Database Principles: Fundamentals of Design, Implementation, and Management

Tenth Edition

Chapter 12

Database Administration and Security

Objectives

In this chapter, students 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

Objectives (cont'd.)

- What the database administrator's managerial and technical roles are
- About data security, database security, and the information security framework
- About several database administration tools and strategies
- How various technical tasks of database administration are performed with Oracle

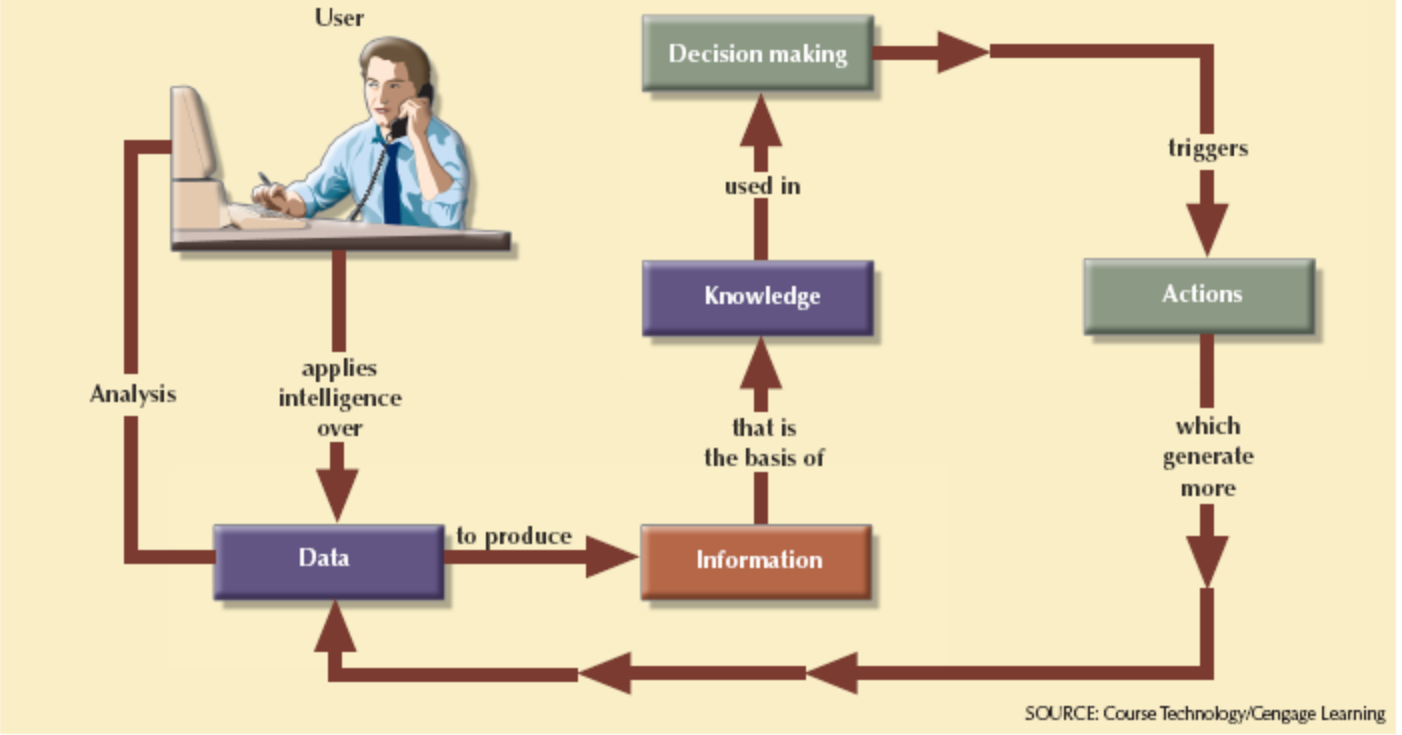
Data as a Corporate Asset

- Data:
  - Valuable asset that requires careful management
  - Valuable resource that translates into information
- Accurate, timely information triggers actions that enhance company's position and generate wealth

Data as a Corporate Asset (cont'd.)

- Dirty data
  - Data that suffer from inaccuracies and inconsistencies
  - Threat to organizations

FIGURE 12.1 The data-information-decision cycle



Data as a Corporate Asset (cont'd.)

- Data quality
  - Comprehensive approach to ensuring the accuracy, validity, and timeliness of the data
- Data profiling software
  - Consists of programs that gather statistics and analyze existing data sources
- Master data management (MDM) software
  - Helps prevent dirty data by coordinating common data across multiple systems.

The Need for and Role of Databases in an Organization

- Database's predominant role is to support managerial decision making at all levels
- DBMS facilitates:
  - Interpretation and presentation of data
  - Distribution of data and information
  - Preservation and monitoring of data
  - Control over data duplication and use
- Three levels to organization management:
  - Top, middle, operational

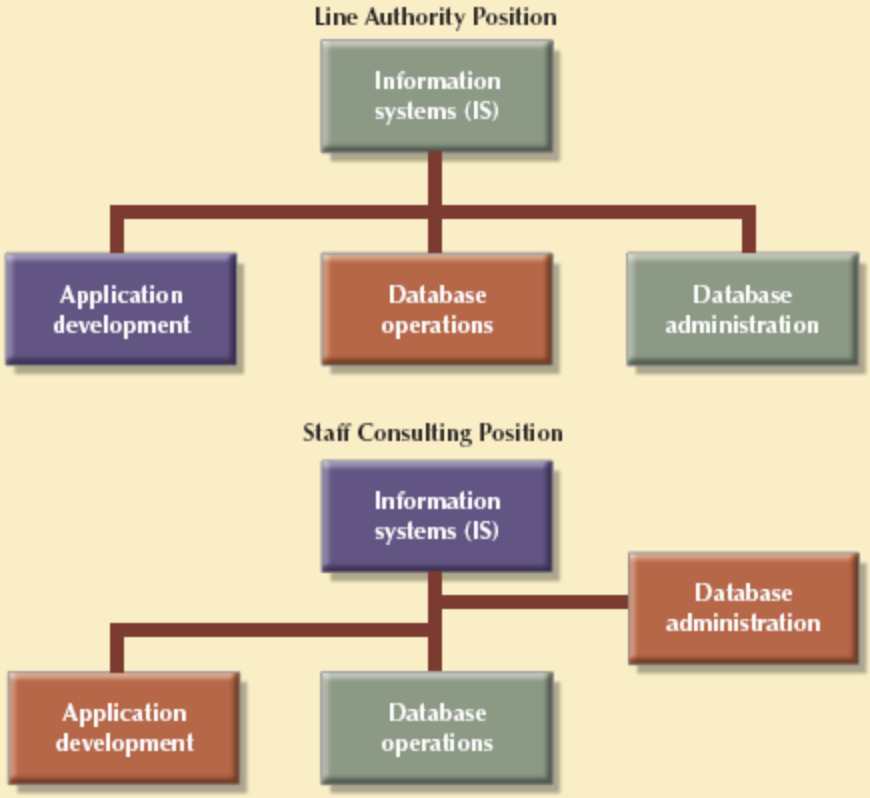
Introduction of a Database: Special Considerations

- Introduction of a DBMS is likely to have a profound impact
  - Might be positive or negative, depending on how it is administered
- Three aspects to DBMS introduction:
  - Technological
  - Managerial
  - Cultural
- One role of DBA department is to educate end users about system uses and benefits

The Evolution of the Database Administration Function

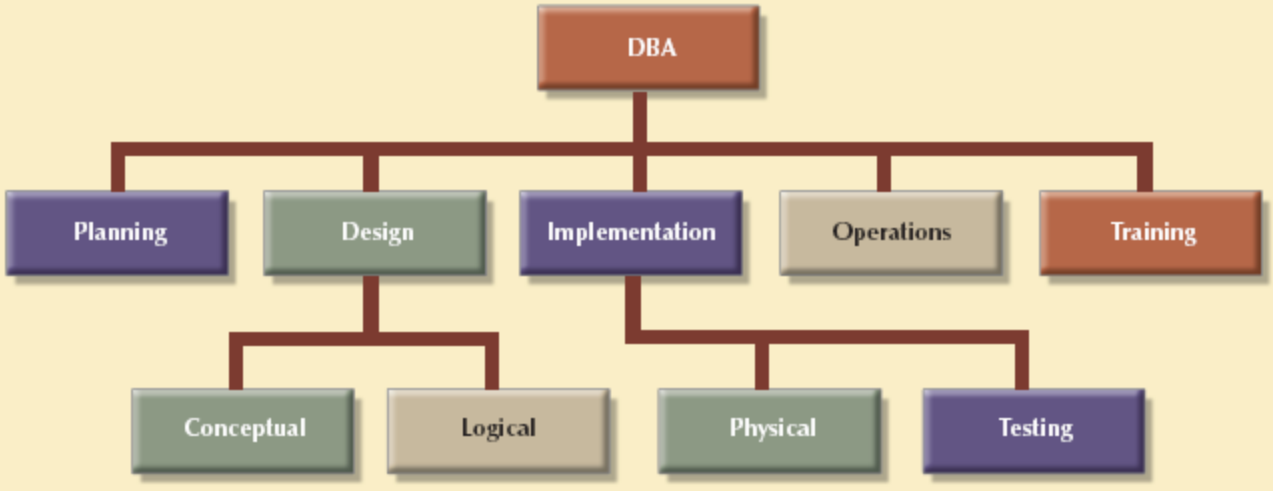
- Data administration has its roots in the old, decentralized world of the file system
- Advent of DBMS produced new level of data management sophistication
  - DP department evolved into information systems (IS) department
- Data management became increasingly complex
  - Development of database administrator (DBA) function

FIGURE 12.3 The placement of the DBA function



SOURCE: Course Technology/Cengage Learning

FIGURE 12.4 A DBA functional organization

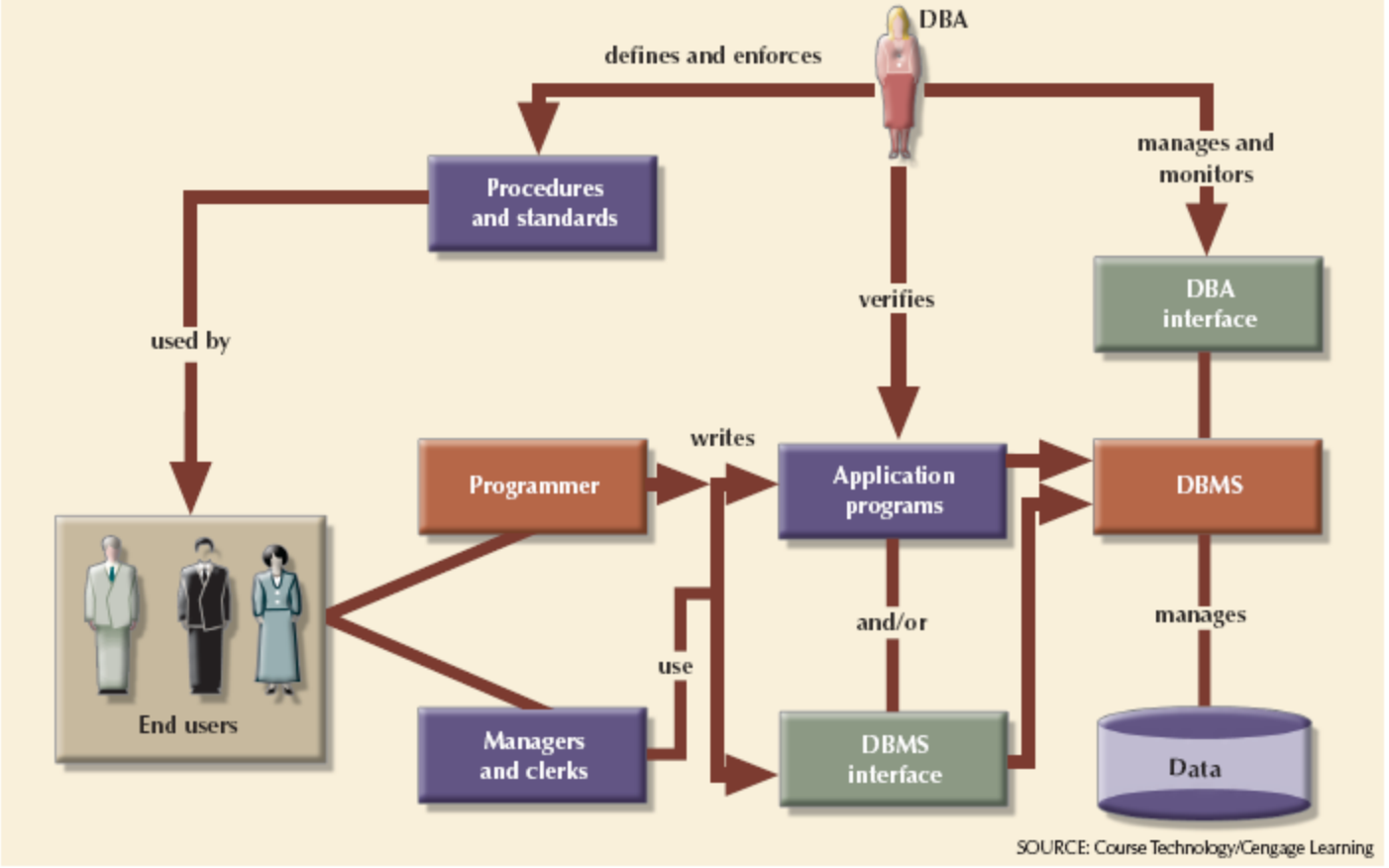


SOURCE: Course Technology/Cengage Learning

The Database Environment's Human Component

- Even most carefully crafted database system cannot operate without human component
- Effective data administration requires both technical and managerial skills
- DA must set data administration goals
- DBA is focal point for data/user interaction
- Need for diverse mix of skills

FIGURE 12.6 A summary of DBA activities



The DBA's Managerial Role

- DBA responsible for:
  - Coordinating, monitoring, allocating resources
    - Resources include people and data
  - Defining goals and formulating strategic plans
- Interacts with end user by providing data and information
- Enforces policies, standards, procedures

The DBA's Managerial Role (cont'd.)

- Manages security, privacy, integrity
- Ensures data can be fully recovered
  - In large organizations, database security officer (DSO) responsible for disaster management
- Ensures data is distributed appropriately
  - Makes it easy for authorized end users to access the database

TABLE 12.3 **DBA Activities and Services**

DBA ACTIVITY		DBA SERVICE
Planning		End-user support
Organizing		Policies, procedures, and standards
Testing	← of →	Data security, privacy, and integrity
Monitoring		Data backup and recovery
Delivering		Data distribution and use

The DBA's Technical Role

- Evaluates, selects, and installs DBMS and related utilities
- Designs and implements databases and applications
- Tests and evaluates databases and applications

The DBA's Technical Role (cont'd.)

- Operates DBMS, utilities, and applications
- Trains and supports users
- Maintains DBMS, utilities, and applications

The DBA's Role in the Cloud

- Cloud services provide:
  - DBMS installation and updates
  - Server/network management
  - Backup and recovery operations
- DBA's managerial role is largely unchanged

Security

- Securing data entails securing overall information system architecture
- Confidentiality: data protected against unauthorized access
- Integrity: keep data consistent and free of errors or anomalies
- Availability: accessibility of data by authorized users for authorized purposes

Security Policies

- Database security officer secures the system and the data
  - Works with the database administrator
- Security policy: collection of standards, policies, procedures to guarantee security
  - Ensures auditing and compliance
- Security audit process identifies security vulnerabilities
  - Identifies measures to protect the system

Security Vulnerabilities

- Security vulnerability: weakness in a system component
  - Could allow unauthorized access or cause service disruptions
- Security threat: imminent security violation
  - Could occur at any time
- Security breach yields a database whose integrity is either:
  - Preserved
  - Corrupted

TABLE 12.4 Sample Security Vulnerabilities and Related Protective Measures

SYSTEM COMPONENT	SECURITY VULNERABILITY	SECURITY MEASURES
People	• 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.	• 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	• 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 are stored on a laptop computer. • Data are lost due to a stolen hard disk or laptop. • A natural disaster occurs.	• 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. • Insure the system against natural disasters—use co-location strategies.
Operating system	• Buffer overflow attacks • Virus attacks • Root kits and worm attacks • Denial-of-service attacks • Trojan horses • Spyware applications • Password crackers	• 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.

Applications	• Application bugs—buffer overflow • SQL injection, session hijacking, etc. • Application vulnerabilities—cross-site scripting, nonvalidated inputs • E-mail attacks—spamming, phishing, etc. • Social engineering e-mails	• Test application programs extensively. • Build safeguards into code. • Do extensive vulnerability testing in applications. • Install spam filters and antivirus software for e-mail systems. • Use secure coding techniques (see *www.owasp.org*). • Educate users about social engineering attacks.
Network	• IP spoofing • Packet sniffers • Hacker attacks • Clear passwords on network	• Install firewalls. • Use virtual private networks (VPNs). • Use intrusion detection systems (IDSs). • Use network access control (NAC). • Use network activity monitoring.
Data	• Data shares are open to all users. • Data can be accessed remotely. • Data can be deleted from a shared resource.	• Implement file system security. • Implement share access security. • Use access permission. • Encrypt data at the file system or database level.

Database Security

- Refers to the use of DBMS features and other measures to comply with security requirements
- DBA secures DBMS from installation through operation and maintenance
- Authorization management
  - User access management
  - View definition
  - DBMS access control
  - DBMS usage monitoring

Database Administration Tools

- Data dictionary
- CASE tools

The Data Dictionary

- Two main types of data dictionaries:
  - Integrated
  - Standalone
- Active data dictionary is 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 database

The Data Dictionary (cont'd.)

- Data dictionary that includes data external to DBMS becomes flexible tool
  - Enables use and allocation of all of an organization's information
- Metadata is often the basis for monitoring database use
  - Also for assigning access rights to users
- DBA uses data dictionary to support data analysis and design

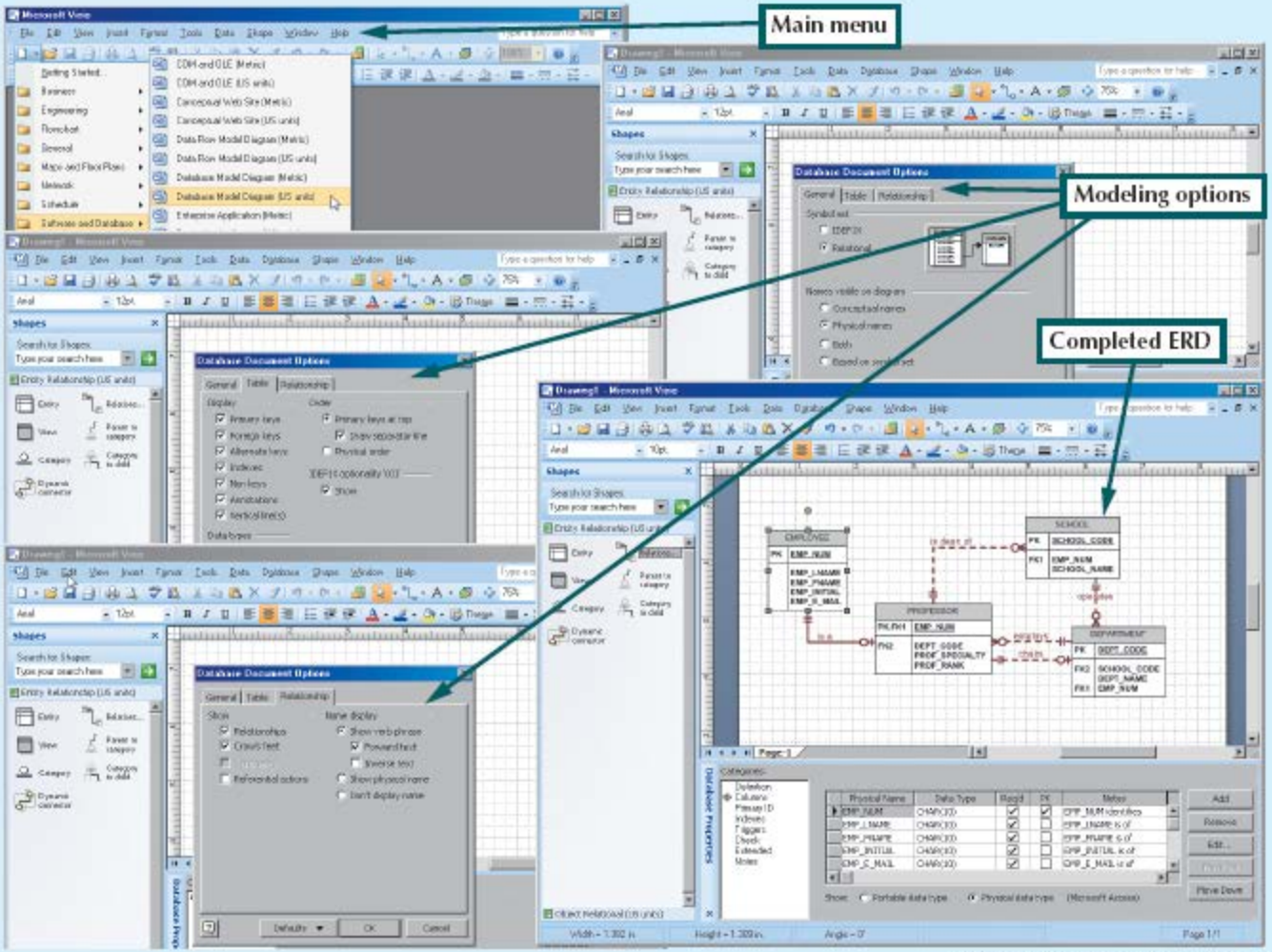
CASE Tools

- Computer-aided systems engineering
  - Automated framework for SDLC
  - Structured methodologies and powerful graphical interfaces
- Front-end CASE tools provide support for planning, analysis, and design phases
- Back-end CASE tools provide support for coding and implementation phases

CASE Tools (cont'd.)

- Typical CASE tool has five components
  - Graphics for diagrams
  - Screen painters and report generators
  - Integrated repository
  - Analysis segment
  - Program documentation generator

FIGURE 12.7 An example of a CASE tool: Visio Professional



SOURCE: Course Technology/Cengage Learning

Developing a Data Administration Strategy

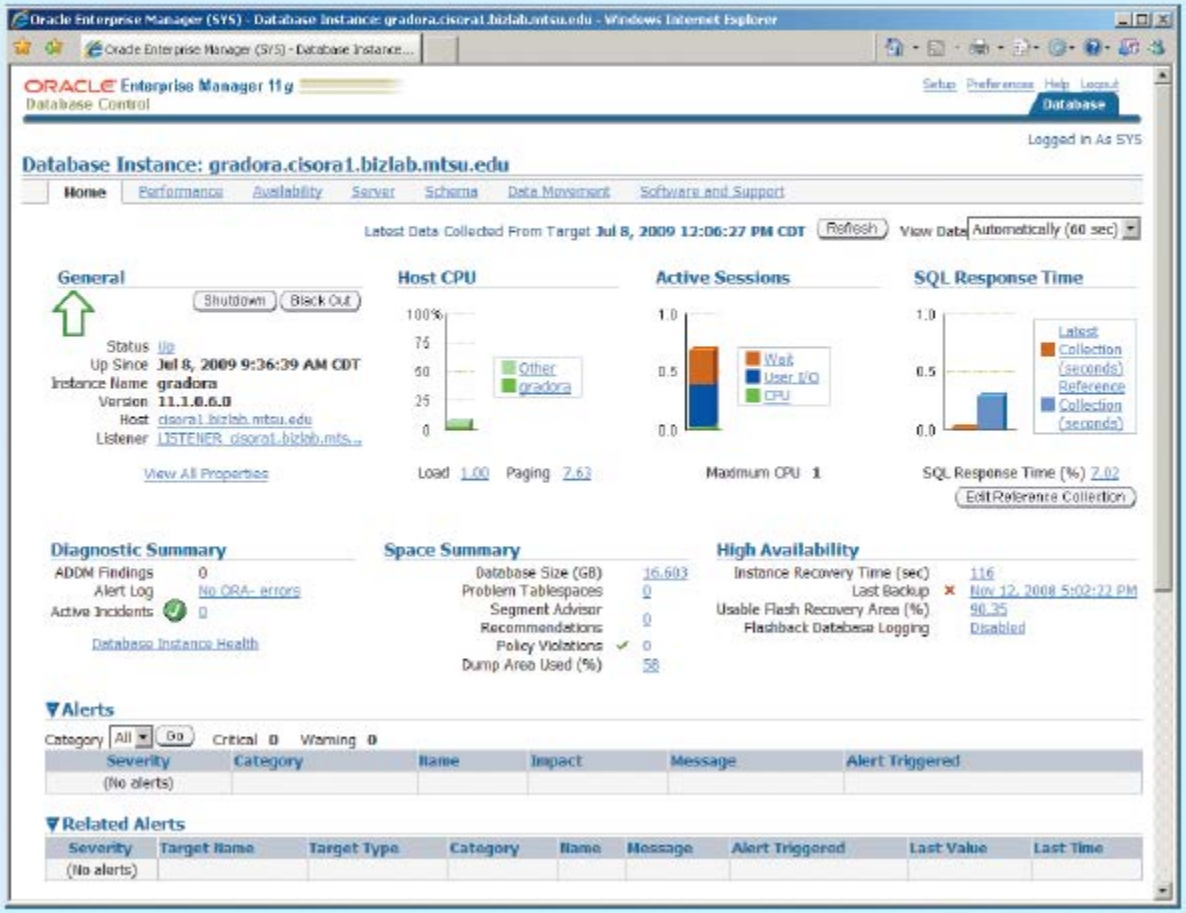
- Information engineering (IE) translates strategic goals into data and applications
- Information systems architecture (ISA) is the output of IE process
- Implementing IE is a costly process
  - Provides a framework that includes use of computerized, automated, and integrated tools
- Success of information systems strategy depends on critical success factors
  - Managerial, technological, and corporate culture

The DBA at Work: Using Oracle for Database Administration

- Technical tasks handled by the DBA in a specific DBMS:
  - Creating and expanding database storage structures
  - Managing database objects
  - Managing end-user database environment
  - Customizing database initialization parameters
- All DBMS vendors provide programs to perform database administrative tasks

Oracle Database Administration Tools

FIGURE 12.9 The Oracle Enterprise Manager interface



SOURCE: Course Technology/Cengage Learning

The Default Login

- Must connect to the database to perform administrative tasks
  - Username with administrative privileges
- Oracle automatically creates SYSTEM and SYS user IDs with administrative privileges
- Define preferred credentials by clicking on Preferences link, then Preferred Credentials
- Username and passwords are database-specific

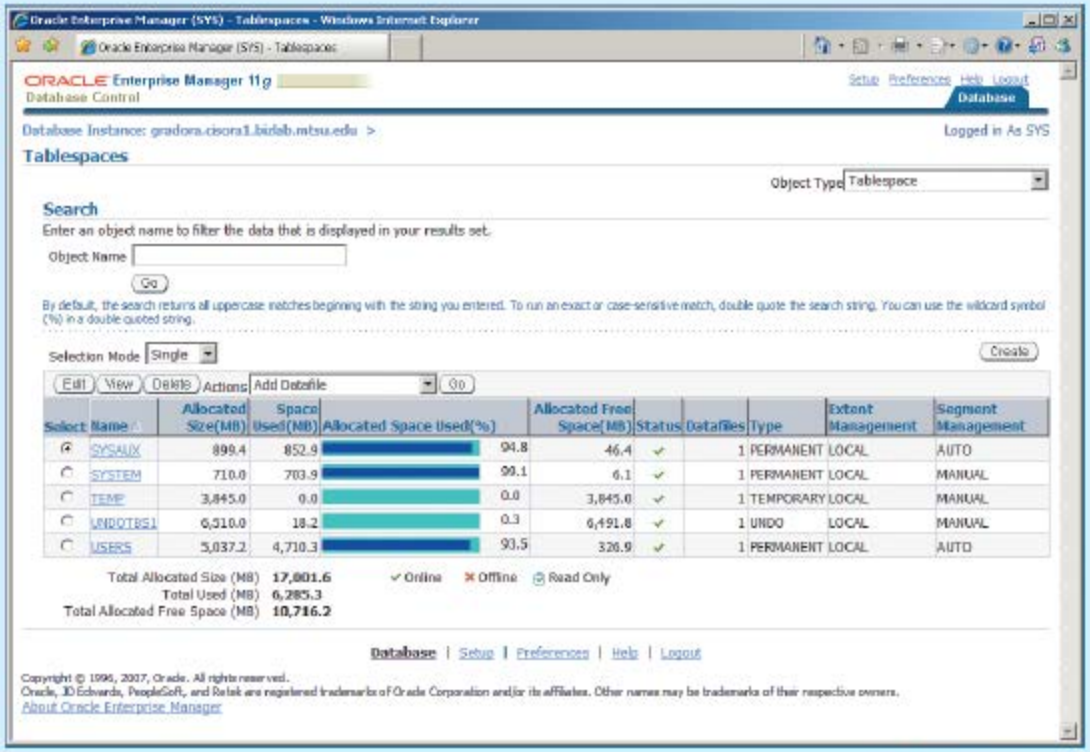
Ensuring that the RDBMS Starts Automatically

- DBA ensures database access is automatically started when computer turned on
- A service is a Windows system name for a special program that runs automatically
  - Part of the operating system
- Database instance: separate location in memory reserved to run the database
  - May have several databases running in memory at the same time

Creating Tablespaces and Datafiles

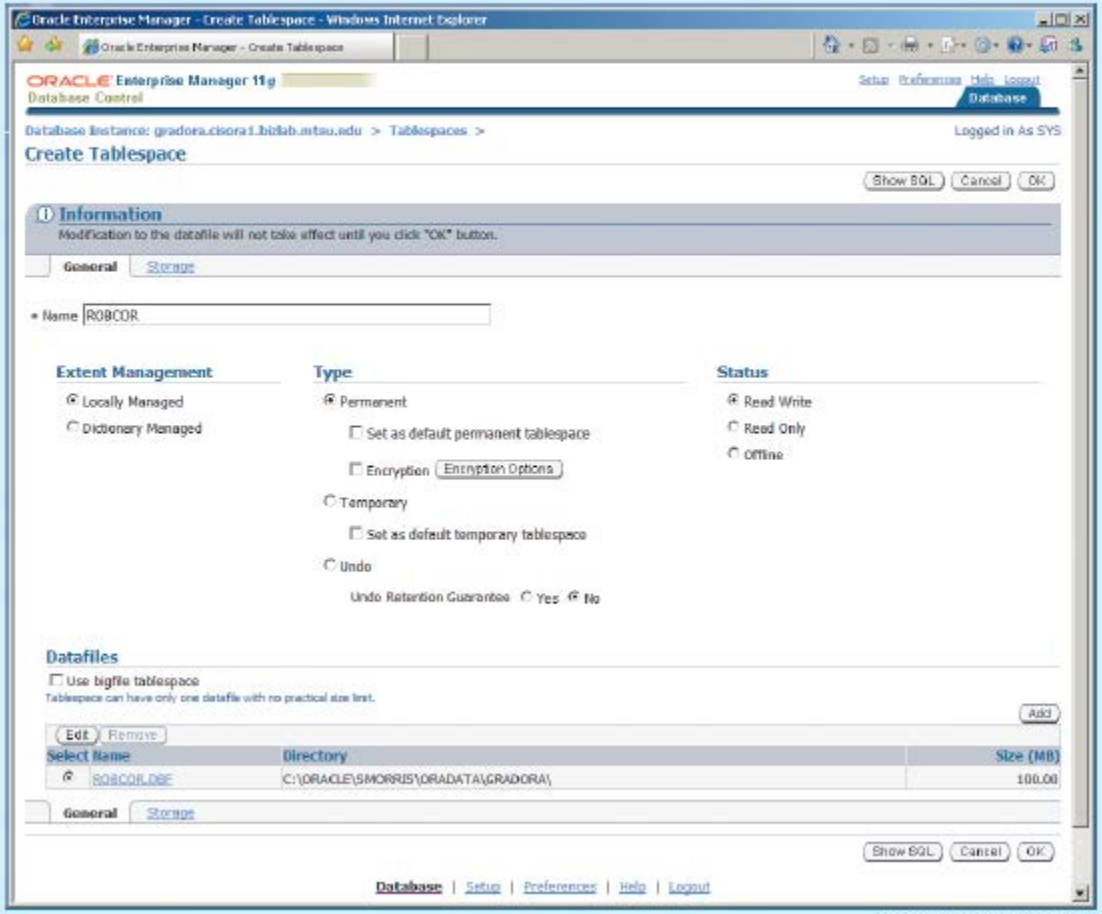
- Database composed of one or more tablespaces
- Tablespace is a logical storage space
  - Physically stored in one or more datafiles
- Datafile physically stores the database's data
  - Each datafile can reside in a different directory on the hard disk
- Database has 1:M relationship with tablespaces
- Tablespace has 1:M relationship with datafiles

FIGURE 12.12 The Oracle Storage Manager



SOURCE: Course Technology/Cengage Learning

FIGURE 12.13 Creating a new tablespace



SOURCE: Course Technology/Cengage Learning

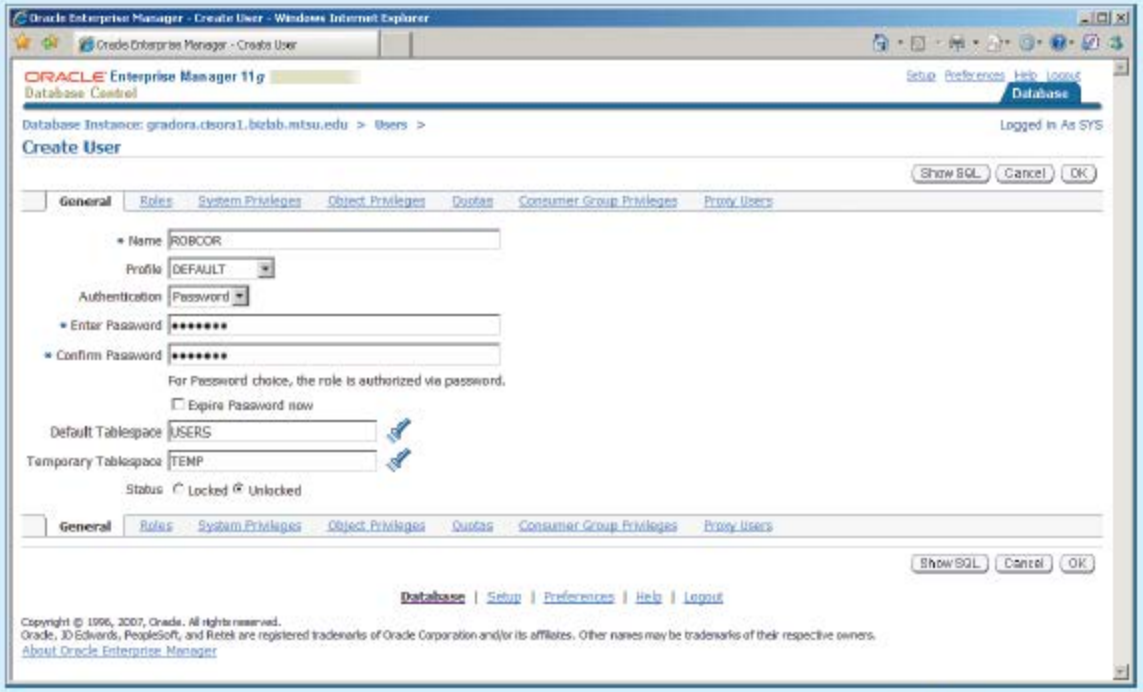
Managing the Database Objects: Tables, Views, Triggers, and Procedures

- Database object: any object created by end users
- Schema: logical section of the database that belongs to a given user
  - Schema identified by a username
  - Within the schema, users create their own tables and other objects
- Normally, users are authorized to access only the objects that belong to their own schemas

Managing Users and Establishing Security

- User: uniquely identifiable object
  - Allows a given person to log on to the database
- Role: a named collection of database access privileges
  - Authorizes a user to connect to the database and use system resources
- Profile: named collection of settings
  - Controls how much of a resource a given user can use

FIGURE 12.16 The Create User page



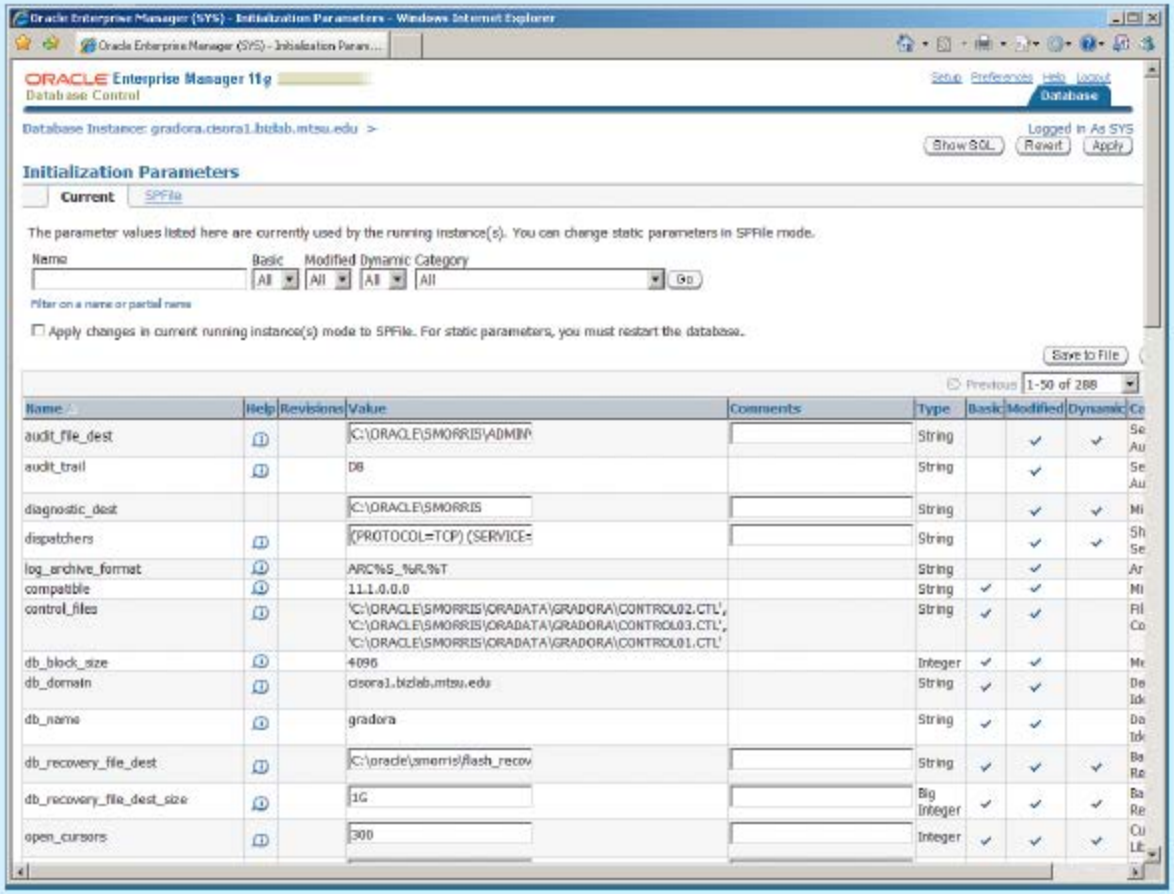
SOURCE: Course Technology/Cengage Learning

Customizing the Database Initialization Parameters

- Fine-tuning requires modification of database configuration parameters
  - Some are changed in real time using SQL
  - Some affect database instance
  - Others affect entire RDBMS and all instances
- Initialization parameters reserve resources used by the database at run time
- After modifying parameters, may need to restart the database

FIGURE 12.17

The Oracle Enterprise Manager initialization parameters



SOURCE: Course Technology/Cengage Learning

Summary

- Data management is a critical activity for any organization
  - Data should be treated as a corporate asset
- DBMS is the most commonly used electronic tool for corporate data management
- DBMS has impact on organization's managerial, technological, and cultural framework
- Data administration function evolved from centralized electronic data processing

Summary (cont'd.)

- Database administrator (DBA) is responsible for managing corporate database
- Broader data management activity is handled by data administrator (DA)
- DA is more managerially oriented than more technically oriented DBA
  - DA function is DBMS-independent
  - DBA function is more DBMS-dependent
- When there is no DA, DBA executes all DA functions

Summary (cont'd.)

- Managerial services of DBA function:
  - Supporting end-user community
  - Defining and enforcing policies, procedures, and standards for database function
  - Ensuring data security, privacy, and integrity
  - Providing data backup and recovery services
  - Monitoring distribution and use of data in database

Summary (cont'd.)

- Technical role of DBA:
  - Evaluating, selecting, and installing DBMS
  - Designing and implementing databases and applications
  - Testing and evaluating databases and applications
  - Operating DBMS, utilities, and applications
  - Training and supporting users
  - Maintaining DBMS, utilities, and applications

Summary (cont'd.)

- Security: ensures confidentiality, integrity, availability of information system and data
- Security policy: collection of standards, policies, and practices
- Security vulnerability: weakness in system component
- Information engineering guides development of data administration strategy
- CASE tools and data dictionaries translate strategic plans to operational plans