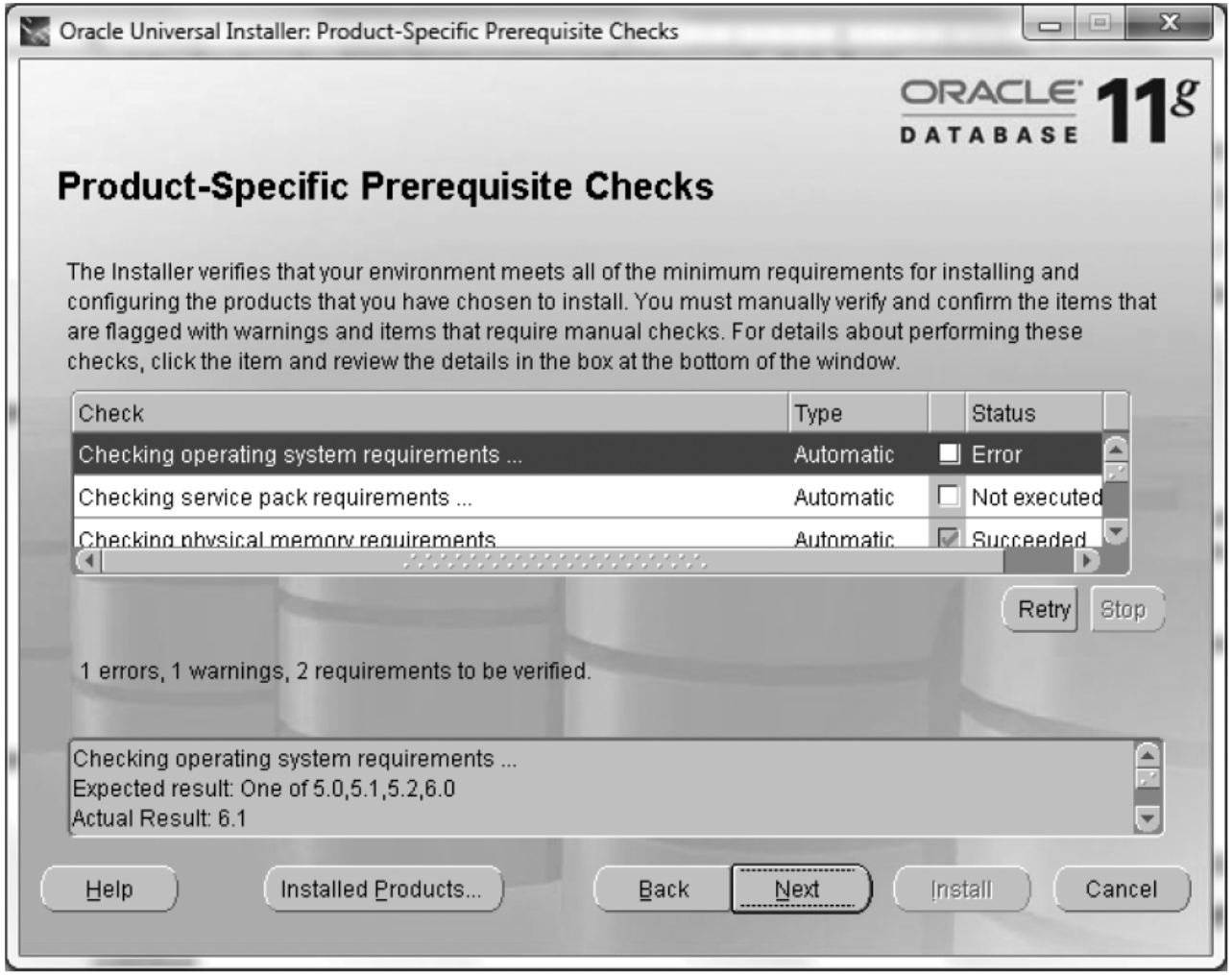

Figure 5-4 The prerequisite check

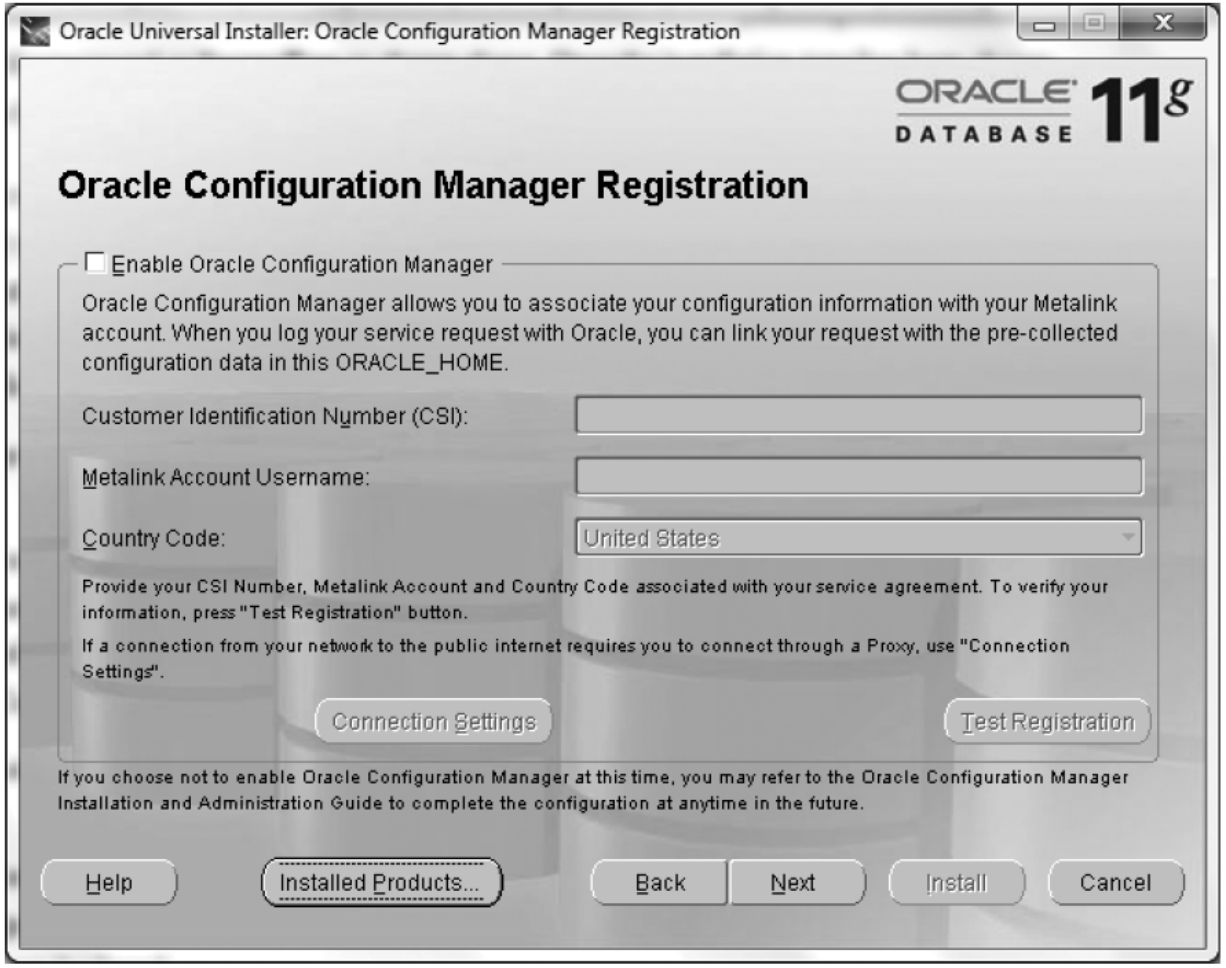

Figure 5-5 Configuration Manager

Step-by-Step Installation for Windows (cont'd.)

6. An installation summary is displayed
   - Click Install to begin the installation
7. Progress window will appear
8. When installation completes, Configuration Assistant Window appears
   - Begins creating the database
   - Confirmation window appears
   - Click Password Management to review accounts with passwords

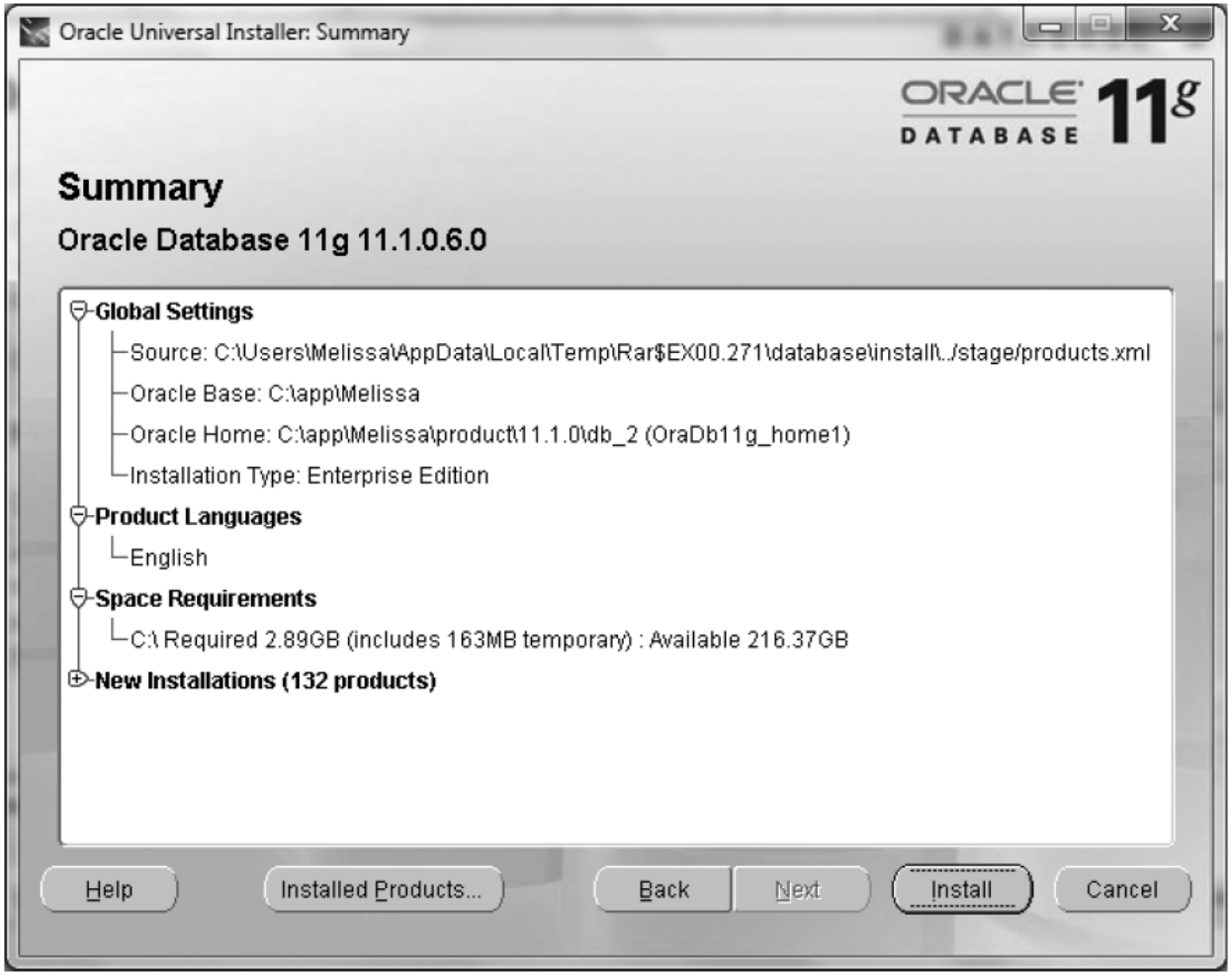

Figure 5-6 Installation Summary

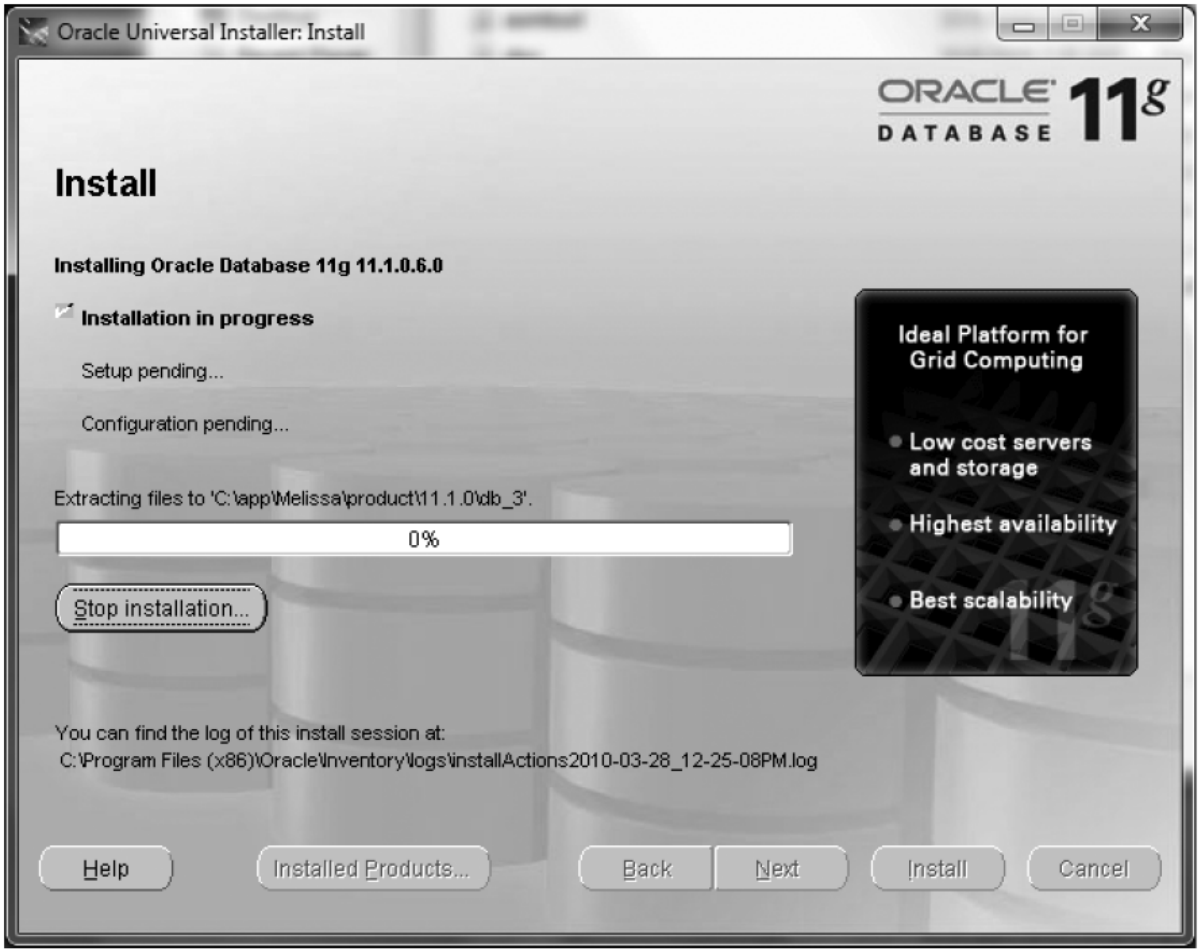

Figure 5-7 Progress window

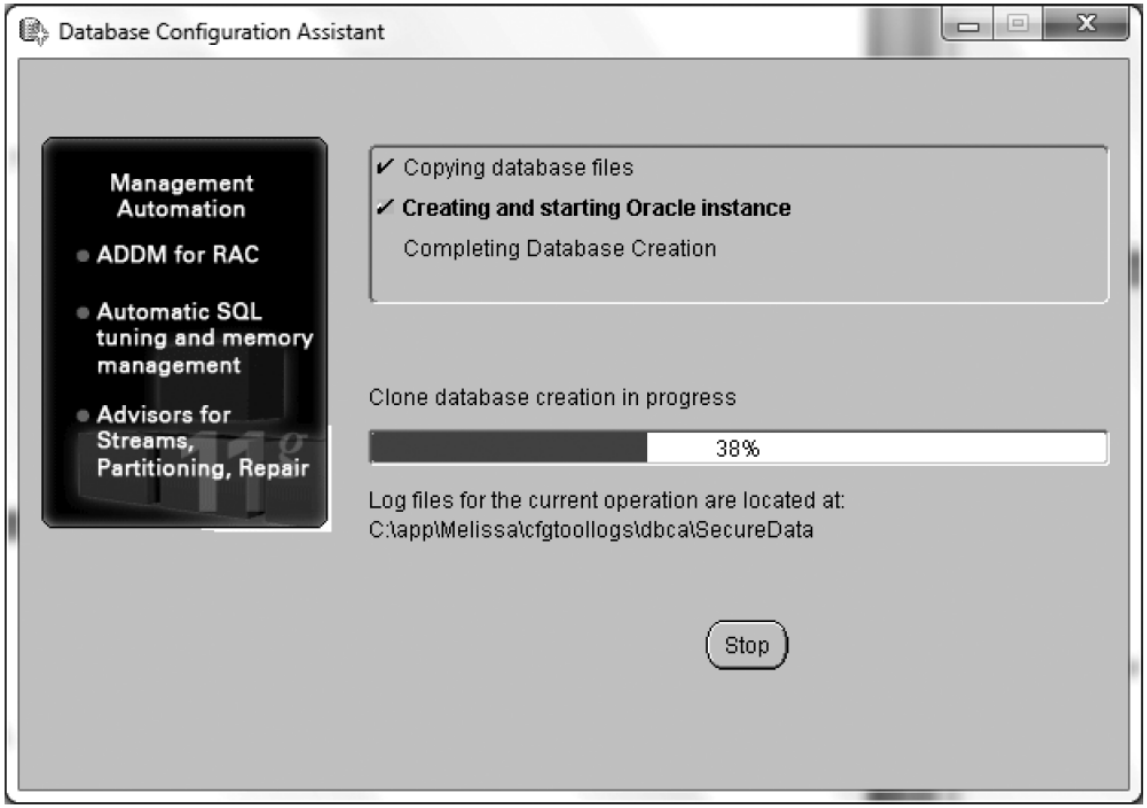

Figure 5-8 Configuration Assistant window

Figure 5-9 Configuration Assistant confirmation window

Step-by-Step Installation for Windows (cont'd.)

9. Ensure unused system administrative accounts are locked
   - Click the cell of an account to lock it
   - Set strong usernames and passwords for all unlocked accounts
10. Installation summary and reminder page appears
    - Review information and click Exit

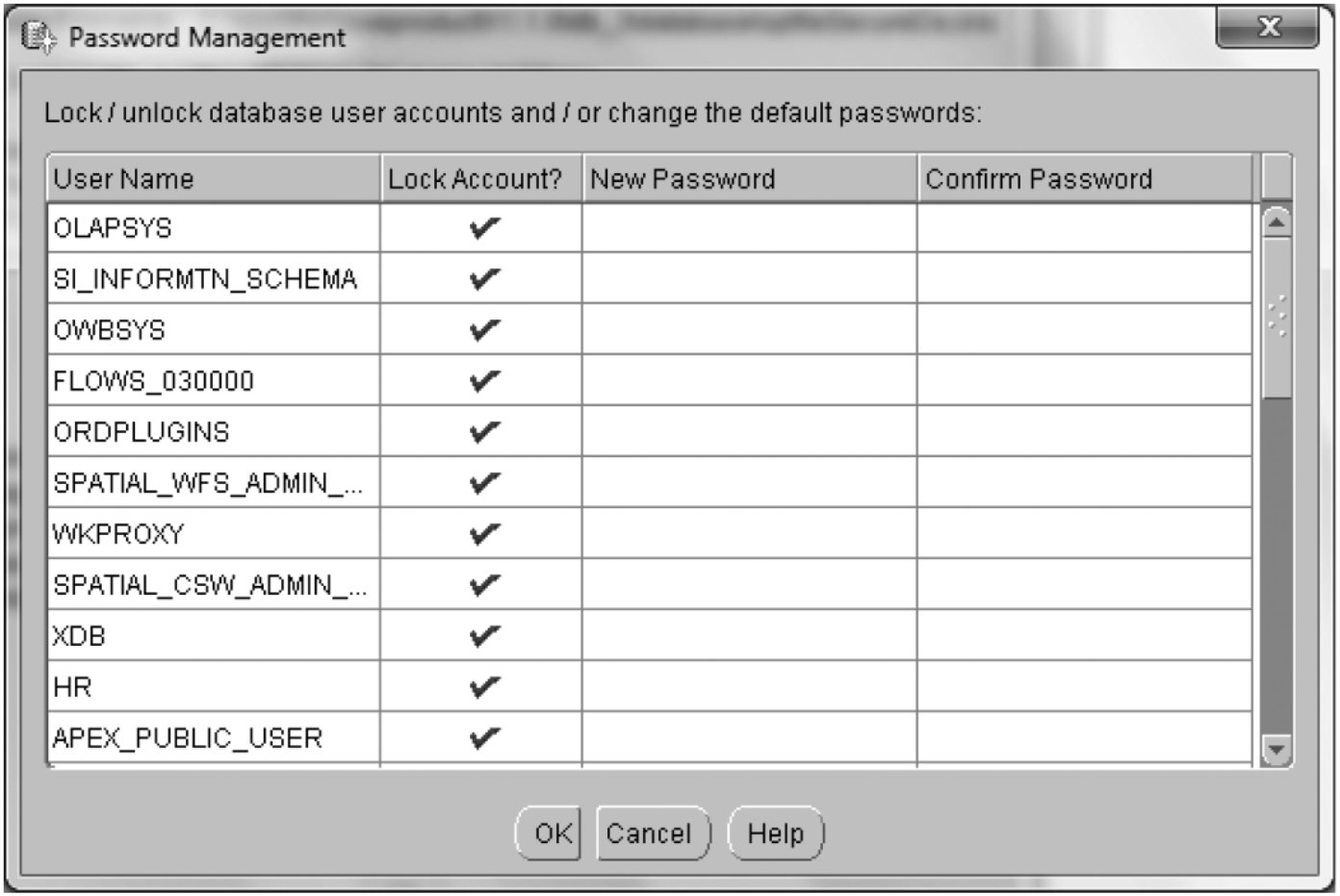

Figure 5-10 Confirm locked accounts

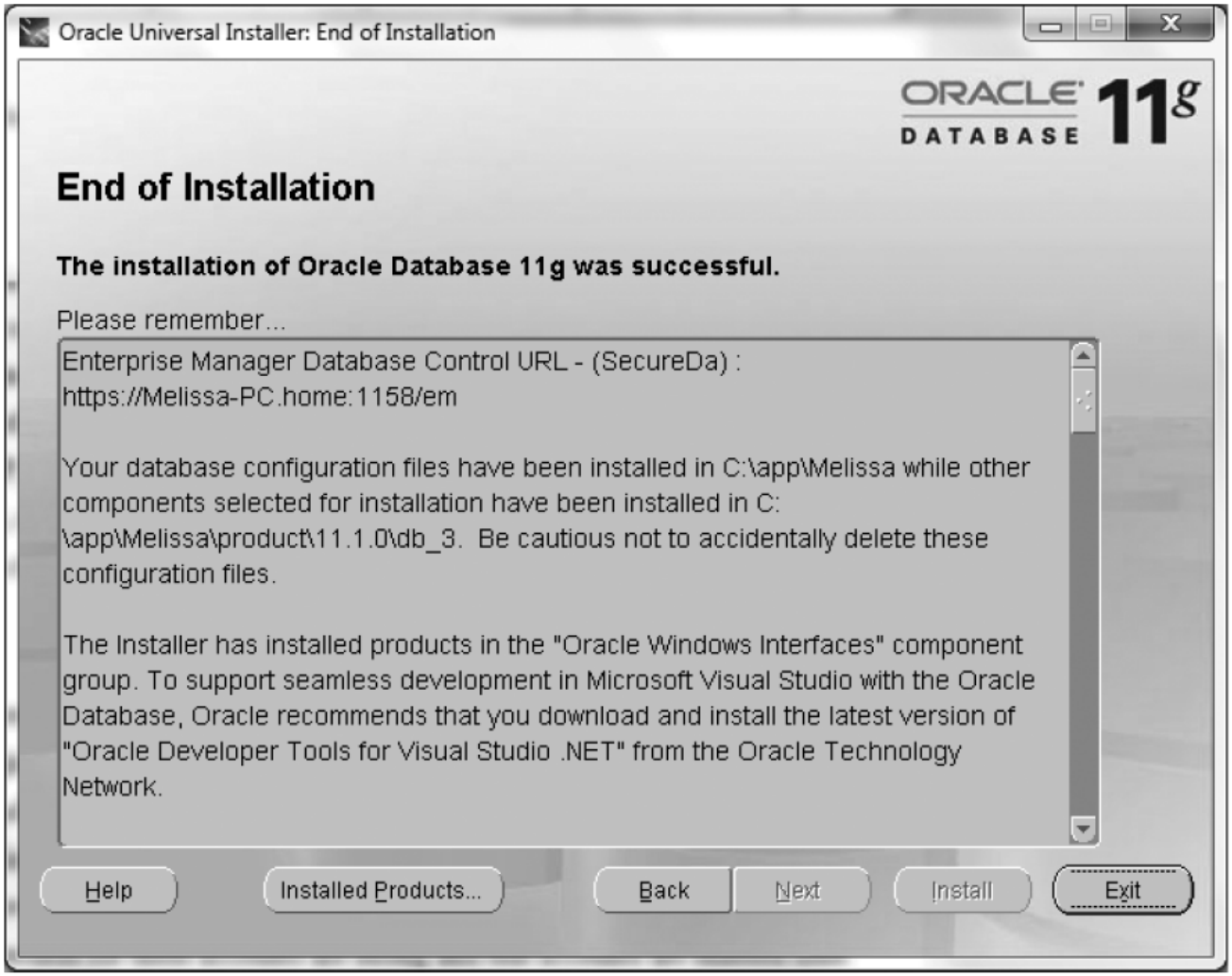

Figure 5-11 Installation summary and reminder

Quick Installation for UNIX-based Systems

- Steps to install Oracle Database Server on Linux 64-bit machine

1. From directory where downloaded files were unzipped:
   - Open a terminal window (xwindow)
   - Startx from the command line for Ubuntu
   - Type `./runInstaller.sh` to start the OUI
2. Choose Basic Installation
3. Provide global name and system password, and click Next

Quick Installation for UNIX-based Systems (cont'd.)

4. Ensure Inventory directory is the correct directory
   - Click Next
5. If all prerequisites are satisfied and there are no errors:
   - Click Next
6. Set the operating system group name
   - Click Next
7. Associate current machine's configuration with Metalink account (optional)
8. Review summary of components to be installed

Quick Installation for UNIX-based Systems (cont'd.)

9. Click Install to begin the Installation
10. Click Password Management to lock and assign passwords to unlocked accounts
    - Unlock orainstRoot.sh and root.sh as the root user
11. Type the following into a terminal window:

```
su -
<rootpassword>
cd /u01/app/oracle/oraInventory
./orainstRoot.sh
cd ./product/11.1.0/db_1
./root.sh
exit
exit
```

Quick Installation for UNIX-based Systems (cont'd.)

12. Click OK on the OUI window
13. Click Exit to end the installation

Additional Security Considerations for an Oracle Database

- Oracle holds a majority of the data management market
- Oracle database is a great commodity for potential intruders
- Security considerations should be addressed early
  - In the planning stage
  - And throughout system life

Security Checklist

- Best practices
  - Harden the operating system
  - Close ports for unused applications and services
  - Use firewalls
  - Apply the newest security patches
  - Restrict run time
  - Restrict using IP address
  - Include only required software

Security Checklist (cont'd.)

- Best practices (cont'd.)
  - Choose database security
  - Apply Oracle patches
  - Use encryption to transfer
  - Use encryption to store
  - Enforce strict access control
  - Restrict users with operating system access

Take Advantage of Oracle's Security Suite

- Oracle provides several applications to support database confidentiality, integrity and availability
  - Oracle Security
  - Label Security
  - Database Vault
  - Identity Management
  - Transparent Encryption
  - Secure Backup

Take Advantage of Oracle's Security Suite (cont'd.)

- Examples of security strategies used in the applications
  - Encryption
  - Security-based data classifications
  - Internal realms
  - Real-time access control

Oracle Database Vault

- Oracle Database Vault restricts access to specific areas in an Oracle database from any user, including users who have administrative access. For example, you can restrict administrative access to employee salaries, customer medical records, or other sensitive information.
- This enables you to apply fine-grained access control to your sensitive data in a variety of ways. It hardens your Oracle Database instance and enforces industry standard best practices in terms of separating duties from traditionally powerful users. Most importantly, it protects your data from super-privileged users but still allows them to maintain your Oracle databases. Oracle Database Vault is an integral component of your enterprise.
- With Oracle Database Vault, you address the most difficult security problems remaining today: protecting against insider threats, meeting regulatory compliance requirements, and enforcing separation of duty.

Label Security

- Control of access to sensitive information is of concern to managers, information officers, DBAs, application developers, and many others. Selective access control based on a user's level of security clearance can ensure confidentiality without overbroad limitations. This level of access control ensures that sensitive information will be unavailable to unauthorized persons even while authorized users have access to needed information, sometimes in the same tables.

- Data can be viewed as sensitive for different reasons. Examples include personal and private matters or communications, professional trade secrets, company plans for marketing or finance, military information, or government plans for research, purchases, or other actions.

- Allowing information to be seen or used by inappropriate persons can be embarrassing, damaging, or dangerous to individuals, careers, organizations, agencies, governments, or countries.

Label Security (2)

- However, such data is often intermingled with other, less sensitive information that is legitimately needed by diverse users. Restricting access to entire tables or segregating sensitive data into separate databases can create an awkward working environment that is costly in hardware, software, user time, and administration.

- Oracle Label Security obviates the need for such measures by enabling row-level access control, based on the virtual private database technology of Oracle Database Enterprise Edition. It controls access to the contents of a row by comparing that row's label with a user's label and privileges. Administrators can easily add selective row-restrictive policies to existing databases by means of the user-friendly graphical interface provided by Enterprise Manager Database Control. Developers can readily add label-based access control to their Oracle Database applications.

Oracle Data Redaction

- Oracle Data Redaction enables you to mask (redact) data that is returned from queries issued by applications. You can redact column data by using one of the following methods:
  - **Full redaction.** You redact all of the contents of the column data. The redacted value returned to the querying application user depends on the data type of the column. For example, columns of the **NUMBER** data type are redacted with a zero (**0**), and character data types are redacted with a single space.
  - **Partial redaction.** You redact a portion of the column data. For example, you can redact a Social Security number with asterisks (*), except for the last 4 digits.
  - **Regular expressions.** You can use regular expressions to look for patterns of data to redact. For example, you can use regular expressions to redact email addresses, which can have varying character lengths. It is designed for use with character data only.
  - **Random redaction.** The redacted data presented to the querying application user appears as randomly generated values each time it is displayed, depending on the data type of the column.

Oracle Data Redaction (2)

- **No redaction.** The None redaction type option enables you to test the internal operation of your redaction policies, with no effect on the results of queries against tables with policies defined on them. You can use this option to test the redaction policy definitions before applying them to a production environment.

- Oracle Database applies the redaction at runtime, when users access the data (that is, at query-execution time). This solution works well in a production system. During the time that the data is being redacted, all of the data processing is performed normally, and the back-end referential integrity constraints are preserved.

- Data redaction can help you to comply with industry regulations such as Payment Card Industry Data Security Standard (PCI DSS) and the Sarbanes-Oxley Act.

Transparent Data Encryption

- Oracle Database uses authentication, authorization, and auditing mechanisms to secure data in the database, but not in the operating system data files where data is stored. To protect these data files, Oracle Database provides Transparent Data Encryption (TDE). TDE encrypts sensitive data stored in data files. To prevent unauthorized decryption, TDE stores the encryption keys in a security module external to the database.
- Database users and applications do not need to manage key storage or create auxiliary tables, views, and triggers. An application that processes sensitive data can use TDE to provide strong data encryption with little or no change to the application.
- Use TDE to protect confidential data, such as credit card and social security numbers, stored in table columns. You can also use TDE to encrypt entire tablespaces.

Oracle Virtual Private Database

- Oracle Virtual Private Database (VPD) enables you to create security policies to control database access at the row and column level. Essentially, Oracle Virtual Private Database adds a dynamic **WHERE** clause to a SQL statement that is issued against the table, view, or synonym to which an Oracle Virtual Private Database security policy was applied.

- Oracle Virtual Private Database enforces security, to a fine level of granularity, directly on database tables, views, or synonyms. Because you attach security policies directly to these database objects, and the policies are automatically applied whenever a user accesses data, there is no way to bypass security.

- When a user directly or indirectly accesses a table, view, or synonym that is protected with an Oracle Virtual Private Database policy, Oracle Database dynamically modifies the SQL statement of the user. This modification creates a **WHERE** condition (called a predicate) returned by a function implementing the security policy. Oracle Database modifies the statement dynamically, transparently to the user, using any condition that can be expressed in or returned by a function. You can apply Oracle Virtual Private Database policies to **SELECT**, **INSERT**, **UPDATE**, **INDEX**, and **DELETE** statements.

Oracle Virtual Private Database (2)

- For example, suppose a user performs the following query:
  - SELECT * FROM OE.ORDERS;
- The Oracle Virtual Private Database policy dynamically appends the statement with a **WHERE** clause. For example:
  - SELECT * FROM OE.ORDERS
  - WHERE SALES_REP_ID = 159;
- In this example, the user can only view orders by Sales Representative 159.
- If you want to filter the user based on the session information of that user, such as the ID of the user, then you can create the **WHERE** clause to use an application context. For example:
  - SELECT * FROM OE.ORDERS
  - WHERE SALES_REP_ID = SYS_CONTEXT('USERENV','SESSION_USER');

Password Policies and User Accounts

- Preset user accounts
  - Automatically installed by Oracle during installation
  - Most default user accounts locked and set to expire
- Additional measures to secure accounts
  - Change default password during or immediately after install
  - Specify different passwords for all administrative accounts
  - Use strong password standards
    - Oracle allows “_”, “&”, and “#” symbols

Password Policies and User Accounts (cont'd.)

- Password characteristics that can be combined to develop a password policy
  - Complexity
    - Specify length and character combination required
  - Failed attempts
    - Lock account after certain number of failed attempts
  - Expired passwords
    - Force users to change password regularly
  - Reused passwords
    - Specify number of password changes a user must wait to reuse a password

Summary

- Oracle offers several software and hardware components that be integrated to provide a comprehensive solution
- 32-bit and 64-bit versions of Oracle are available
- Supported platforms of Oracle depend on their edition
- Four main editions include Express, Oracle Database Standard One, Oracle Database Standard, and Enterprise
  - Many tools available as extra add-on support

Summary (cont'd.)

- Licensing can be purchased on a per-user or per-processor basis
- Metalink is a support service for all licensed Oracle users
- Oracle University Installer and Database Configuration Assistant automate Oracle installation
- Oracle offers several security-related applications to help organizations maintain confidentiality, integrity, and availability