



Chapter 16

Database Administration and Security

Learning Objectives

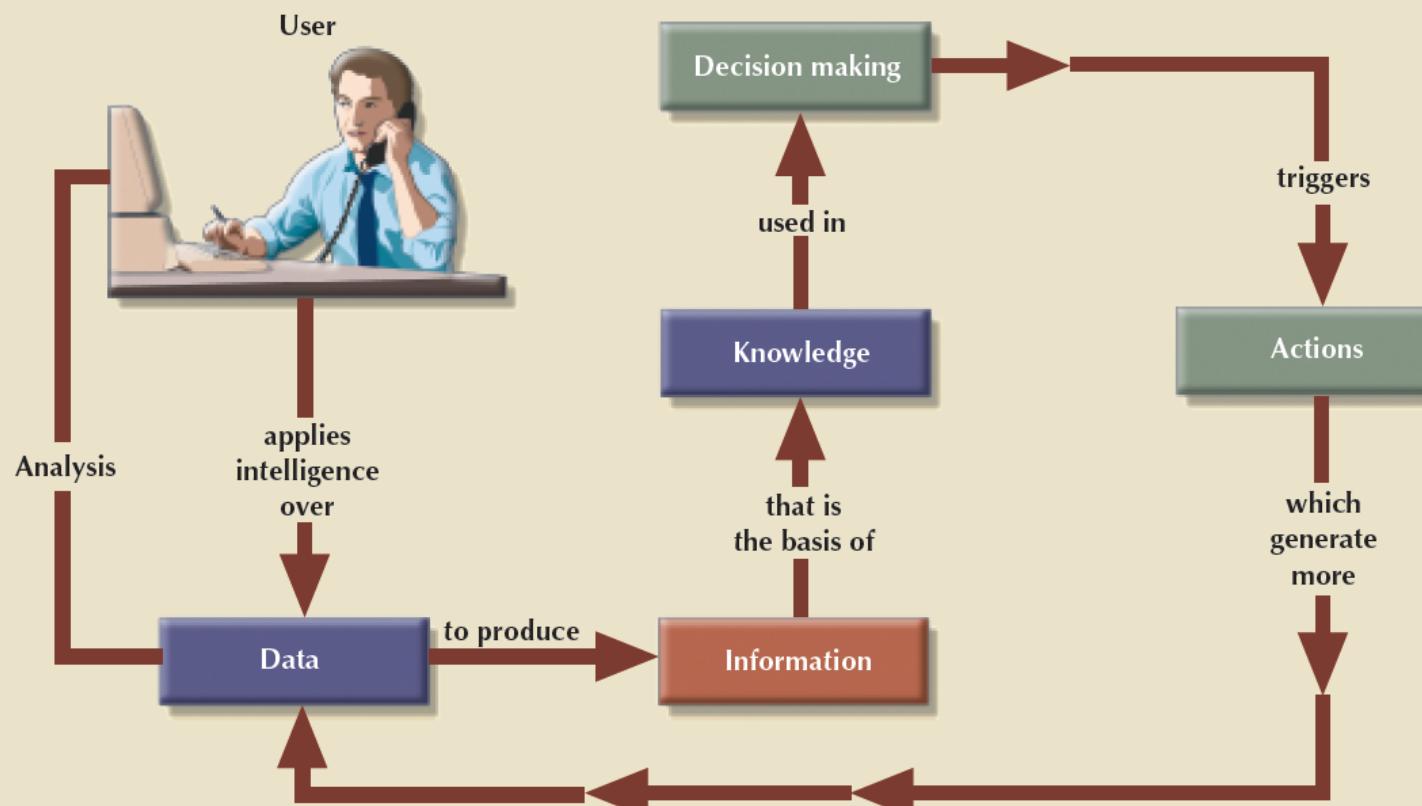
- In this chapter, you will learn:
 - That data are a valuable business asset requiring careful management
 - How a database plays a critical role in an organization
 - That the introduction of a DBMS has important technological, managerial, and cultural consequences for an organization
 - About the database administrator's managerial and technical roles

Learning Objectives

- In this chapter, you will learn:
 - About data security, database security, and the information security framework
 - About several database administration tools and strategies
 - How cloud-based data services impact the DBA's role
 - How various technical tasks of database administration are performed with Oracle

Figure 16.1 - The Data-Information-Decision Making Cycle

FIGURE 16.1 THE DATA-INFORMATION-DECISION-MAKING CYCLE



Data

Dirty data

- Data that suffer from inaccuracies and inconsistencies

Data quality

- Ensuring accuracy, validity, and timeliness of data

Data profiling software

- Determine data patterns and compare them against standards defined by the organization

Master data management (MDM) software

- Helps prevent dirty data by coordinating across multiple systems

Need for and Role of a Database in an Organization

At the top management level

- Enable strategic decision making and planning
- Identify growth opportunities
- Define and enforce organizational policies
- Reduce costs and boost productivity
- Provide feedback

At the middle management level

- Deliver the data required for tactical planning
- Monitor the use of resources
- Evaluate performance
- Enforce security and privacy of data in the database

At the operational management level

- Represent and support company operations
- Produce query results within specified performance levels
- Enhance the company's short-term operations

Introduction of a Database: Special Considerations

Technological aspect

- Selecting, installing, configuring, and monitoring the DBMS to ensure that it operates efficiently

Managerial aspect

- Careful planning to create an appropriate organizational structure

Cultural aspect

- Listening to people's concerns about the system and explaining its uses and benefits

Evolution of the Database Administration Function

Information systems (IS) department

- Provides end users with data management support and solutions for information needs

Database administrator

- Responsible for control of the centralized and shared database

Systems administrator

- General coordinator of all DBAs

Data administrator (DA) or information resource manager (IRM)

- Has a higher degree of responsibility and authority than the DBA

Figure 16.2 - The IS Department's Internal Organization

FIGURE 16.2 THE IS DEPARTMENT'S INTERNAL ORGANIZATION

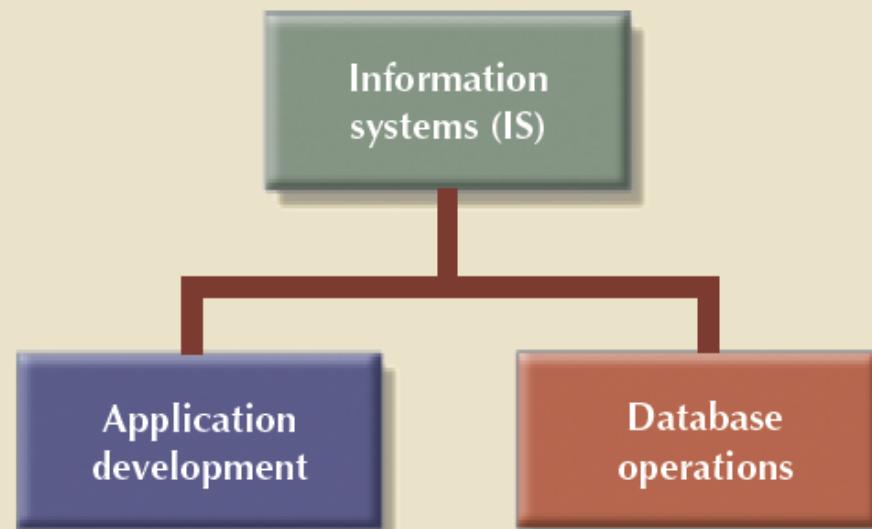


Figure 16.3 - The Placement of the DBA Function

FIGURE 16.3 THE PLACEMENT OF THE DBA FUNCTION

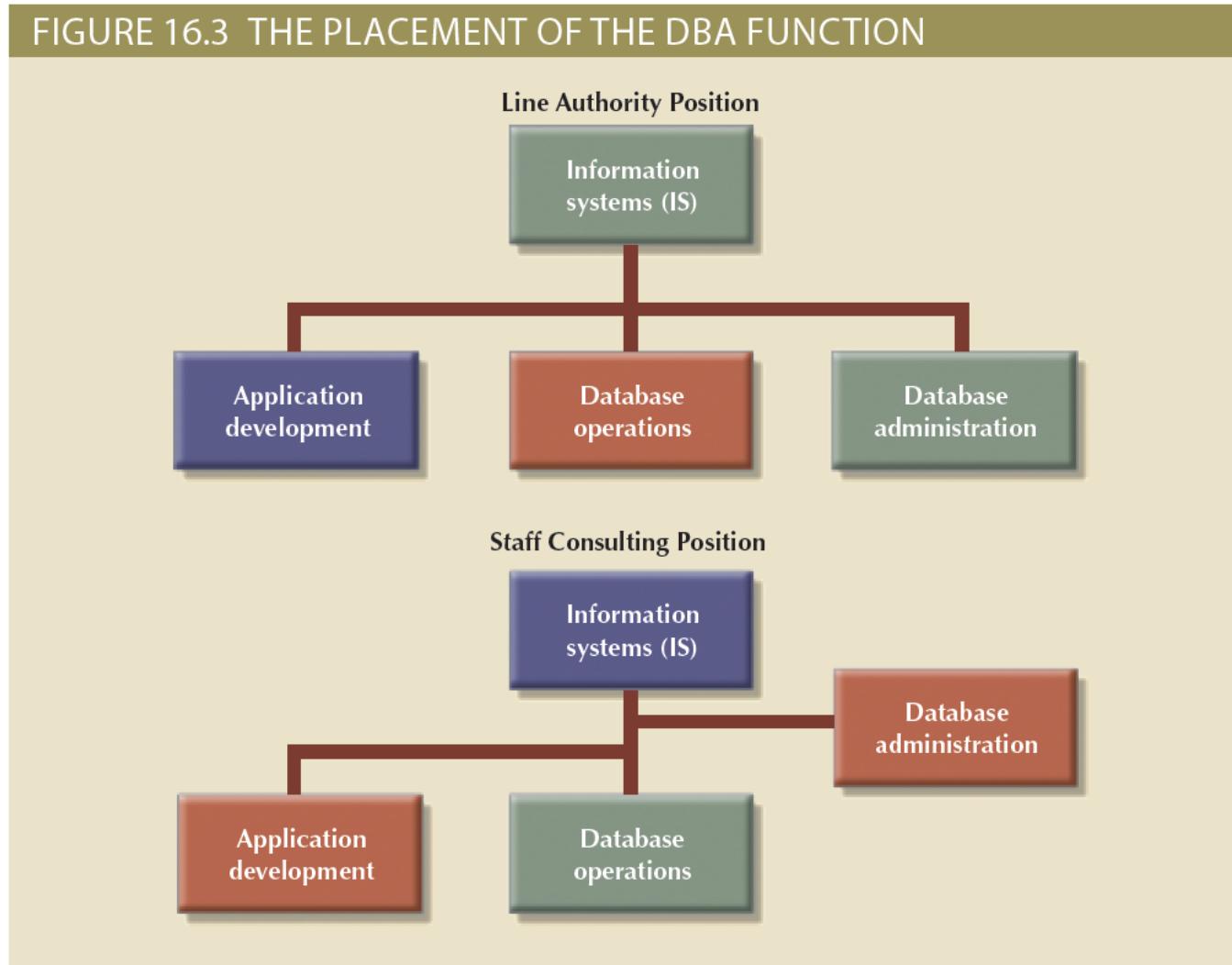


Figure 16.4 - A DBA Functional Organization

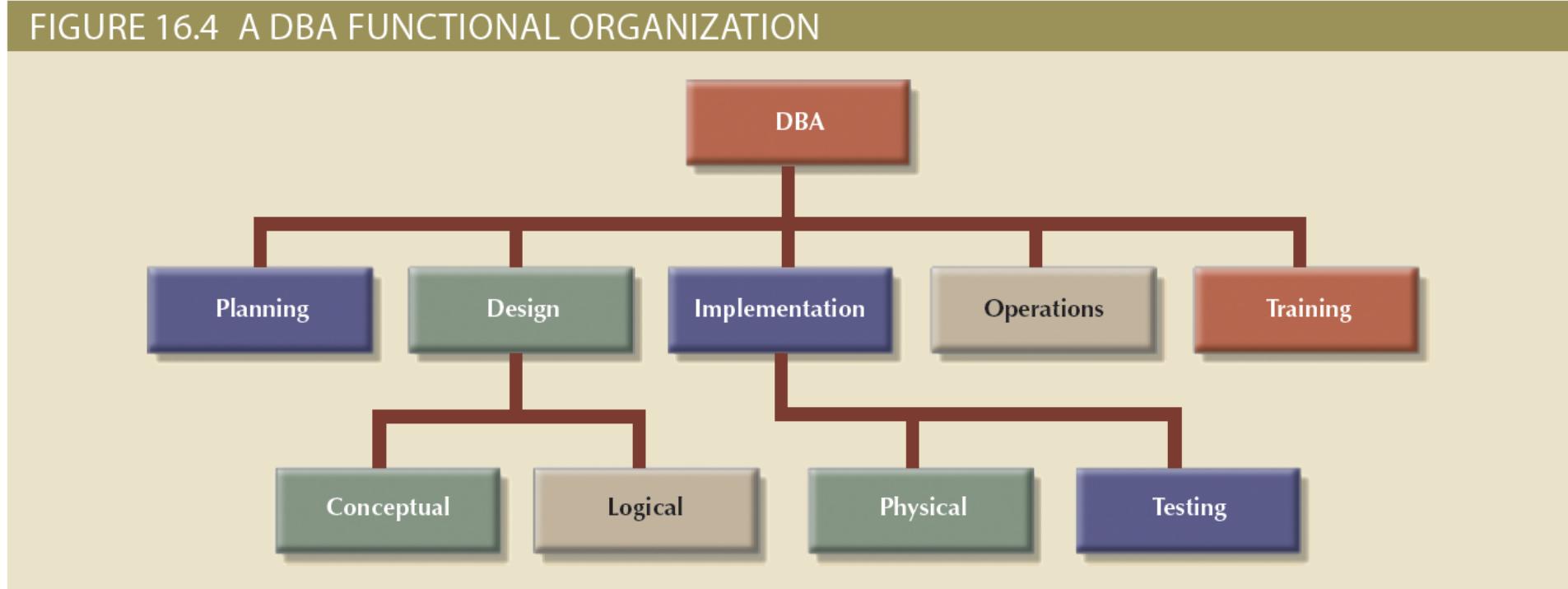


Figure 16.5 – Multiple Database Administrators in an Organization

FIGURE 16.5 MULTIPLE DATABASE ADMINISTRATORS IN AN ORGANIZATION

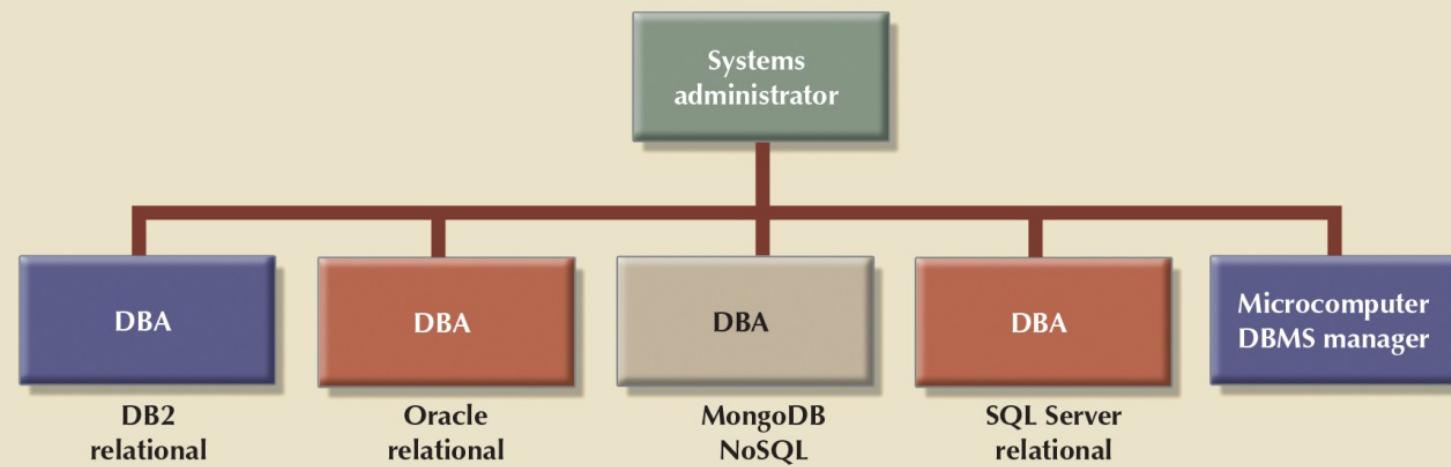


Table 16.1 - Contrasting DA and DBA Activities and Characteristics

TABLE 16.1

CONTRASTING DA AND DBA ACTIVITIES AND CHARACTERISTICS

DATA ADMINISTRATOR (DA)	DATABASE ADMINISTRATOR (DBA)
Performs strategic planning	Controls and supervises
Sets long-term goals	Executes plans to reach goals
Sets policies and standards	Enforces policies and procedures Enforces programming standards
Job is broad in scope	Job is narrow in scope
Focuses on the long term	Focuses on the short term (daily operations)
Has a managerial orientation	Has a technical orientation
Is DBMS-independent	Is DBMS-specific

Figure 16.6 – Summary of DBA Activities

FIGURE 16.6 A SUMMARY OF DBA ACTIVITIES

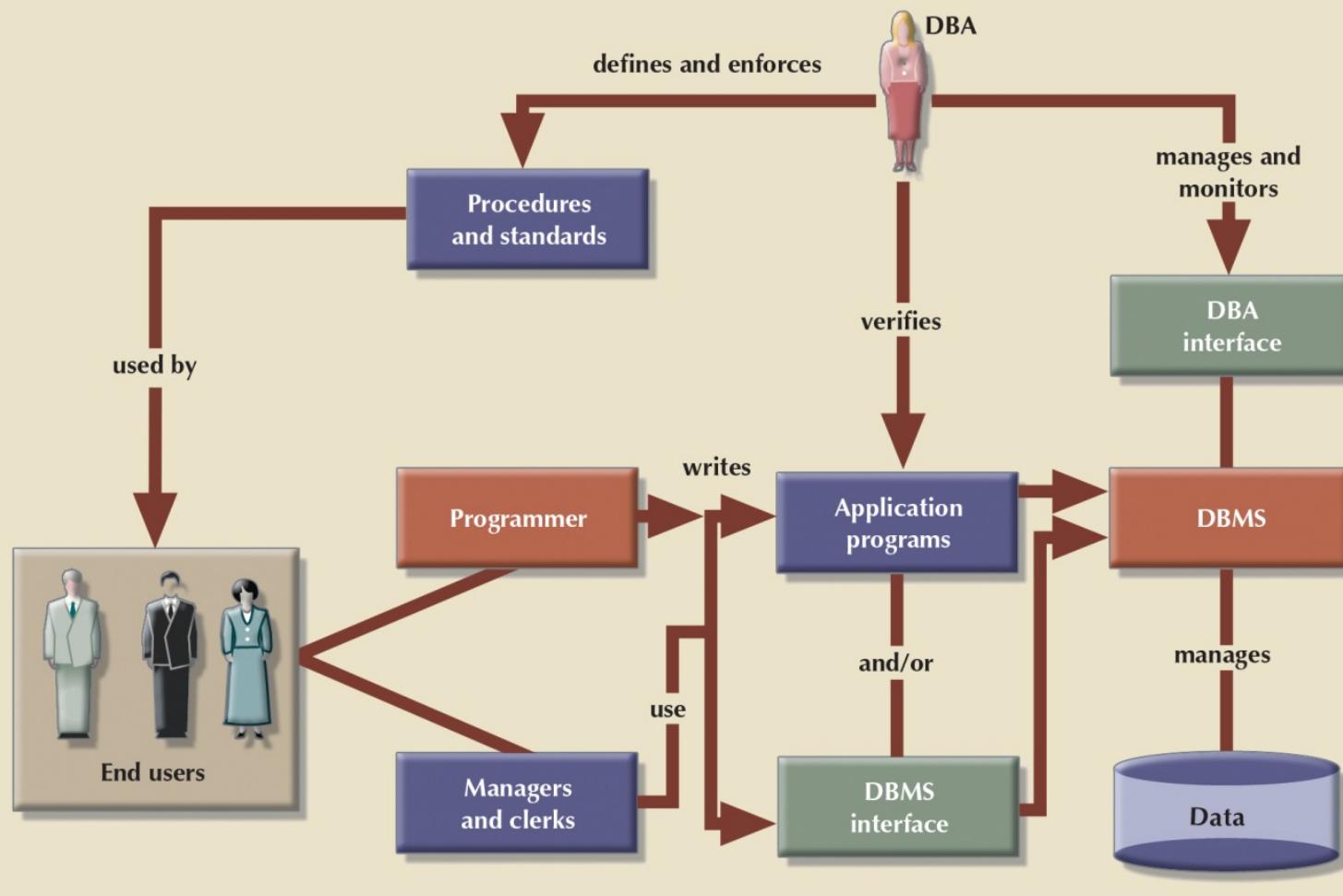


Table 16.2 - Desired DBA Skills

TABLE 16.2	
DESIRED DBA SKILLS	
MANAGERIAL	TECHNICAL
Broad business understanding	Broad data-processing background and up-to-date knowledge of database technologies
Coordination skills	Understanding of Systems Development Life Cycle
Analytical skills	Structured methodologies <ul style="list-style-type: none">• Data flow diagrams• Structure charts• Programming languages
Conflict resolution skills	Knowledge of Database Life Cycle
Communication skills (oral and written)	Database modeling and design skills <ul style="list-style-type: none">• Conceptual• Logical• Physical
Negotiation skills	Operational skills: Database implementation, data dictionary management, security, and so on
Experience: 10 years in a large DP department	

DBA's Managerial Role

- Provide end-user support
- Enforce policies, procedures, and standards for correct data creation, usage, and distribution within the database
- Manage data security, privacy, and integrity
- Manage data backup and recovery
 - Fully recover data in case of data loss
 - **Database security officer (DSO):** Ensures database security and integrity

DBA's Managerial Role

- **Disaster management:** Planning, organizing, and testing of database contingency plans and recovery procedures
- Backup and recovery measures must include at least periodic data and application backups:
 - **Full backup or database dump:** Produces a complete copy of the entire database
 - **Incremental backup:** Produces a backup of all data since the last backup date
 - **Concurrent backup:** Takes place while the user is working on the database

DBA's Managerial Role

- Backup and recovery measures must include at least:
 - Proper backup identification
 - Convenient and safe backup storage
 - Physical protection of both hardware and software
 - Personal access control to the software of a database installation
 - Insurance coverage for the data in the database

DBA's Managerial Role

- Additional points:
 - Data recovery and contingency plans must be tested, evaluated and practiced frequently
 - Backup and recovery plan not likely to cover all information system components
 - Ensure data is distributed to the right people at the right time and in the right format

DBA's Technical Role

- Evaluate, select, and install DBMS and related utilities
- Design and implement databases and applications
- Test and evaluate databases and applications
- Operate the DBMS, utilities, and applications
- Train and support users
- Maintain the DBMS, utilities, and applications

Security Goals

- **Confidentiality:** Protecting data against unauthorized access
- **Compliance:** Activities that meet data privacy and security reporting guidelines
- **Integrity:** Keeping data consistent and free of errors or anomalies
- **Availability:** Accessibility of data whenever required by authorized users and for authorized purposes

Security Policies

- Collection of standards, policies, and procedures created to guarantee security
 - Ensures auditing and compliance
- Security audit process
 - Identifies security vulnerabilities
 - Identifies measures to protect the system

Security Vulnerabilities

- Weakness in a system component that could allow unauthorized access or cause service disruptions
- Categories: Technical, managerial, cultural, and procedural
- **Security threat:** Imminent security violation
- **Security breach:** Occurs when a security threat is exploited and could lead to a database whose integrity is preserved or corrupted

Table 16.4 - Sample Security Vulnerabilities and Related Protective Measures

TABLE 16.4

SAMPLE SECURITY VULNERABILITIES AND RELATED PROTECTIVE MEASURES		
SYSTEM COMPONENT	SECURITY VULNERABILITY	SECURITY MEASURES
People	<ul style="list-style-type: none">The user sets a blank password.The password is short or includes a birth date.The user leaves the office door open all the time.The user leaves payroll information on the screen for long periods of time.	<ul style="list-style-type: none">Enforce complex password policies.Use multilevel authentication.Use security screens and screen savers.Educate users about sensitive data.Install security cameras.Use automatic door locks.
Workstation and servers	<ul style="list-style-type: none">The user copies data to a flash drive.The workstation is used by multiple users.A power failure crashes the computer.Unauthorized personnel can use the computer.Sensitive data is stored on a laptop computer.Data is lost due to a stolen hard disk or laptop.A natural disaster occurs.	<ul style="list-style-type: none">Use group policies to restrict the use of flash drives.Assign user access rights to workstations.Install uninterrupted power supplies (UPSs).Add security locks to computers.Implement a kill switch for stolen laptops.Create and test data backup and recovery plans.Protect the system against natural disasters—use co-location strategies.
Operating system	<ul style="list-style-type: none">Buffer overflow attacksVirus attacksRoot kits and worm attacksDenial-of-service attacksTrojan horsesSpyware applicationsPassword crackers	<ul style="list-style-type: none">Apply OS security patches and updates.Apply application server patches.Install antivirus and antispyware software.Enforce audit trails on the computers.Perform periodic system backups.Install only authorized applications.Use group policies to prevent unauthorized installations.

Table 16.4 - Sample Security Vulnerabilities and Related Protective Measures

TABLE 16.4

SAMPLE SECURITY VULNERABILITIES AND RELATED PROTECTIVE MEASURES		
SYSTEM COMPONENT	SECURITY VULNERABILITY	SECURITY MEASURES
Applications	<ul style="list-style-type: none">Application bugs—buffer overflowSQL injection, session hijacking, etc.Application vulnerabilities—cross-site scripting, nonvalidated inputsEmail attacks—spamming, phishing, etc.Social engineering emails	<ul style="list-style-type: none">Test application programs extensively.Build safeguards into code.Do extensive vulnerability testing in applications.Install spam filters and antivirus software for email systems.Use secure coding techniques (see www.owasp.org).Educate users about social engineering attacks.
Network	<ul style="list-style-type: none">IP spoofingPacket sniffersHacker attacksClear passwords on network	<ul style="list-style-type: none">Install firewalls.Use virtual private networks (VPNs).Use intrusion detection systems (IDSs).Use network access control (NAC).Use network activity monitoring.
Data	<ul style="list-style-type: none">Data shares are open to all users.Data can be accessed remotely.Data can be deleted from a shared resource.	<ul style="list-style-type: none">Implement file system security.Implement share access security.Use access permission.Encrypt data at the file system or database level.

Database Security

- DBMS features and related measures that comply with the security requirements
- **Authorization management:** Procedures to protect database security and integrity
 - User access management
 - View definition
 - DBMS access control
 - DBMS usage monitoring
 - **Audit log:** Automatically records description of database operations performed by all users

Database Administration Tools

- Database monitoring
- Database load testing
- Database performance tuning
- SQL code optimization
- Database bottleneck identification and remediation
- Database modeling and design
- Database data extraction, transformation, and loading

Data Dictionary

- Two main types:
 - Integrated - Included with the DBMS
 - Standalone - Third-party systems
- **Active data dictionary:** Automatically updated by the DBMS with every database access
- **Passive data dictionary:** Requires running a batch process
- Main function - Store description of all objects that interact with the database

Data Dictionary

- Key element of information resource management
 - Can be described as the **information resource dictionary**
- Metadata is the basis for monitoring database use and for assigning access rights to users
- DBA uses data dictionary to support data analysis and design

Computer-Aided Systems Engineering (CASE) Tools

- Automated framework for the Systems Development Life Cycle (SDLC)
- Use structured methodologies and powerful graphical interfaces
- Classified according to extent of support provided:
 - **Front-end CASE tools:** Provide support for the planning, analysis, and design phases
 - **Back-end CASE tools:** Provide support for the coding and implementation phases

Components of a CASE Tool

Graphics

Screen painters and report generators

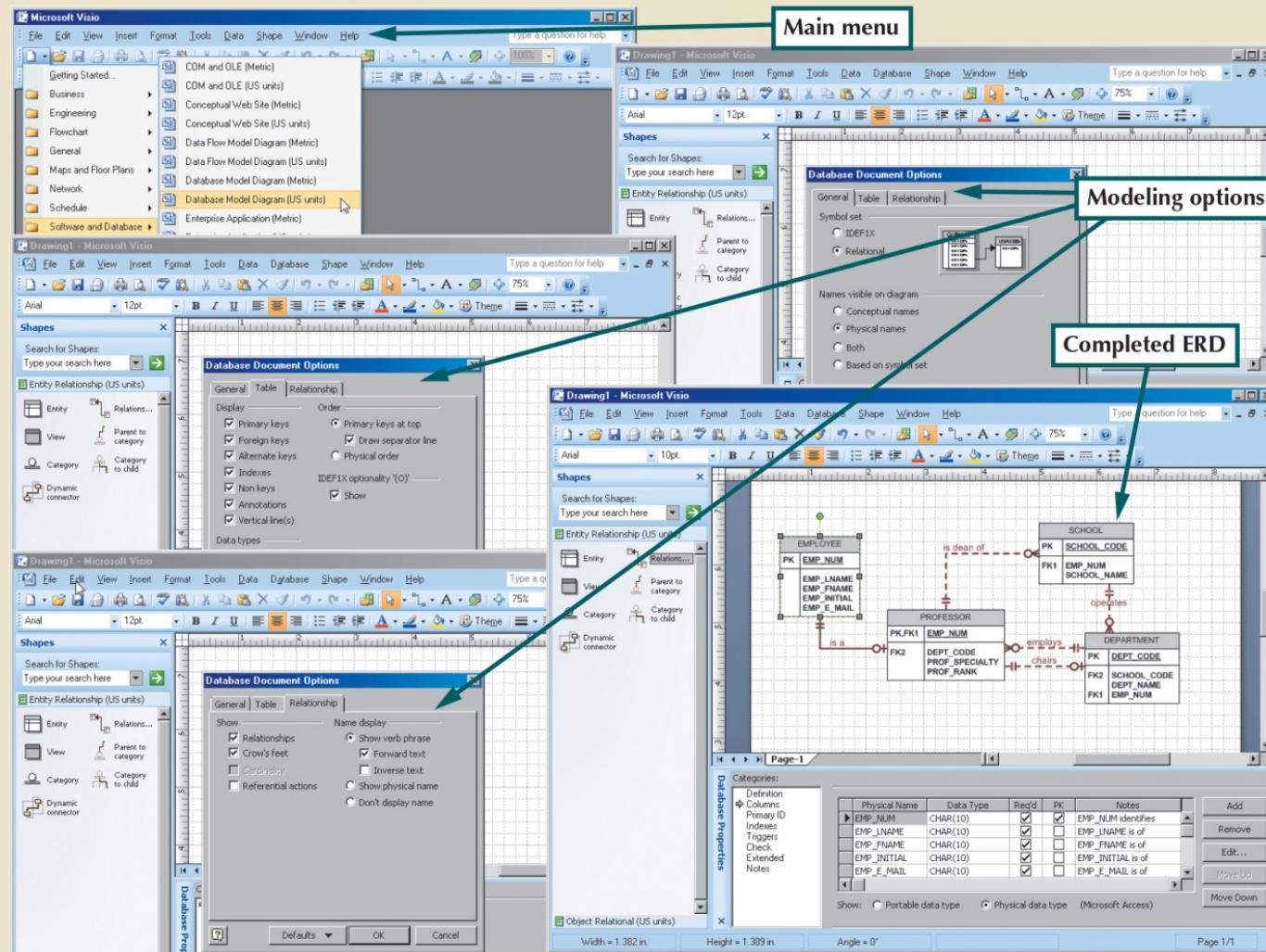
Integrated repository

Analysis segment

Program documentation generator

Figure 16.7 – An Example of a Case Tool: MS Visio Professional

FIGURE 16.7 AN EXAMPLE OF A CASE TOOL: MICROSOFT VISIO PROFESSIONAL



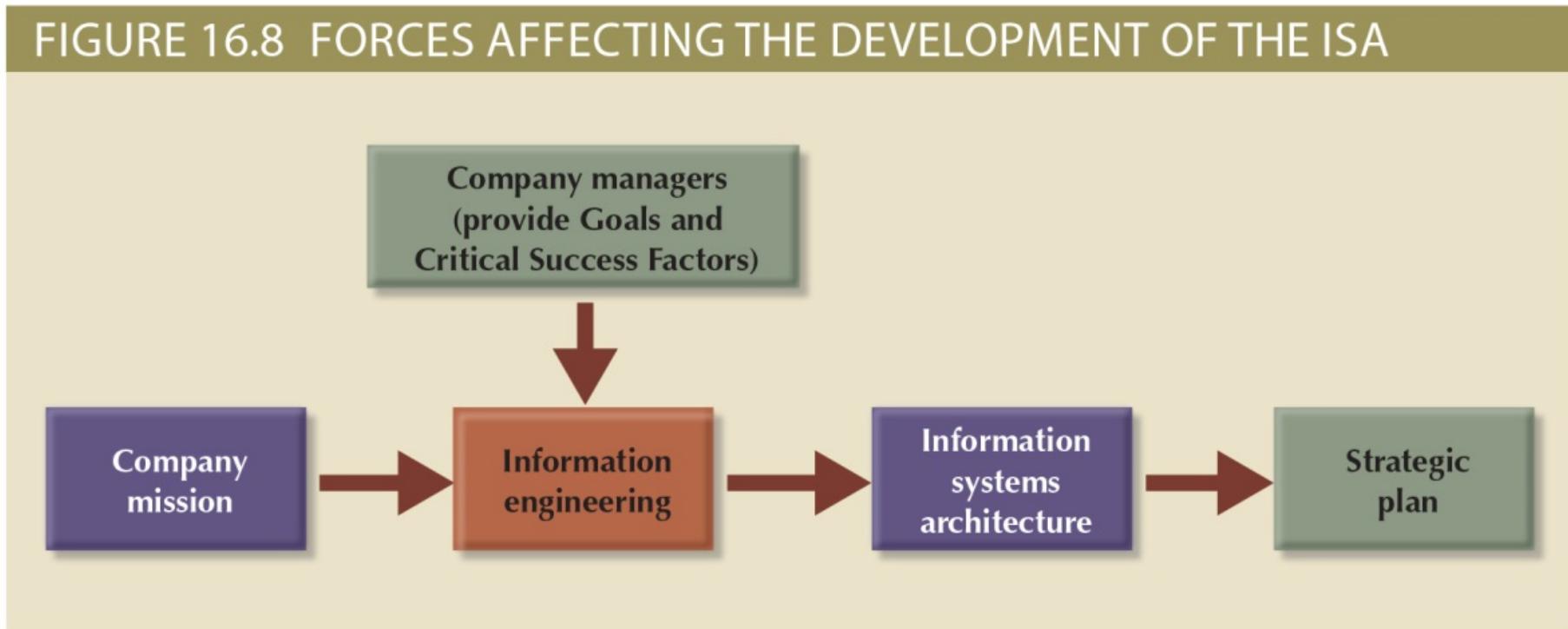
icense distributed with a

Developing a Data Administration Strategy

- **Information engineering (IE)**: Translates strategic goals into data and applications
- **Information systems architecture (ISA)**: Helps plan, develop, and control future information systems
- Critical success factors:
 - Management commitment and defined standards
 - Thorough analysis of the company situation
 - End-user involvement
 - Training and a small pilot project

Figure 16.8 – Forces Affecting the Development of the ISA

FIGURE 16.8 FORCES AFFECTING THE DEVELOPMENT OF THE ISA



DBA's Role in the Cloud

- Significant impact on role of DBAs
- Tasks split between internal DBA and cloud service provider
- Cloud service partner company provides:
 - DBMS installation and updates
 - Server/network management
 - Backup and recovery operations

Oracle Database Administration Tools

- Ensure the RDBMS starts automatically
- Create tablespaces and datafiles
 - **Tablespace:** Logical storage space
 - **Datafile:** Physically stores the database's data
- Manage users and establish security
 - **User:** Allows a given person to log on to the database
 - **Role:** Authorizes a user to connect to the database and use its system resources
 - **Profile:** Controls how much of the database resource a given user can access

Figure 16.9 – Oracle Enterprise Manager Express Interface

FIGURE 16.9 THE ORACLE ENTERPRISE MANAGER EXPRESS INTERFACE

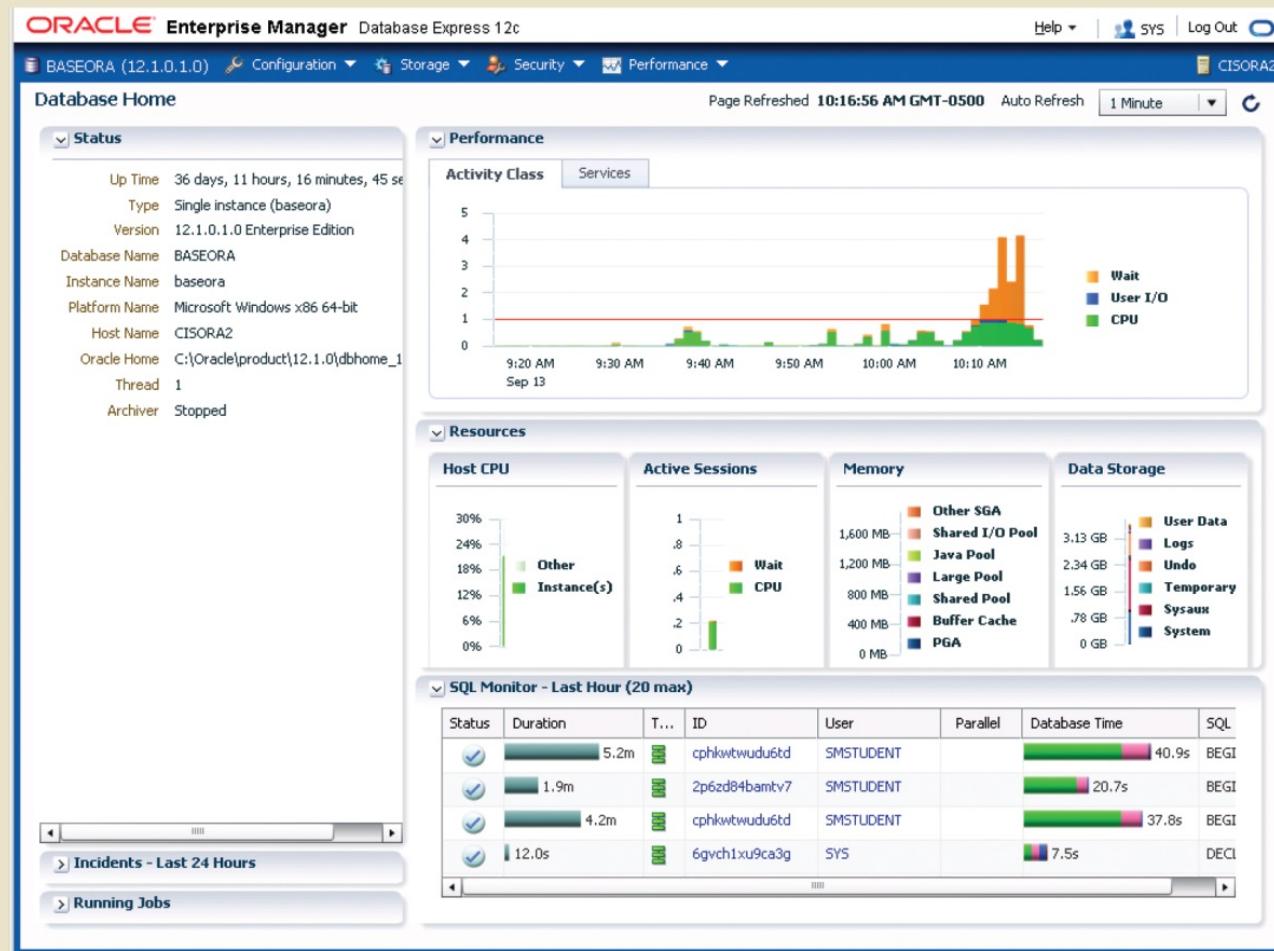
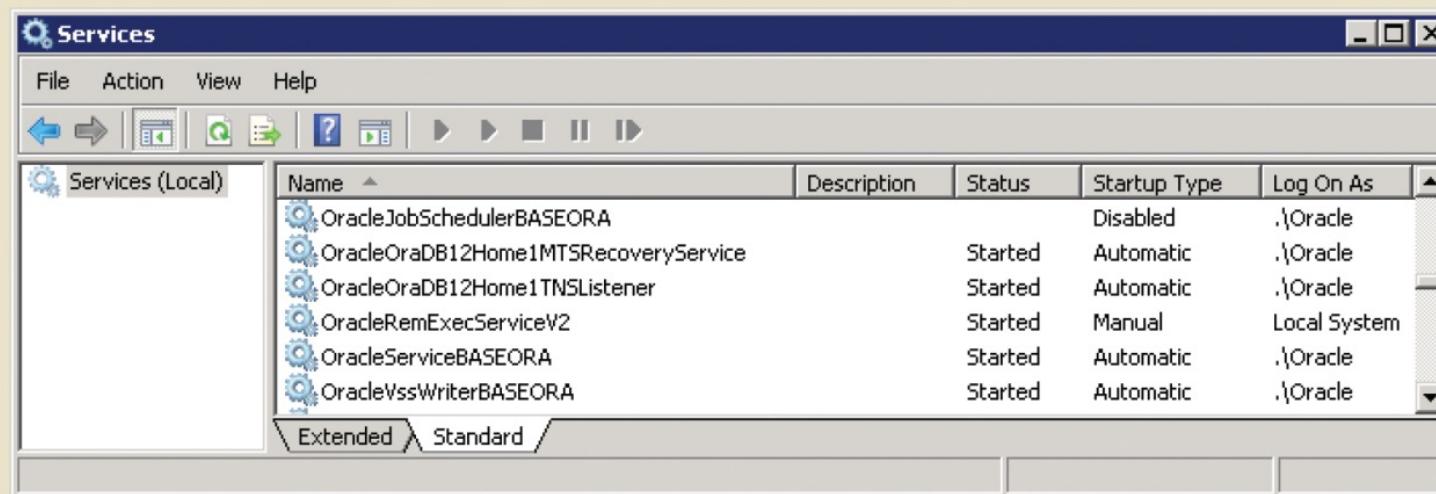


Figure 16.10 – Oracle RDBMS Services

FIGURE 16.10 ORACLE RDBMS SERVICES



Types of Tablespace

SYSTEM

- Stores the data dictionary data

USERS

- Stores the table data created by the end users

TEMP

- Stores the temporary tables and indexes created during the execution of SQL statements

UNDOTBS1

- Stores database transaction recovery information

Figure 16.11 – Oracle Storage Management

FIGURE 16.11 ORACLE STORAGE MANAGEMENT

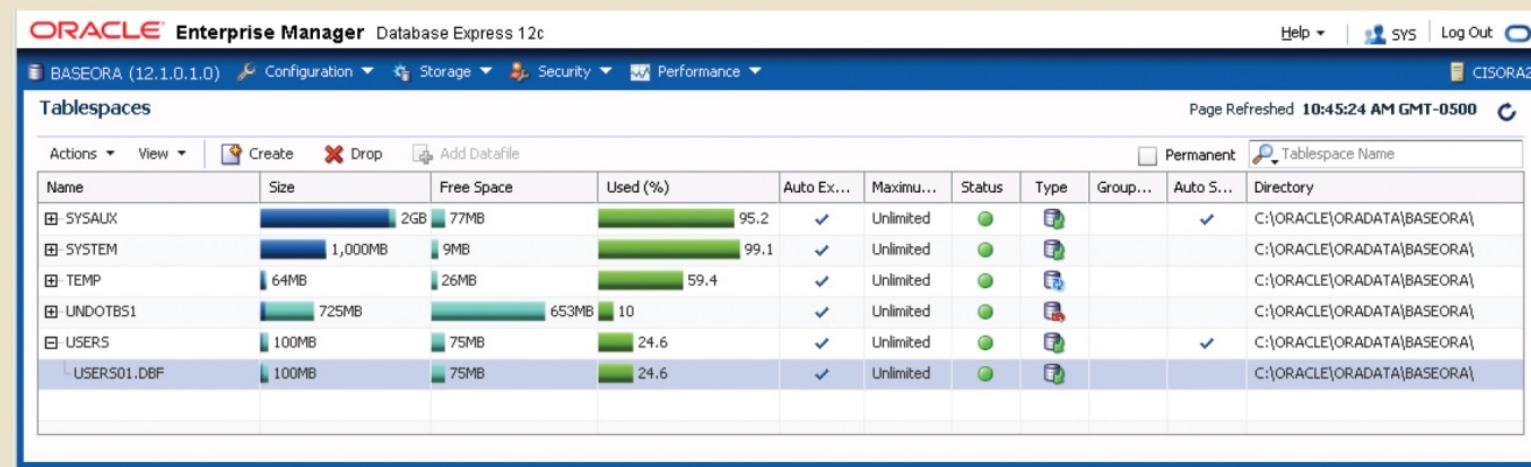


Figure 16.12 – Create New Oracle Tablespace

FIGURE 16.12 CREATING A NEW ORACLE TABLESPACE

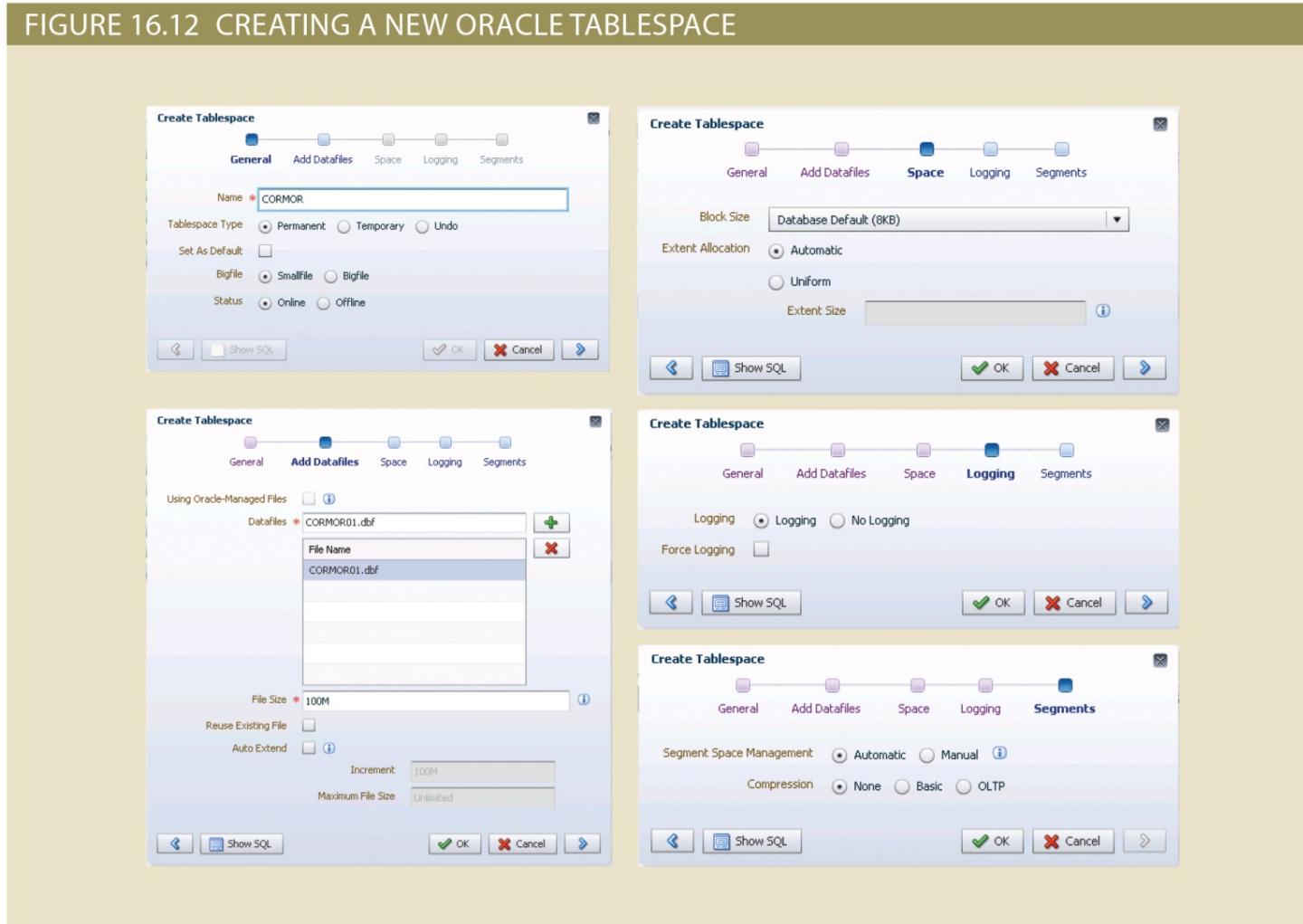


Figure 16.13 – Oracle Enterprise Manager Users Page

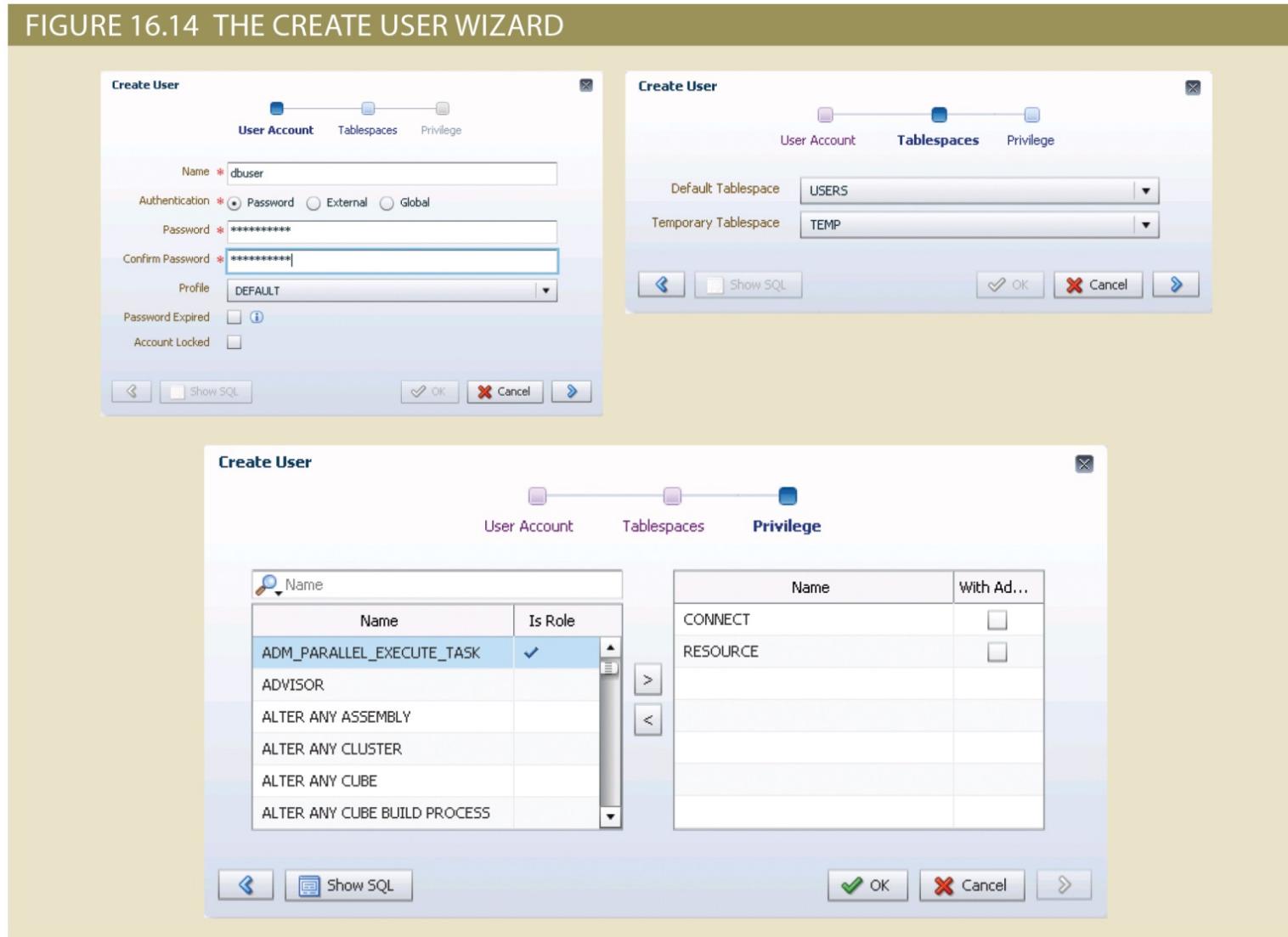
FIGURE 16.13 THE ORACLE ENTERPRISE MANAGER USERS PAGE

The screenshot shows the Oracle Enterprise Manager Database Express 12c interface. The title bar reads "ORACLE Enterprise Manager Database Express 12c". The top navigation menu includes "Configuration", "Storage", "Security", and "Performance". The sub-navigation bar shows "BASEORA (12.1.0.1.0)" and "CISORA2". The main content area is titled "Users" and displays a table of user information. The table columns are: Name, Account Status, Expiration Date, Default Tablespace, Temporary Tablespace, Profile, and Created. The table lists numerous users, many of which are locked (indicated by a padlock icon). The "Actions" column contains icons for "Create User", "Create Like", and "Drop User". A search bar at the top right allows filtering by "Name". The page is refreshed at "11:23:58 AM GMT-0500".

Name	Account Status	Expiration Date	Default Tablespace	Temporary Tablespace	Profile	Created
ANONYMOUS	🔒	Fri Jun 28, 2013 11:24:56 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 9:16:23 AM
APEX_030200	🔒	Wed Aug 7, 2013 11:04:34 PM	SYSAUX	TEMP	DEFAULT	Wed Aug 7, 2013 11:04:34 PM
APEX_040200	🔒	Fri Jun 28, 2013 10:39:53 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 10:36:04 AM
APEX_PUBLIC_USER	🔒	Fri Jun 28, 2013 10:36:04 AM	USERS	TEMP	DEFAULT	Fri Jun 28, 2013 10:36:04 AM
APPQOSSYS	🔒	Fri Jun 28, 2013 9:16:11 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 9:16:11 AM
AUDSYS	🔒	Fri Jun 28, 2013 9:03:35 AM	USERS	TEMP	DEFAULT	Fri Jun 28, 2013 9:03:35 AM
BCUSER	✓		USERS	TEMP	DEFAULT	Fri Sep 13, 2013 10:06:54 AM
BOOK	✓		USERS	TEMP	DEFAULT	Wed Aug 7, 2013 11:04:34 PM
CIS207	✓		USERS	TEMP	DEFAULT	Wed Aug 7, 2013 11:04:34 PM
CTXSYS	🔒	Fri Jun 28, 2013 10:05:18 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 10:03:31 AM
DBSNMP	🔒	Fri Jun 28, 2013 9:16:09 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 9:16:09 AM
DIP	🔒	Fri Jun 28, 2013 9:06:44 AM	USERS	TEMP	DEFAULT	Fri Jun 28, 2013 9:06:44 AM
DVF	🔒	Fri Jun 28, 2013 11:24:56 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 11:22:32 AM
DVSYS	🔒	Fri Jun 28, 2013 11:23:14 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 11:22:32 AM
ECUSER	✓		USERS	TEMP	DEFAULT	Fri Sep 13, 2013 10:06:54 AM
FACT	✓		USERS	TEMP	DEFAULT	Wed Aug 7, 2013 11:04:34 PM
FINUSER	✓		USERS	TEMP	DEFAULT	Fri Sep 13, 2013 10:06:54 AM
FLOWWS_FILES	🔒	Fri Jun 28, 2013 10:39:53 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 10:36:04 AM
GSMADMIN_INTERNAL	🔒	Fri Jun 28, 2013 9:06:36 AM	SYSAUX	TEMP	DEFAULT	Fri Jun 28, 2013 9:06:36 AM
GSMCATUSER	🔒	Fri Jun 28, 2013 9:20:53 AM	USERS	TEMP	DEFAULT	Fri Jun 28, 2013 9:20:53 AM
GSMUSER	🔒	Fri Jun 28, 2013 9:06:36 AM	USERS	TEMP	DEFAULT	Fri Jun 28, 2013 9:06:36 AM
HRUSER	✓		USERS	TEMP	DEFAULT	Fri Sep 13, 2013 10:06:53 AM
LBACSYS	🔒	Fri Jun 28, 2013 11:24:56 AM	SYSTEM	TEMP	DEFAULT	Fri Jun 28, 2013 10:35:06 AM
MANUFACTURE	✓		USERS	TEMP	DEFAULT	Wed Aug 7, 2013 11:04:34 PM

Figure 16.14 – Create User Wizard

FIGURE 16.14 THE CREATE USER WIZARD



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Figure 16.15 – Assigning User Quota

FIGURE 16.15 ASSIGNING A USER QUOTA

The screenshot shows the Oracle Enterprise Manager Database Express 12c interface. The main window displays the 'View User: DBUSER' page. On the left, there's an 'Account Summary' section with details like Name: DBUSER, Profile: DEFAULT, Authentication: PASSWORD, and Default Tablespace: USERS. Below it is a 'Details' section with tabs for Privileges & Roles, Object Privileges, and Quotas. The Quotas tab is selected, showing a table with rows for SYSTEM, SYSAUX, USERS, and CORMOR. An 'Edit' link is next to the SYSTEM row. A modal dialog box titled 'Alter Quota' is open over the Quotas table. It has a 'Tablespace' dropdown set to 'CORMOR' and a 'Quota' input field containing '20M'. At the bottom of the dialog are 'Show SQL', 'OK', and 'Cancel' buttons. The background of the main window shows the Quotas table with the same four rows and their current quota values all set to 0.

Tablespace	Allocated	Quota	Tablespace Dropped
SYSTEM	0	0	
SYSAUX	0	0	
USERS	0	0	
CORMOR	0	0	

Customize Database Initialization Parameters

- Fine-tuning a database is an important task that usually requires modification of parameters
- Initialization parameters reserve resources used by the database at run time
- After modifying parameters database restart may be required

Figure 16.16 – Oracle Enterprise Manager Initialization Parameters

FIGURE 16.16 ORACLE ENTERPRISE MANAGER INITIALIZATION PARAMETERS

The screenshot shows the Oracle Enterprise Manager Database Express 12c interface. The title bar reads "ORACLE Enterprise Manager Database Express 12c". The top navigation bar includes links for Configuration, Storage, Security, and Performance, with "Performance" selected. The user is logged in as "SYS". The main content area is titled "Initialization Parameters" and displays a table of current initialization parameters. The table has columns for Name, Value, Comment, Modified, Dyna..., Session, Basic, Type, Category, and Description. The table is organized into sections: "Ansi Compliance" and "Archiving and Recovery". The "Archiving and Recovery" section contains numerous parameters related to log files and recovery.

Name	Value	Comment	Modified	Dyna...	Session	Basic	Type	Category	Description
blank_trimming	false					Boolean	Ansi Compliance	blank trimming semantics p...	
control_file_record_keep_time	7		✓			Integer	Archiving and Recovery	control file record keep tim...	
db_create_online_log_dest_1			✓	✓	✓	String	Archiving and Recovery	online log/controlfile destin...	
db_create_online_log_dest_2			✓	✓	✓	String	Archiving and Recovery	online log/controlfile destin...	
db_create_online_log_dest_3			✓	✓		String	Archiving and Recovery	online log/controlfile destin...	
db_create_online_log_dest_4			✓	✓		String	Archiving and Recovery	online log/controlfile destin...	
db_create_online_log_dest_5			✓	✓		String	Archiving and Recovery	online log/controlfile destin...	
db_recovery_file_dest	C:\Oracle\fast_recovery_area		✓	✓	✓	String	Archiving and Recovery	default database recovery...	
db_recovery_file_dest_size	6930M		✓	✓	✓	Big In...	Archiving and Recovery	database recovery files siz...	
db_unrecoverable_scn_tracking	true		✓	✓		Boolean	Archiving and Recovery	Track nologging SCN in co...	
fast_start_io_target	0		✓			Integer	Archiving and Recovery	Upper bound on recovery ...	
fast_start_mttr_target	0		✓			Integer	Archiving and Recovery	MTTR target in seconds	
log_archive_config			✓			String	Archiving and Recovery	log archive config parameter	