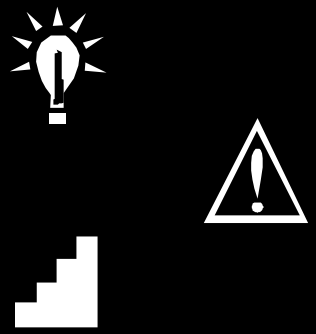


Oracle9*i* DBA Fundamentals I

Electronic Presentation

D11321GC10
Production 1.0
May 2001
D32645

ORACLE®

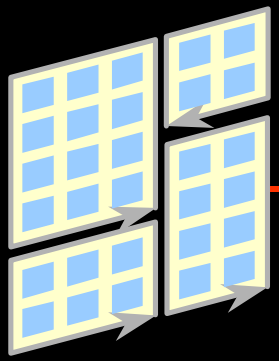
Introduction

Objectives

After completing this course, you should be able to do the following:

- Identify the various components of the Oracle architecture.
- Start and shut down an Oracle database
- Create an operational database
- Manage Oracle control files, redo log files, database files, tablespaces, segments, extents, and blocks
- Manage users, privileges, and resources
- Use Globalization Support features

Oracle9*i* Enterprise Edition



Partitioning

ORACLE

9i

INTERNET

Real Application Clusters

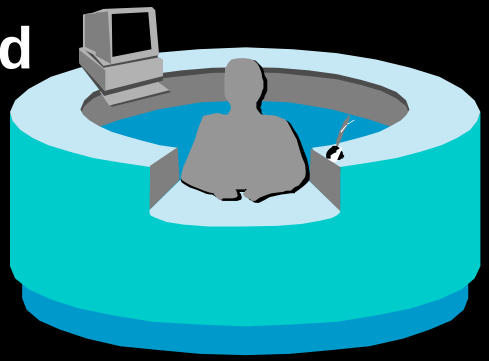
ORACLE

Oracle Enterprise Manager Packs

Advanced Security

Database Administrator Tasks

- Plan and create databases
- Manage database availability
- Manage physical and logical structures
- Manage storage based on design
- Manage security



- Network administration
- Backup and recovery
- Database tuning

1

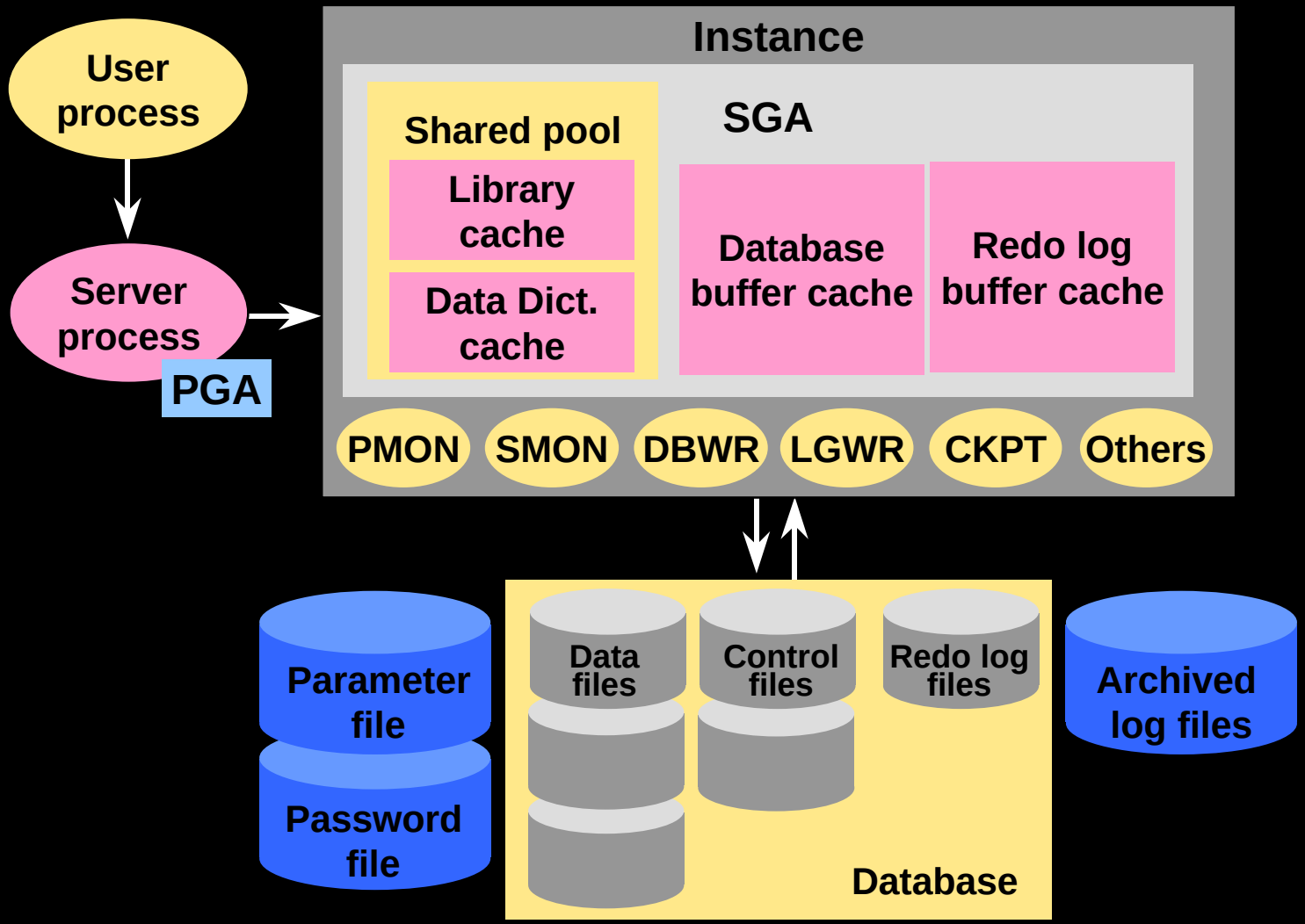
Oracle Architectural Components

Objectives

After completing this lesson, you should be able to do the following:

- Outline the Oracle architecture and its main components
- List the structures involved in connecting a user to an Oracle instance

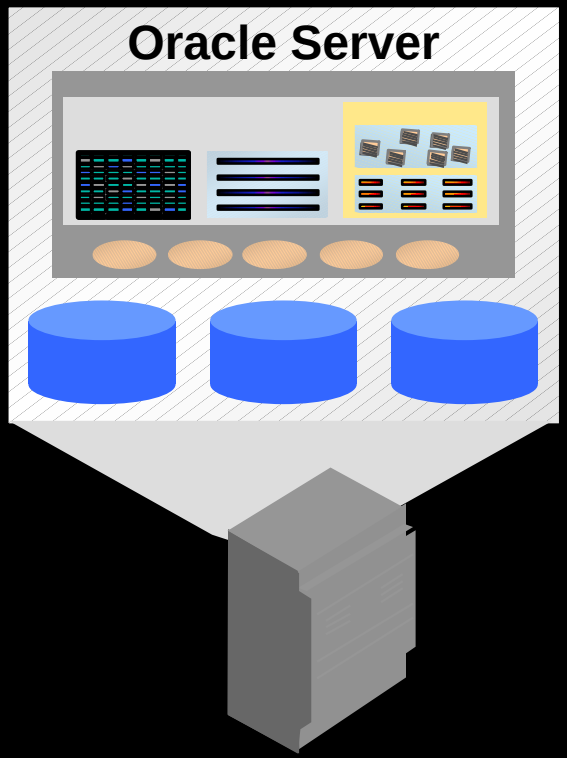
Overview of Primary Components



Oracle Server

An Oracle server:

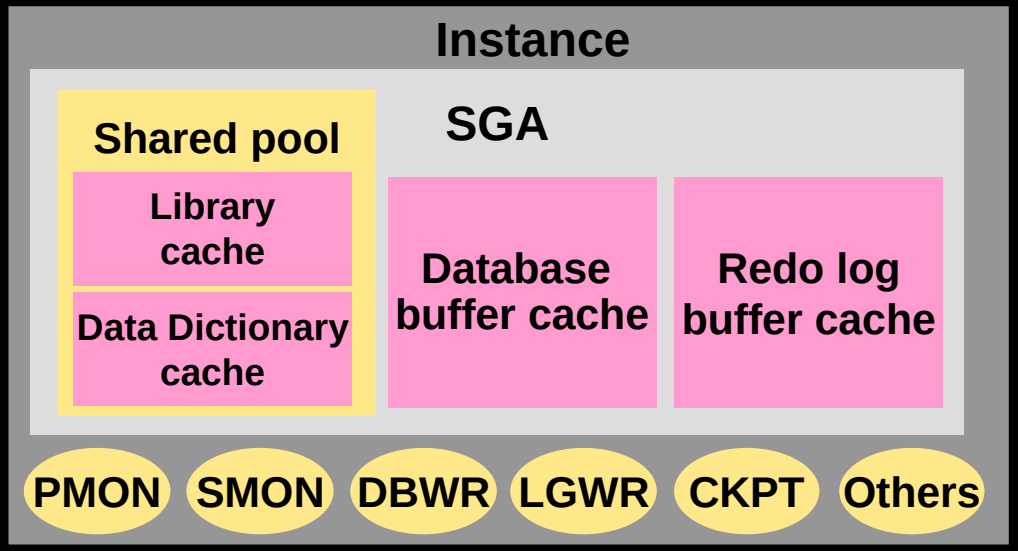
- Is a database management system that provides an open, comprehensive, integrated approach to information management
- Consists of an Oracle instance and an Oracle database



Oracle Instance

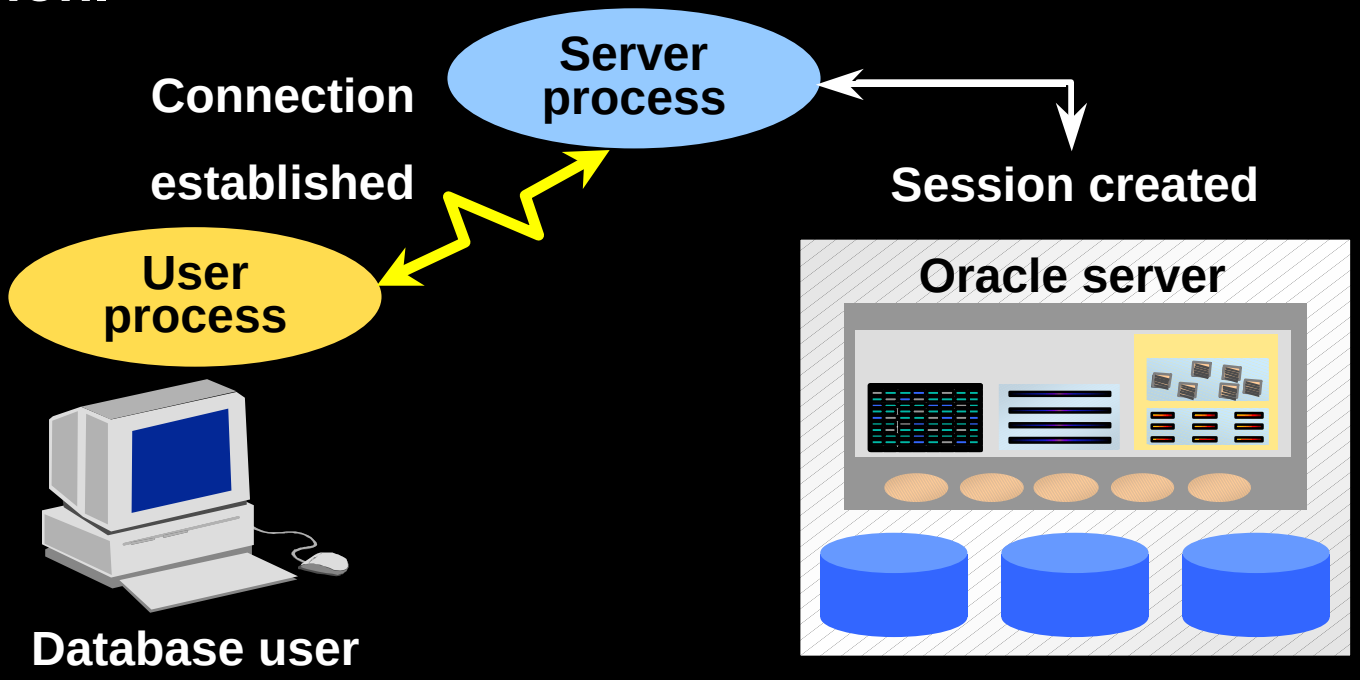
An Oracle instance:

- Is a means to access an Oracle database
- Always opens one and only one database
- Consists of memory and process structures



Establishing a Connection and Creating a Session

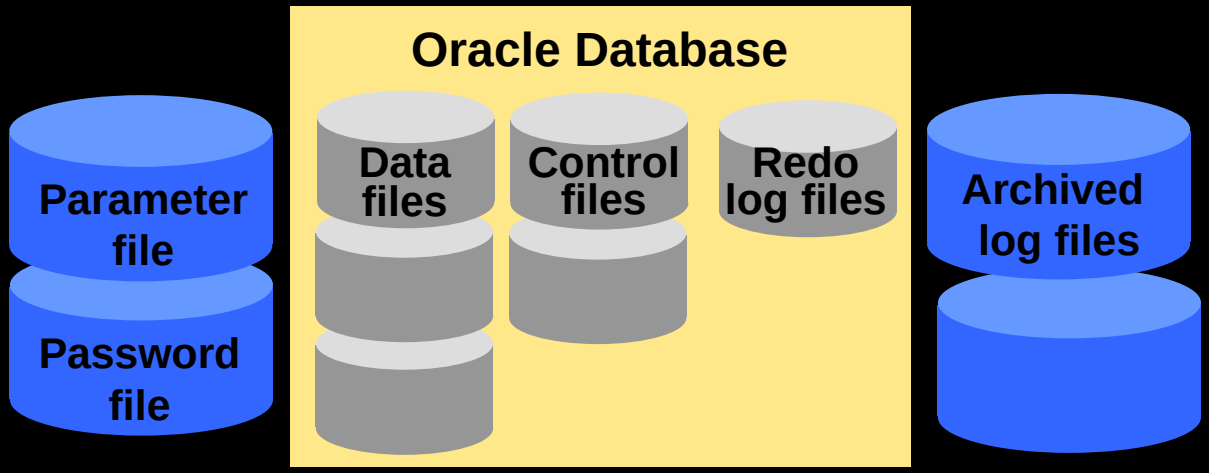
Connecting to an Oracle instance consists of establishing a user connection and creating a session.



Oracle Database

An Oracle database:

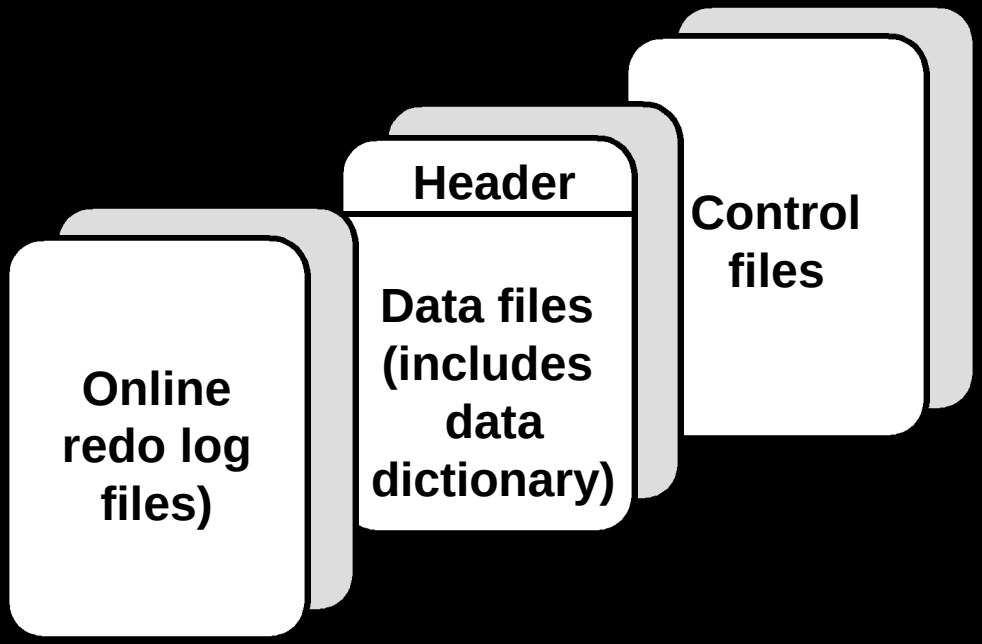
- Is a collection of data that is treated as a unit
- Consists of three file types



Physical Structure

The physical structure of an Oracle database is determined by the operating system files that provide the actual physical storage for database information.

- Control files
- Data files
- Redo log files



Memory Structure

Oracle's memory structure consists of two memory areas known as:

- System Global Area (SGA): Allocated at instance startup, and is a fundamental component of an Oracle Instance
- Program Global Area (PGA): Allocated when the server process is started

System Global Area (SGA)

- The SGA consists of several memory structures:
  - Shared pool
  - Database buffer cache
  - Redo log buffer
  - Other structures (e.g. lock and latch management, statistical data)
- There are two optional memory structures that can be configured within the SGA:
  - Large pool
  - Java pool

System Global Area (SGA)

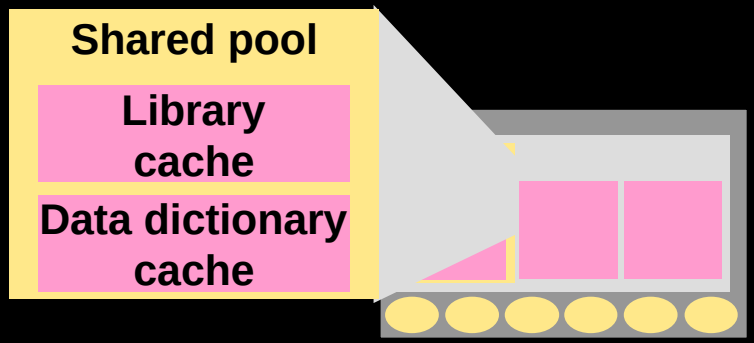
- SGA is dynamic and sized using `SGA_MAX_SIZE`.
- SGA memory allocated and tracked in granules by SGA components
  - Contiguous virtual memory allocation
  - Size based on `SGA_MAX_SIZE`

Shared Pool

The shared pool is used to store the most recently executed SQL statements and the most recently used data definitions.

- It consists of two key performance-related memory structures:
  - Library cache
  - Data dictionary cache
- Sized by the parameter `SHARED_POOL_SIZE`.

```
ALTER SYSTEM SET
SHARED_POOL_SIZE = 64M;
```



Library Cache

The library cache stores information about the most recently used SQL and PL/SQL statements. The library cache:

- Enables the sharing of commonly used statements
- Is managed by a least recently used (LRU) algorithm
- Consists of two structures:
  - Shared SQL area
  - Shared PL/SQL area
- Has its size determined by the shared pool sizing

Data Dictionary Cache

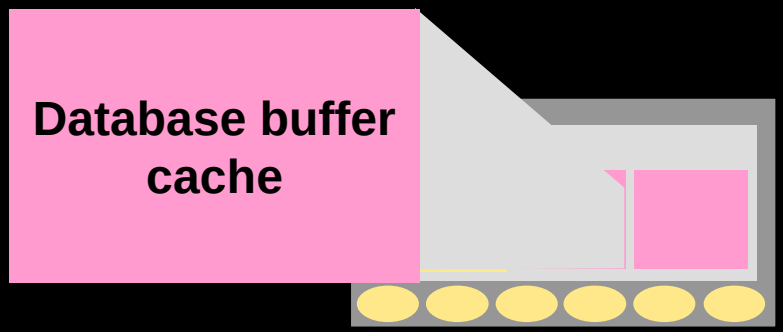
The data dictionary cache is a collection of the most recently used definitions in the database.

- It includes information about database files, tables, indexes, columns, users, privileges, and other database objects.
- During the parse phase, the server process looks at the data dictionary for information to resolve object names and validate access.
- Caching the data dictionary information into memory improves response time on queries.
- Size is determined by the shared pool sizing.

Database Buffer Cache

The database buffer cache stores copies of data blocks that have been retrieved from the data files.

- It enables great performance gains when you obtain and update data.
- It is managed through a least recently used (LRU) algorithm.
- `DB_BLOCK_SIZE` determines the primary block size.



Database Buffer Cache

- Consists of independent sub-caches:
  - DB_CACHE_SIZE
  - DB_KEEP_CACHE_SIZE
  - DB_RECYCLE_CACHE_SIZE
- Database buffer cache can be dynamically resized to grow or shrink using ALTER SYSTEM.

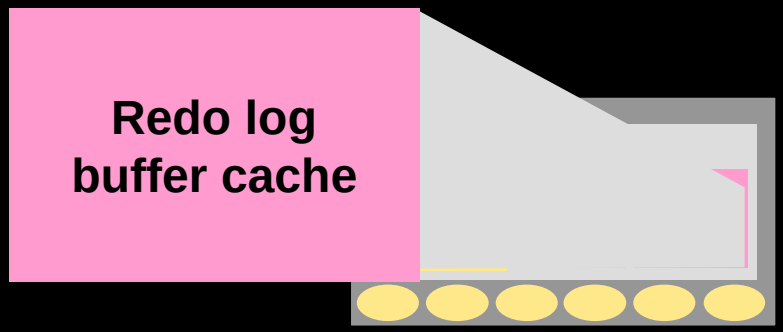
```
ALTER SYSTEM SET DB_CACHE_SIZE = 96M;
```

- DB_CACHE_ADVICE can be set to gather statistics for predicting different cache size behavior.

Redo Log Buffer Cache

The redo log buffer cache records all changes made to the database data blocks.

- Its primary purpose is recovery.
- Changes recorded within are called redo entries.
- Redo entries contain information to reconstruct or redo changes.
- Size is defined by `LOG_BUFFER`.



Large Pool

The large pool is an optional area of memory in the SGA configured only in a shared server environment.

- It relieves the burden placed on the shared pool.
- This configured memory area is used for session memory (UGA), I/O slaves, and backup and restore operations.
- Unlike the shared pool, the large pool does not use an LRU list.
- Sized by `LARGE_POOL_SIZE`.

```
ALTER SYSTEM SET LARGE_POOL_SIZE = 64M;
```

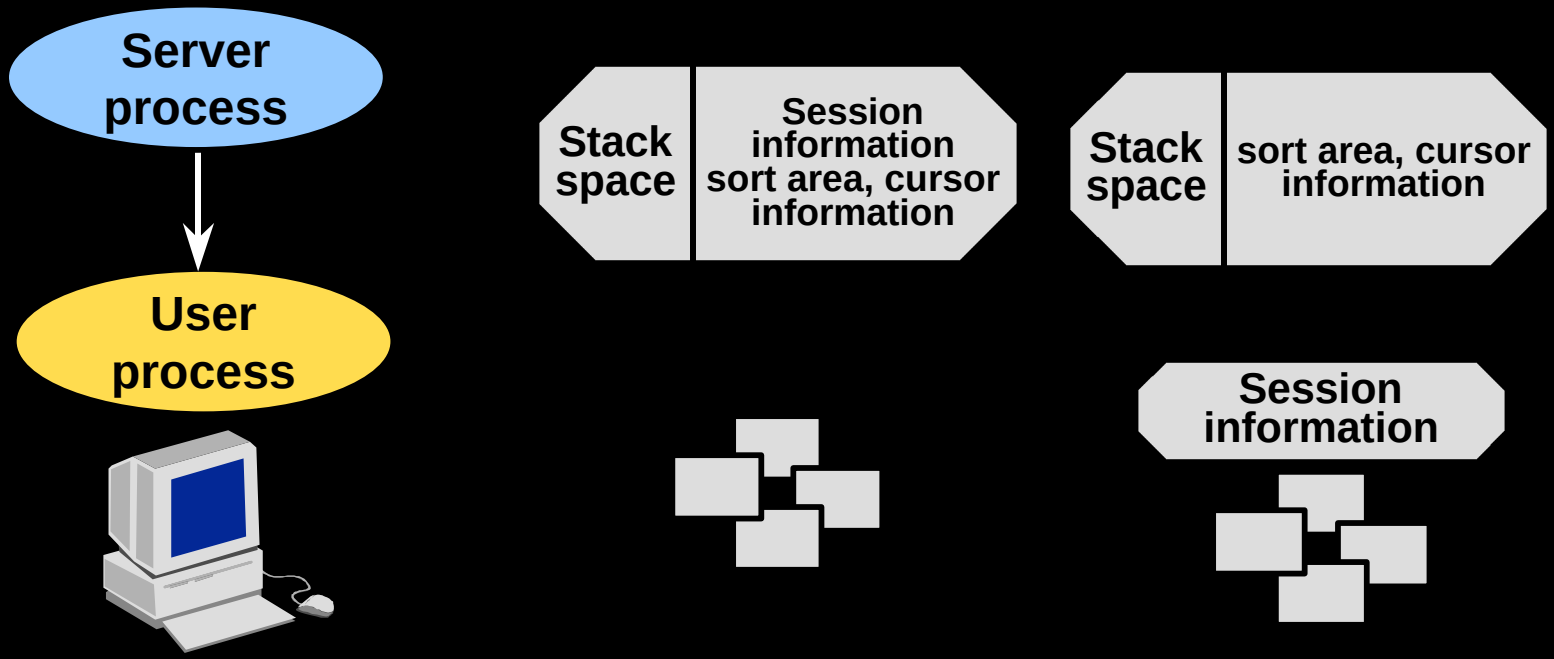
Java Pool

The Java pool services the parsing requirements for Java commands.

- Required if installing and using Java.
- It is stored much the same way as PL/SQL in database tables.
- It is sized by the `JAVA_POOL_SIZE` parameter.

Program Global Area (PGA)

The PGA is memory reserved for each user process that connects to an Oracle database.



Process Structure

An Oracle process is a program that depending on its type can request information, execute a series of steps, or perform a specific task.

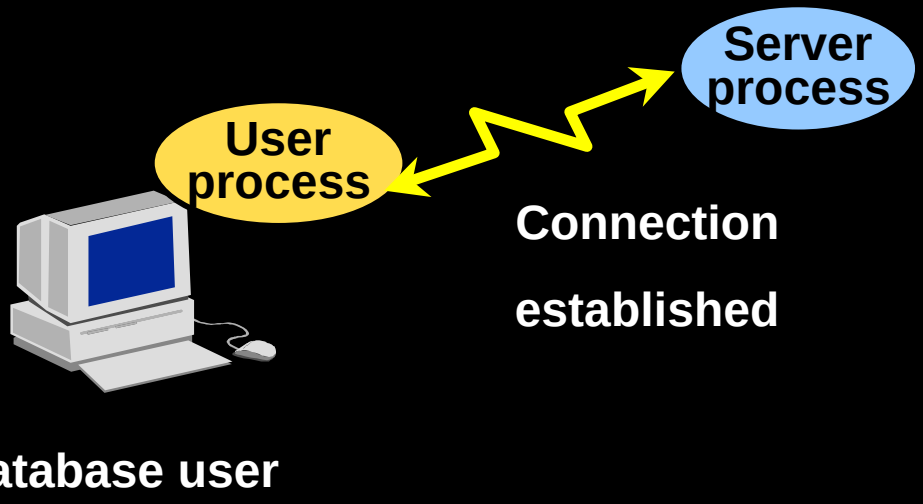
Oracle takes advantage of various types of processes:

- User process: Started at the time a database user requests connection to the Oracle server
- Server process: Connects to the Oracle Instance and is started when a user establishes a session.
- Background process: Available when an Oracle instance is started

User Process

A user process is a program that requests interaction with the Oracle server.

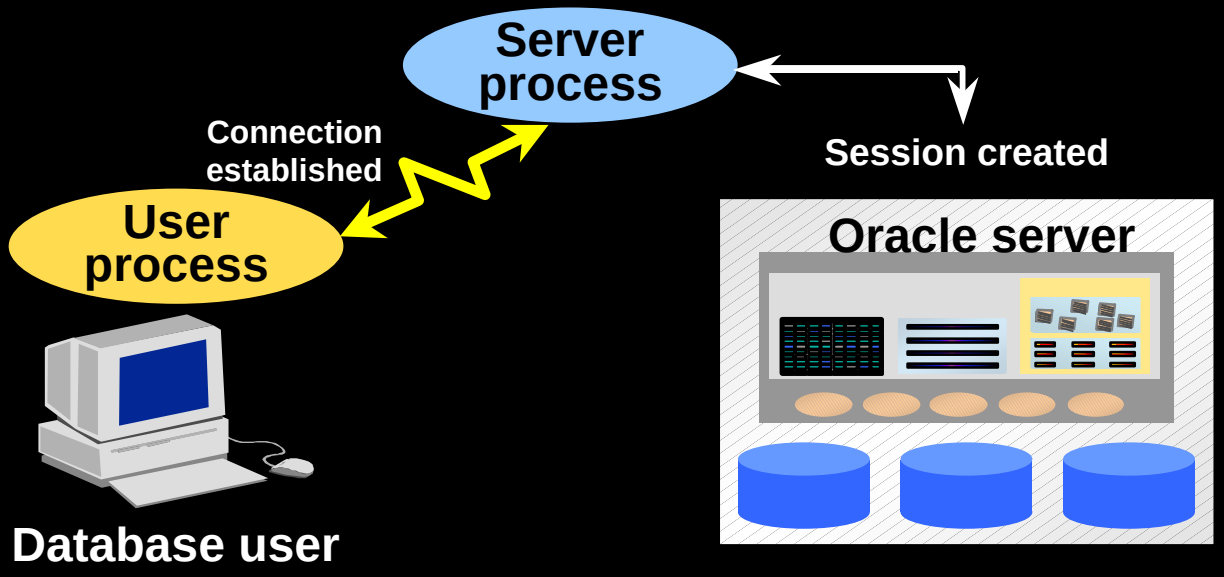
- It must first establish a connection.
- It does not interact directly with the Oracle server.



Server Process

A server process is a program that directly interacts with the Oracle server.

- It fulfills calls generated and returns results.
- Can be dedicated or shared server.



Background Processes

The relationship between the physical and memory structures is maintained and enforced by Oracle's background processes.

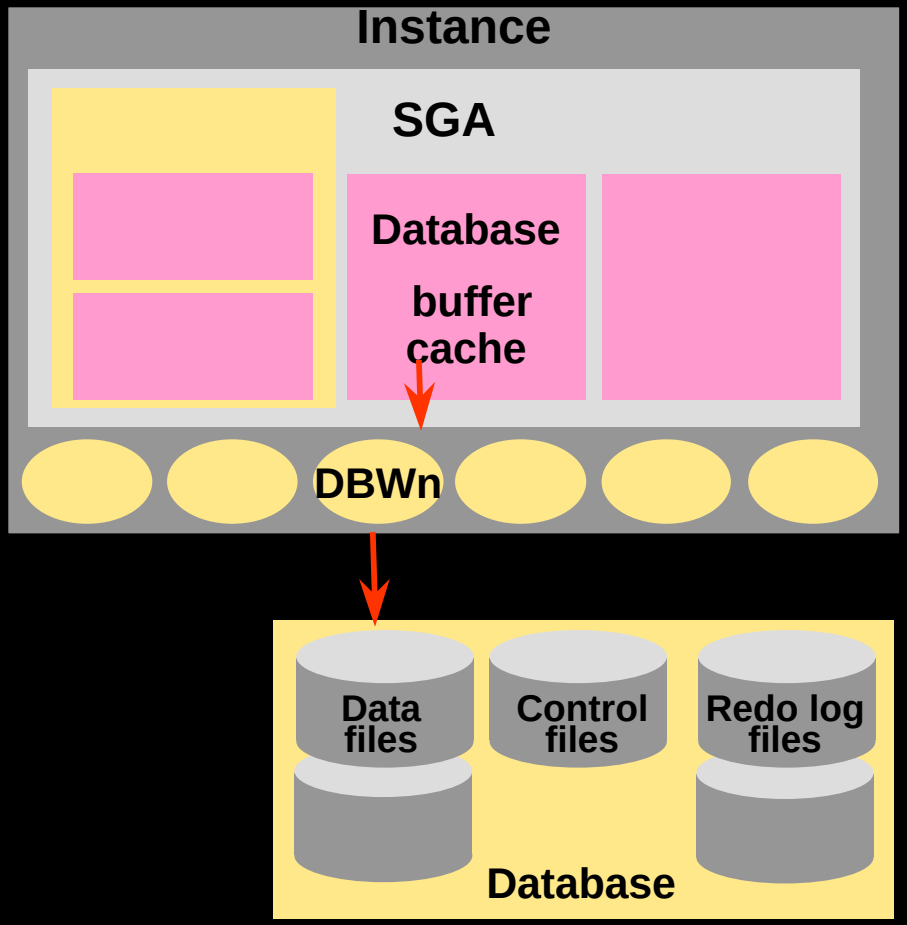
- Mandatory background processes

DBWn	PMON	CKPT
LGWR	SMON	RECO

- Optional background processes

ARCn	LMON	Snnn
QMNn	LMDn	
CJQ0	Pnnn	
LCKn	Dnnn	

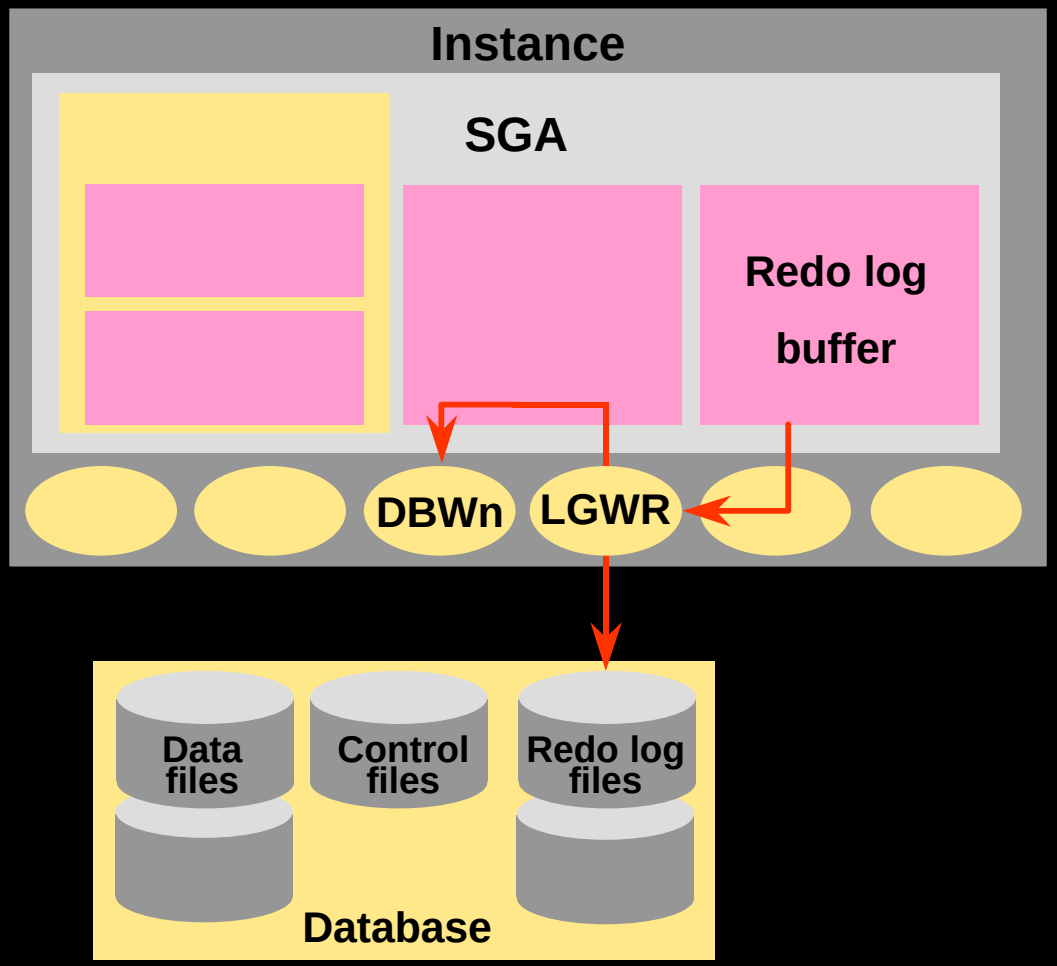
Database Writer (DBWn)



DBWn writes when:

- Checkpoint
- Dirty buffers threshold reached
- No free buffers
- Timeout
- RAC ping request
- Tablespace offline
- Tablespace read only
- Table `DROP` or `TRUNCATE`
- Tablespace `BEGIN BACKUP`

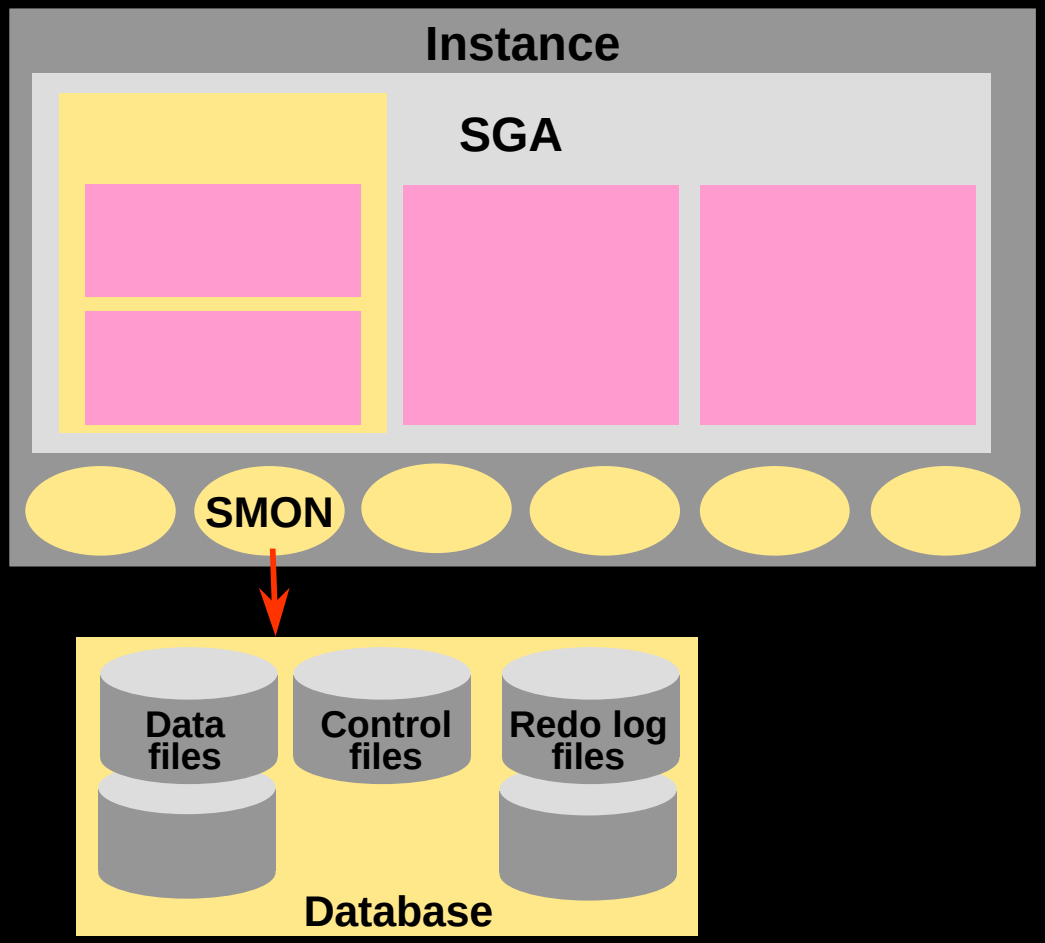
Log Writer (LGWR)



LGWR writes:

- At commit
- When one-third full
- When there is 1 MB of redo
- Every 3 seconds
- Before DBWn writes

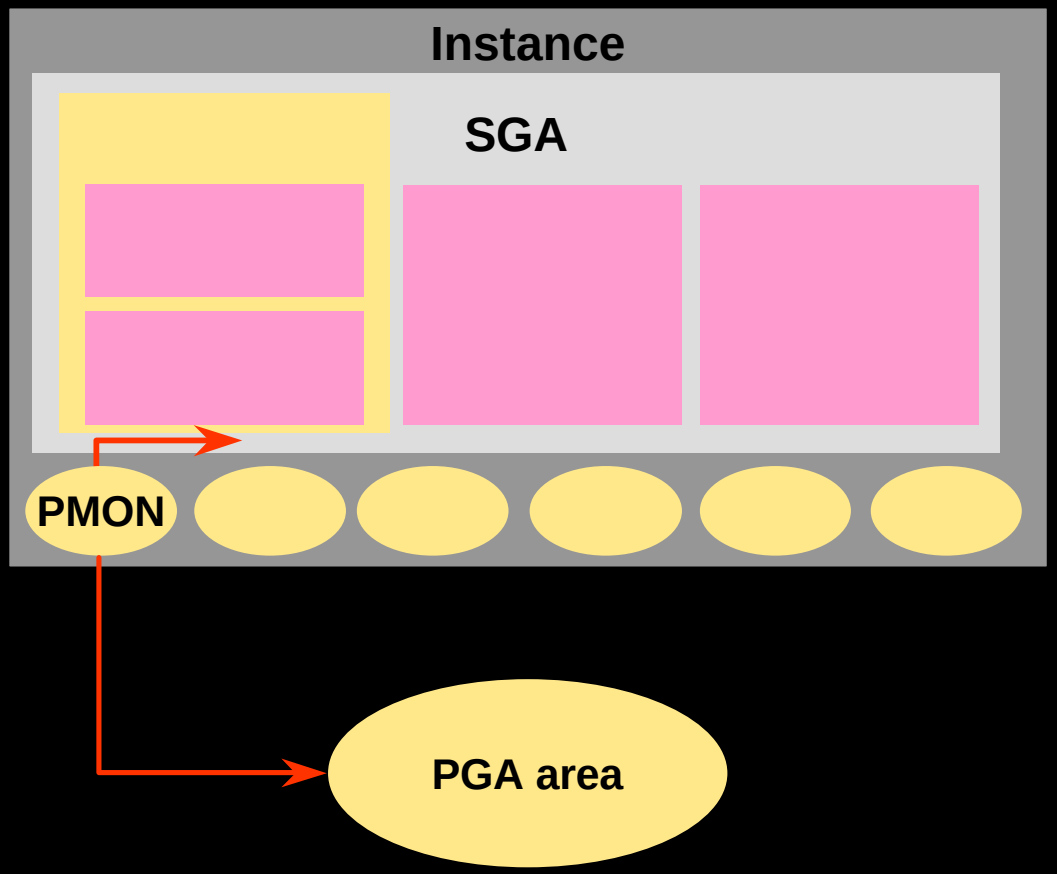
System Monitor (SMON)



Responsibilities:

- Instance recovery:
  - Rolls forward changes in the redo logs
  - Opens the database for user access
  - Rolls back uncommitted transactions
- Coalesces free space ever 3 sec
- Deallocates temporary segments

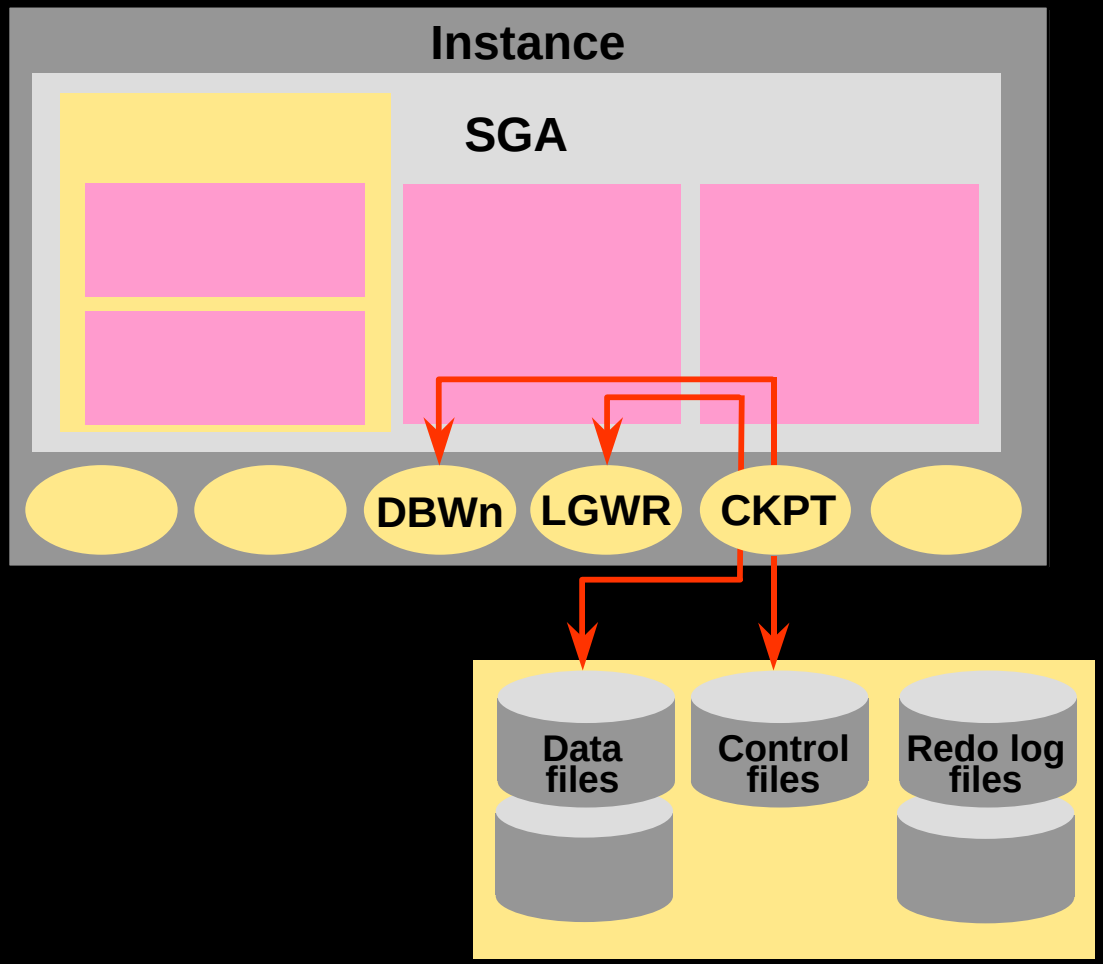
Process Monitor (PMON)



Cleans up after failed processes by:

- Rolling back the transaction
- Releasing locks
- Releasing other resources
- Restarts dead dispatchers

Checkpoint (CKPT)

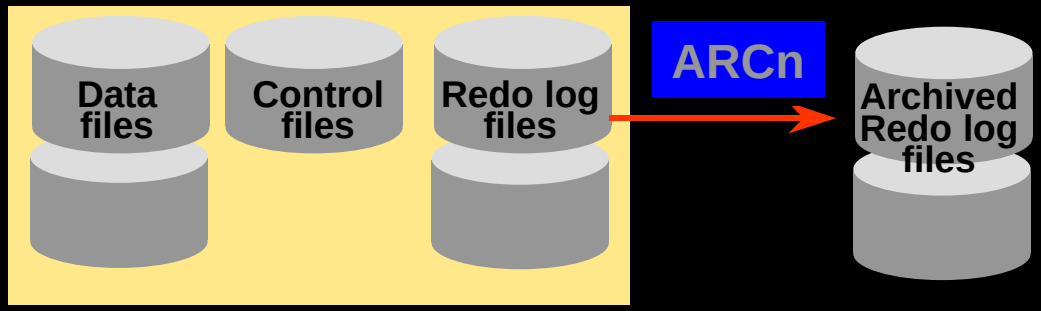


Responsible for:

- Signalling DBWn at checkpoints
- Updating datafile headers with checkpoint information
- Updating control files with checkpoint information

Archiver (ARCn)

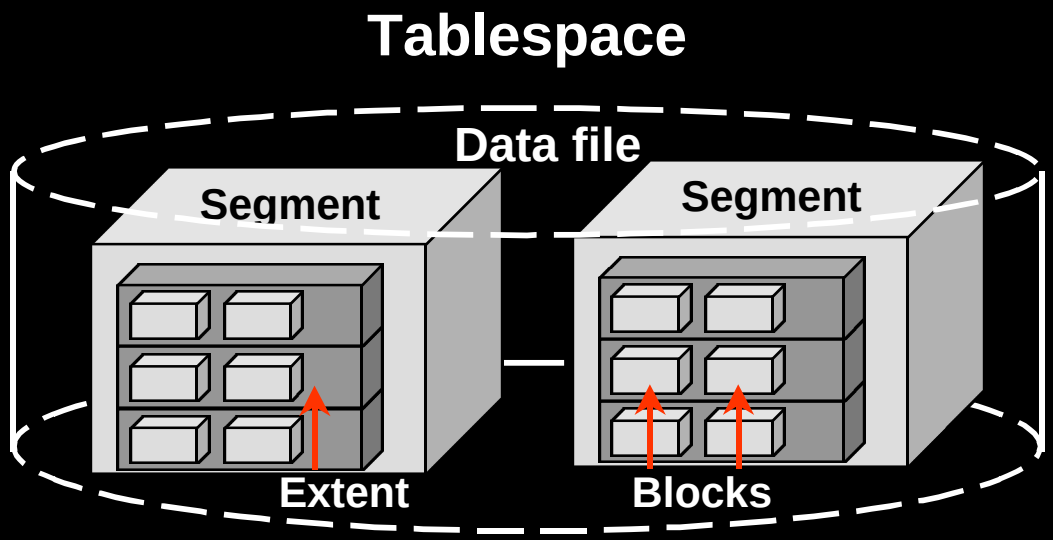
- Optional background process
- Automatically archives online redo logs when `ARCHIVELOG` mode is set
- Preserves the record of all changes made to the database



Logical Structure

The logical structure of the Oracle architecture dictates how the physical space of a database is to be used.

A hierarchy exists in this structure that consists of tablespaces, segments, extents, and blocks.



Processing a SQL Statement

- Connect to an instance using:
  - The user process
  - The server process
- The Oracle server components that are used depend on the type of SQL statement:
  - Queries return rows.
  - DML statements log changes.
  - Commit ensures transaction recovery.
- Some Oracle server components do not participate in SQL statement processing.

Summary

In this lesson, you should have learned how to:

- Explain database files: data files, control files, online redo logs
- Explain SGA memory structures: Database buffer cache, shared SQL pool, and redo log buffer
- Explain primary background processes: DBWn, LGWR, CKPT, PMON, SMON, and ARCn

Practice 1 Overview

This practice covers the following topics:

- Review of architectural components
- Structures involved in connecting a user to an Oracle instance.

2

Getting Started With the Oracle Server

Objectives

After completing this lesson, you should be able to do the following:

- Identify common database administration tools available to a DBA
- Identify the features of the Oracle Universal Installer
- Understand the benefits of Optimal Flexible Architecture
- Set up password file authentication
- List the main components of Oracle Enterprise Manager and their uses

Database Administration Tools

Tool	Description
Oracle Universal Installer (OUI)	Used to install, upgrade, or remove software components
Oracle Database Configuration Assistant	A graphical user interface tool that interacts with the OUI, or can be used independently, to create, delete or modify a database
Password File Utility	Utility for creating a database password file
SQL*Plus	A utility to access data in an Oracle database
Oracle Enterprise Manager	A graphical interface used to administer, monitor, and tune one or more databases

Oracle Universal Installer

- Used to install, upgrade, or remove software components, and create a database
- Based on a Java engine
- Features include:
  - Automatic dependency resolution
  - Allows for Web-based installations
  - Tracking inventory of component and suite installations
  - Deinstallation of installed components
  - Support for multiple Oracle homes
  - Support for globalization technology

Interactive Installation

To start Oracle Universal Installer on Unix:

```
$ ./runInstaller
```

Non-Interactive Installation Using Response Files

To start Universal Installer in non-interactive mode:

```
./runInstaller -responsefile myrespfile -silent
```

Oracle Database Configuration Assistant

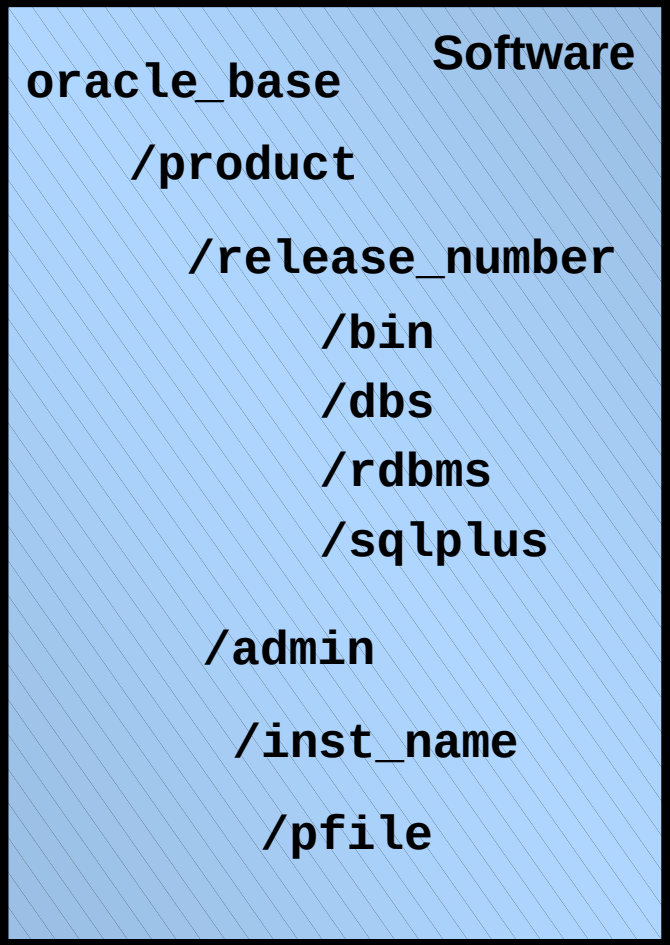
The Oracle Database Configuration Assistant allows you to:

- Create a database
- Configure database options
- Delete a database
- Manage templates

Optimal Flexible Architecture (OFA)

- Oracle's recommended standard database architecture layout
- OFA involves three major rules
  - Establish a directory structure where any database file can be stored on any disk resource
  - Separate objects with different behavior into different tablespaces
  - Maximize database reliability and performance by separating database components across different disk resources

Oracle Software and File Locations



Database Administrator Users

When a database is created the users SYS and SYSTEM are created automatically and granted the DBA role.

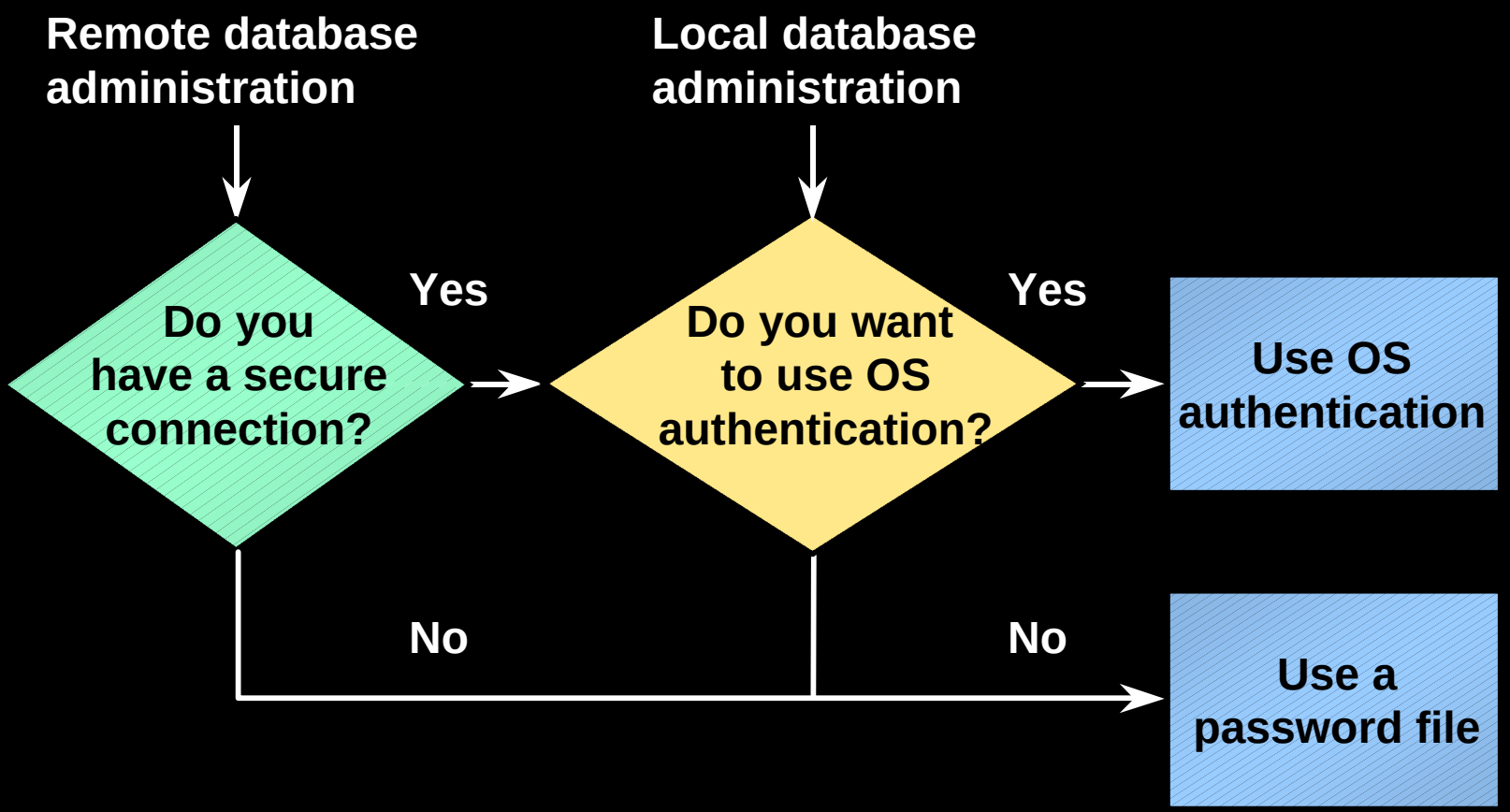
SYS

- Password: `change_on_install`
- Owner of the database data dictionary

SYSTEM

- Password: `manager`
- Owner of additional internal tables and views used by Oracle tools

Authentication Methods for Database Administrators



Using Password File Authentication

- Create the password file using the password utility:

```
$orapwd file=$ORACLE_HOME/dbs/orapwU15
password=admin entries=5
```

- Set `REMOTE_LOGIN_PASSWORDFILE` to `EXCLUSIVE` in the initialization parameter file
- Add users to the password file and assign appropriate privileges to each user

```
GRANT SYSDBA TO HR;
```

SQL*Plus

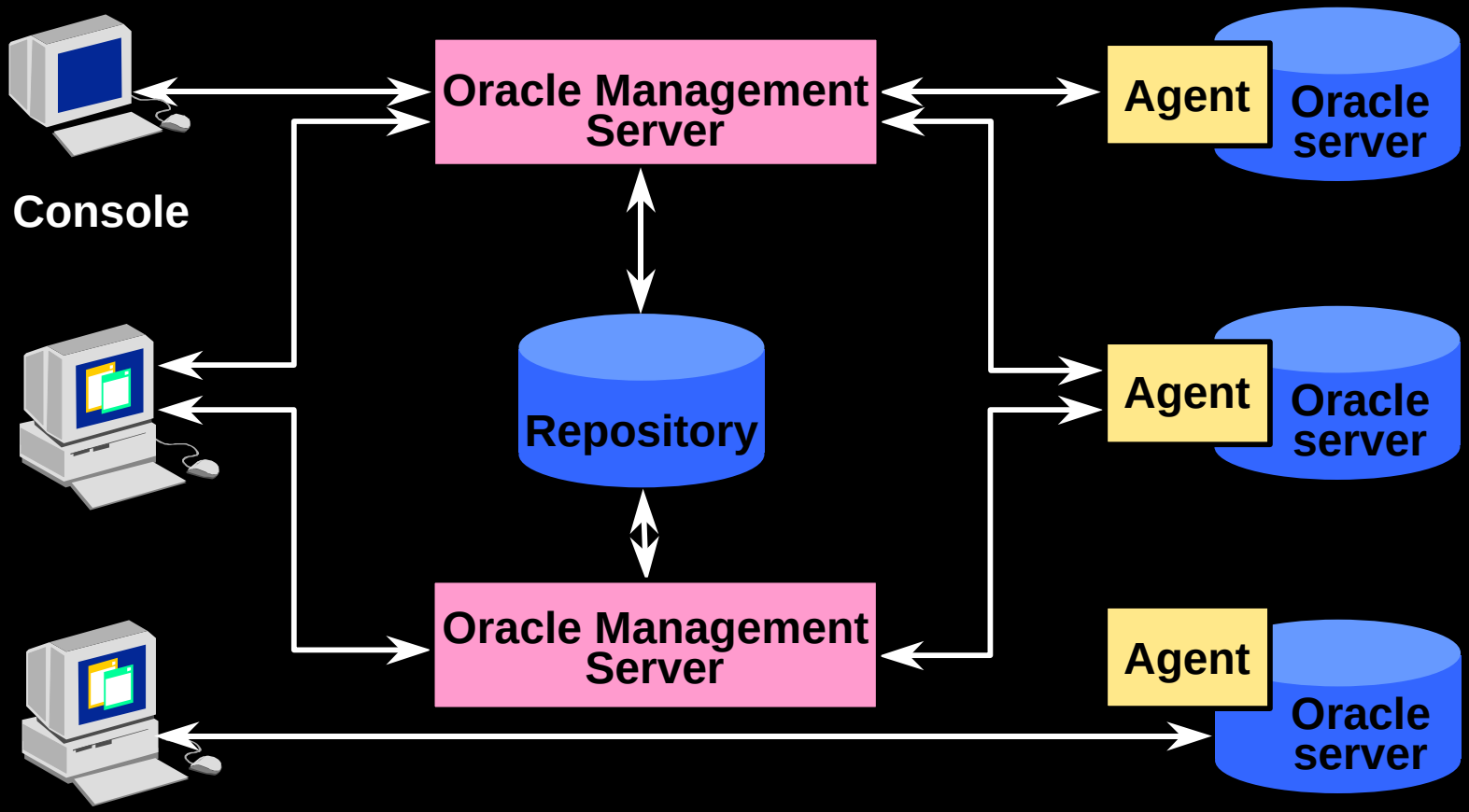
SQL*Plus is an Oracle tool that provides the capability to interact with and manipulate the database.

- Provides the ability to start up and shutdown the database, create and run queries, add rows, modify data, and write customized reports
- Subset of the standard SQL language with specific add ons

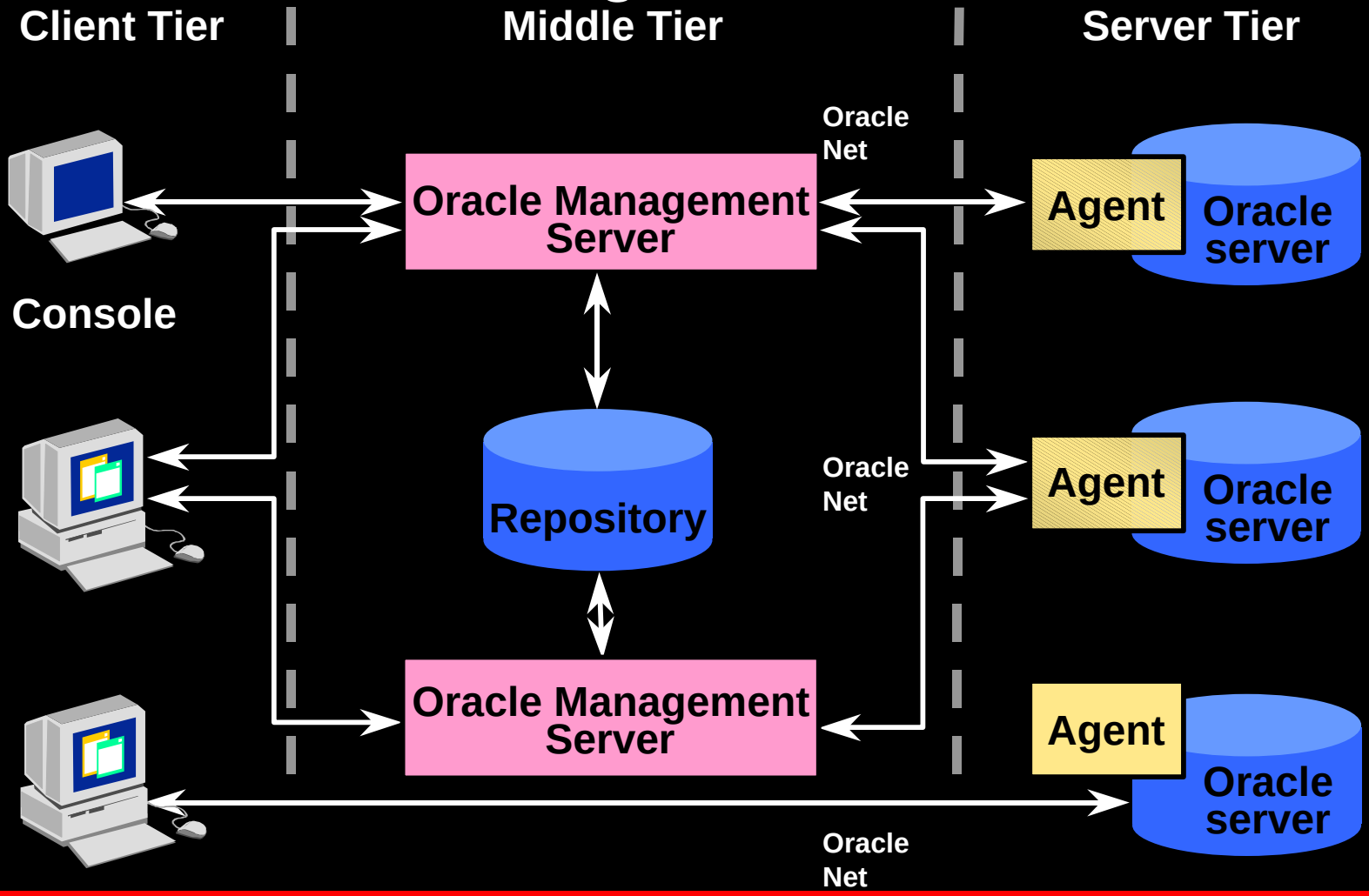
Oracle Enterprise Manager

- Serves as a centralized systems management console for DBAs
- Provides a set of common services that help manage the Oracle environment
- Includes integrated applications
- Manages the environment such as databases, web servers and listeners
- A tool to administer, diagnose and tune multiple databases
- Provides tools for administering parallel servers and replicated databases

Oracle Enterprise Manager Architecture: Java-Based Console and Applications



Oracle Enterprise Manager Architecture: Managed Nodes



Oracle Enterprise Manager Console

Console

- **Central launching point for all applications**
- **Can be run in thin mode or as a fat client**
- **Can be launched either standalone or through Oracle Management Server**

DBA Tools

Standard applications that can be launched from the Console:

- Instance Manager
- Security Manager
- Storage Manager
- Schema Manager
- SQL*Plus Worksheet

Summary

In this lesson, you should have learned to:

- Identify the tools available to a DBA
- Identify the features of the Oracle Universal Installer
- Outline the recommended layout defined by the Optimal Flexible Architecture
- Setup operating system and password file authentication
- Identify the main components of Oracle Enterprise Manager

Practice 2 Overview

This practice covers the following topics:

- Executing SQL*Plus scripts
- Creating password file

3

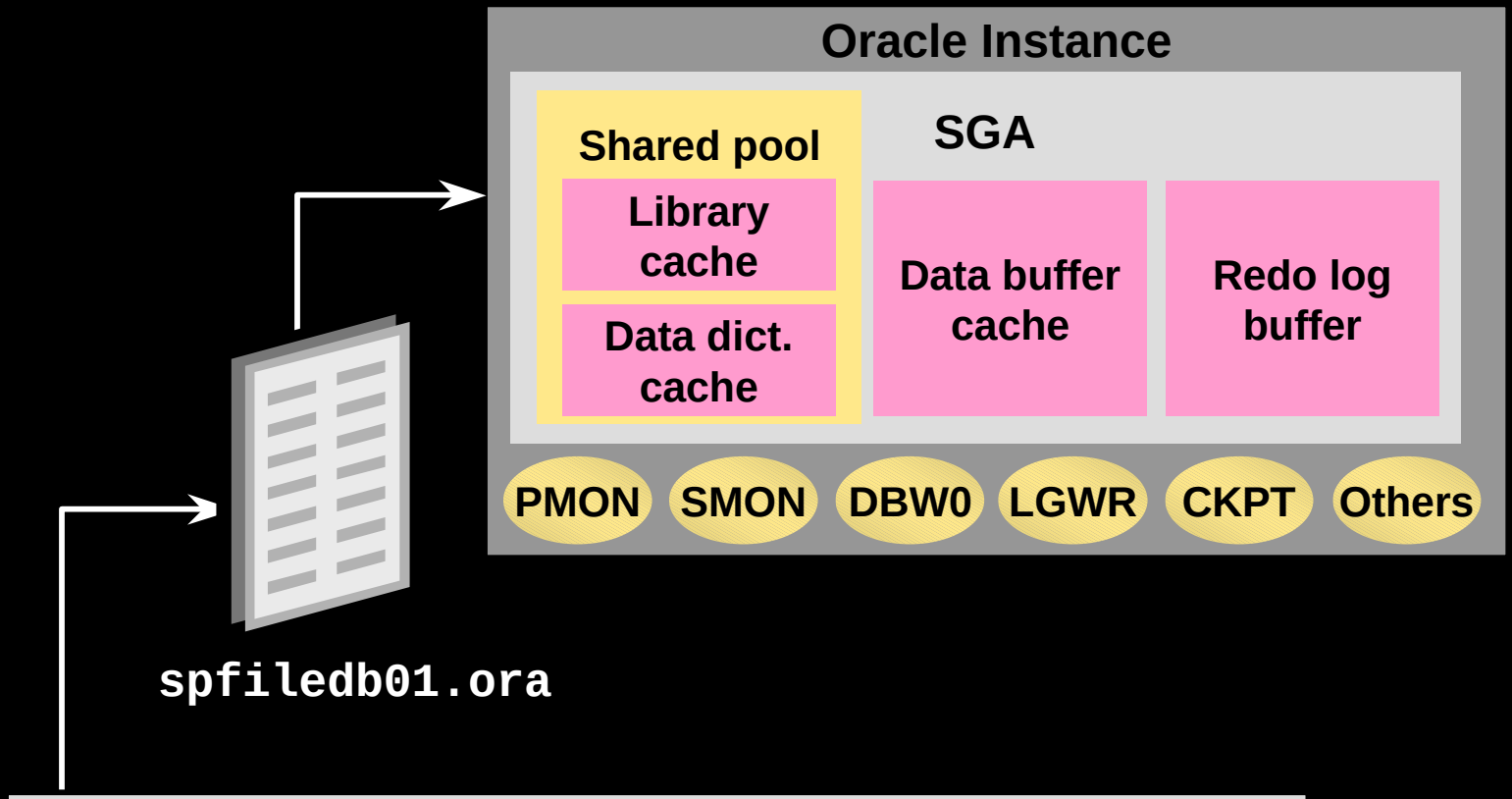
Managing an Oracle Instance

Objectives

After completing this lesson, you should be able to do the following:

- Create and manage initialization parameter files
- Configure OMF
- Start up and shut down an instance
- Monitor and use diagnostic files

Initialization Parameter Files




```
SQL> CONNECT / AS SYSDBA
SQL> STARTUP
```

Initialization Parameter Files

- Entries are specific to the instance being accessed
- There are two kinds of parameters:
  - Explicit: Having an entry in the file
  - Implicit: No entry within the file, but assuming the Oracle default values
- Multiple files can be used for a single database to optimize performance in different situations.
- Changes to entries in the file take effect based on the type of initialization parameter file used;
  - Static parameter file, `PFILE`
  - Persistent parameter file, `SPFILE`

PFILE
initSID.ora

- The PFILE is a text file that can be modified with an operating system editor.
- Modifications to the file are made manually.
- Changes to the file take effect on the next startup.
- Its default location is $ORACLE_HOME/dbs.

PFILE Example

```
# Initialization Parameter File: initdb01.ora
db_name                 = db01
instance_name           = db01
control_files           = ( /u03/oradata/db01/control01db01.ctl,
                            /u03/oradata/db01/control02db01.ctl)
db_block_size           = 4096
db_block_buffers        = 500
shared_pool_size        = 31457280  # 30M Shared Pool
db_files                = 1024
max_dump_file_size      = 10240
background_dump_dest    = /u05/oracle9i/admin/db01/bdump
user_dump_dest          = /u05/oracle9i/admin/db01/udump
core_dump_dest          = /u05/oracle9i/admin/db01/cdump
undo_management         = auto
undo_tablespace         = undtbs
. . .
```

SPFILE
spfileSID.ora

- Binary file with the ability to make changes persistent across shutdown and startup
- Maintained by the Oracle server
- Records parameter value changes made with the `ALTER SYSTEM` command
- Can specify whether the change being made is temporary or persistent
- Values can be deleted or reset to allow an instance to revert to the default value

```
ALTER SYSTEM SET undo_tablespace = 'UNDO2';
```

Creating an SPFILE

SPFILE can be created from an initSID.ora file using the CREATE SPFILE command, which can be executed before or after instance startup:

```
CREATE SPFILE FROM PFILE;
```

SPFILE Example

```
*.background_dump_dest='$ORACLE_HOME/admin/db01/bdump'
*.compatible='9.0.0'
*.control_files='/u03/oradata/db01/ctrl01db01.ctl','/u03/orad
ata/db01/ctrl02db01.ctl'
*.core_dump_dest='$ORACLE_HOME/admin/db01/cdump'
*.db_block_buffers=500
*.db_block_size=4096
*.db_files=40
*.db_name='db01'
*.instance_name='db01'
*.remote_login_passwordfile='exclusive'
*.shared_pool_size=31457280  # 30M Shared Pool
*.undo_management='AUTO'
db01.undo_tablespace='UNDOTBS01'
db02.undo_tablespace='UNDOTBS02'
. . .
```

Oracle Managed Files

Oracle Managed Files (OMF) simplify file administration

- **OMF are created and deleted by the Oracle server as directed by SQL commands**
- **OMF are established by setting two parameters:**
  - **`DB_CREATE_FILE_DEST`: Set to give the default location for data files**
  - **`DB_CREATE_ONLINE_LOG_DEST_N`: Set to give the default locations for online redo logs and control files, up to a maximum of 5 locations**

Oracle Managed File Example

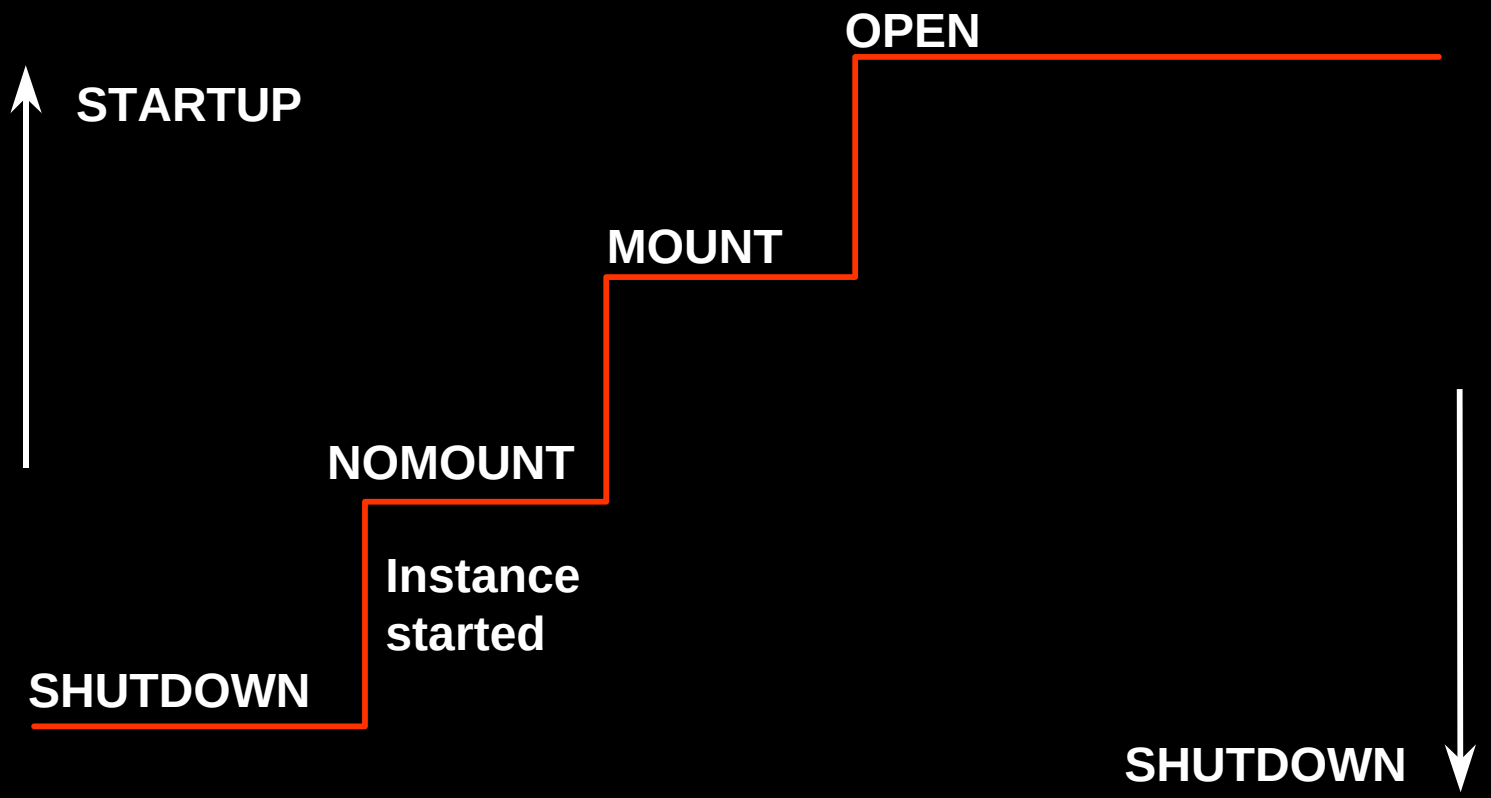
To create a database where data files, control files, and online redo log files are created in separate directories:

- Set the initialization parameters:

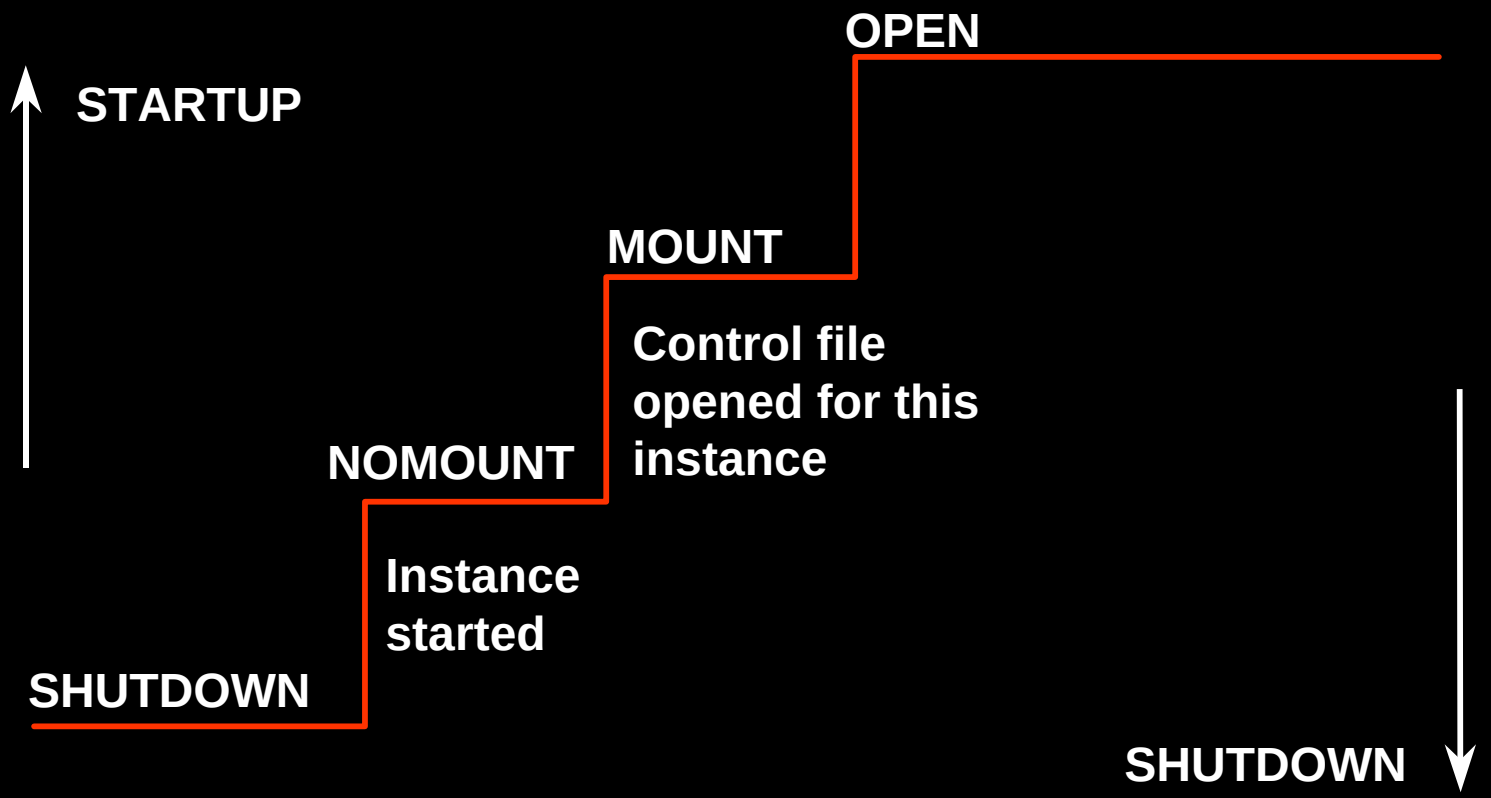
```
DB_CREATE_FILE_DEST = '/u01/oradata/'
DB_CREATE_ONLINE_LOG_DEST_1 = '/u02/oradata/'
DB_CREATE_ONLINE_LOG_DEST_2 = '/u03/oradata/'
```

- Issue the `CREATE DATABASE` SQL statement.

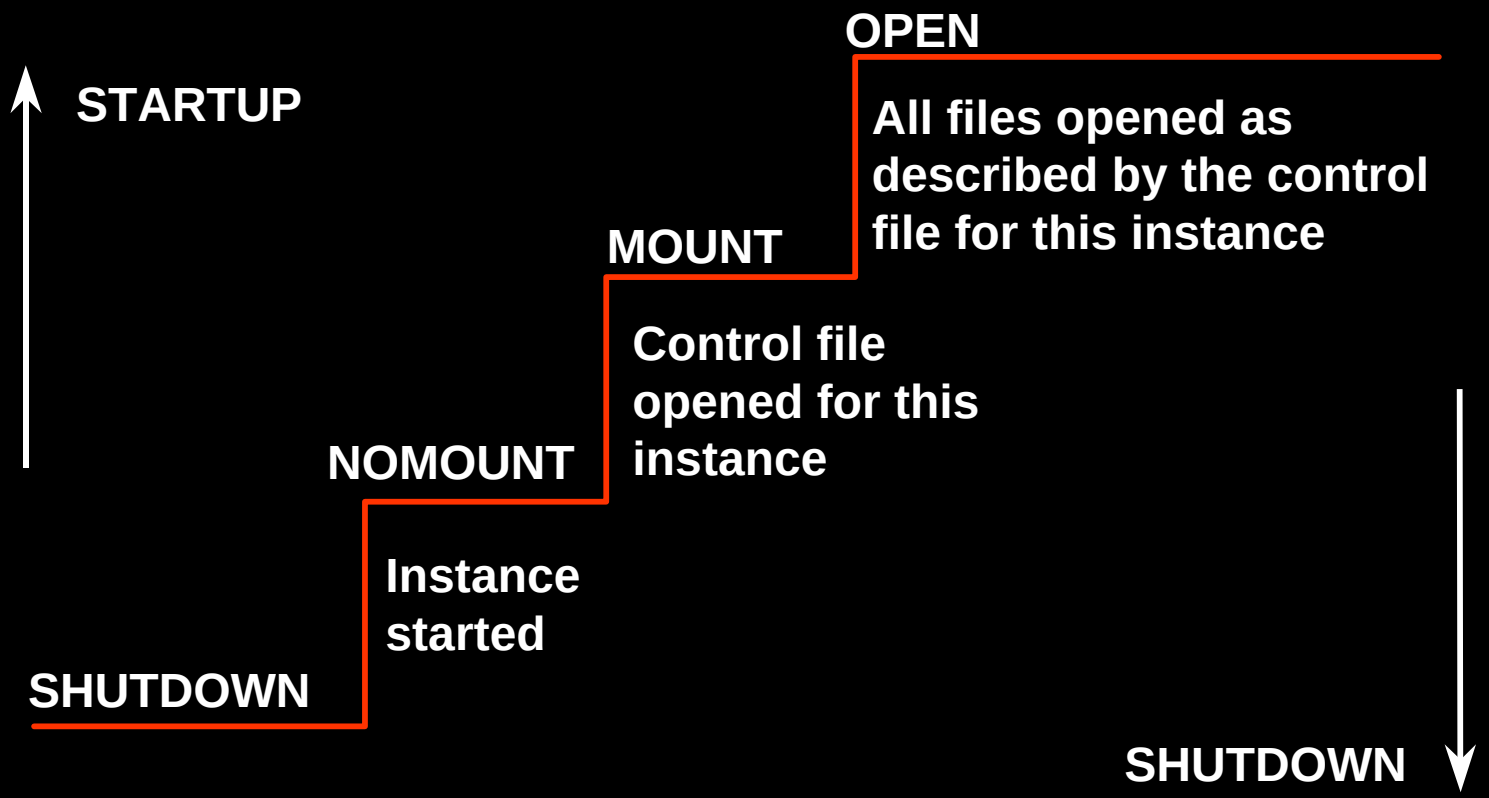
Starting Up a Database
NOMOUNT



Starting Up a Database
MOUNT



Starting Up a Database
OPEN



STARTUP Command

Start up the instance and open the database:

```
STARTUP
```

```
STARTUP PFILE=$ORACLE_HOME/dbs/initdb01.ora
```

The ALTER DATABASE Command

- Change the state of the database from NOMOUNT to MOUNT:

```
ALTER DATABASE db01 MOUNT;
```

- Open the database as a read-only database:

```
ALTER DATABASE db01 OPEN READ ONLY;
```

Opening a Database in Restricted Mode

- Use the `STARTUP` command to restrict access to a database:

```
STARTUP RESTRICT
```

- Use the `ALTER SYSTEM` command to place an instance in restricted mode:

```
ALTER SYSTEM ENABLE RESTRICTED SESSION;
```

Opening a Database in Read-Only Mode

- A databases can be opened as a read-only database.
- A read-only database can be used to:
  - Execute queries
  - Execute disk sorts using locally managed tablespaces
  - Take data files offline and online, not tablespaces
  - Perform recovery of offline data files and tablespaces

Shutting Down the Database

Shutdown Mode	A	I	T	N
Allow new connections	x	x	x	x
Wait until current sessions end	x	x	x	o
Wait until current transactions end	x	x	o	o
Force a checkpoint and close files	x	o	o	o

Shutdown Mode:

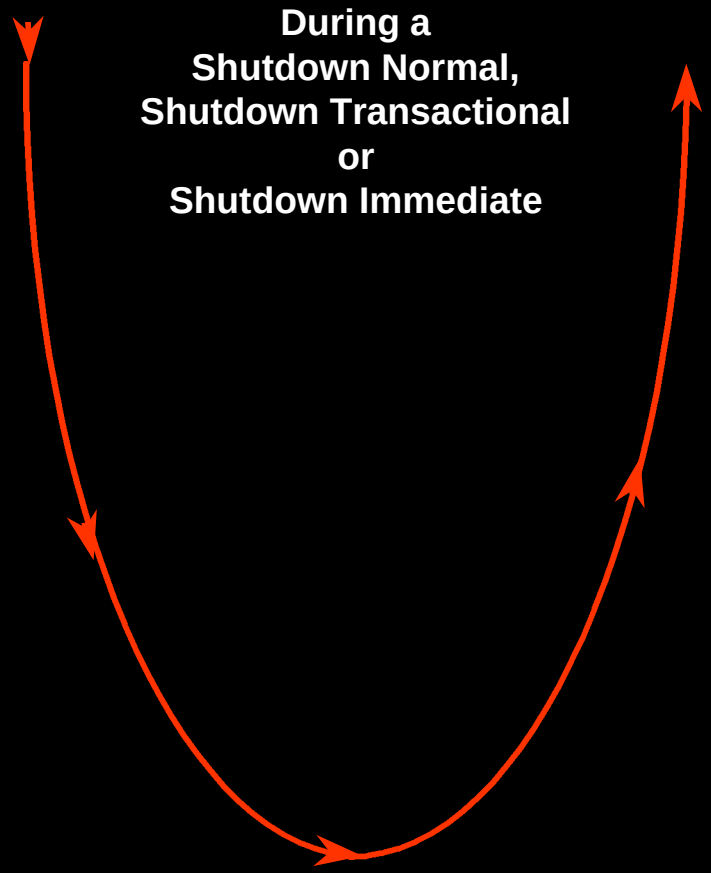
- NORMAL
- TRANSACTIONAL
- IMMEDIATE
- ABORT

x	NO
o	YES

Shutdown Options

On the way down:

- Database buffer cache written to the data files
- Uncommitted changes rolled back
- Resources released.



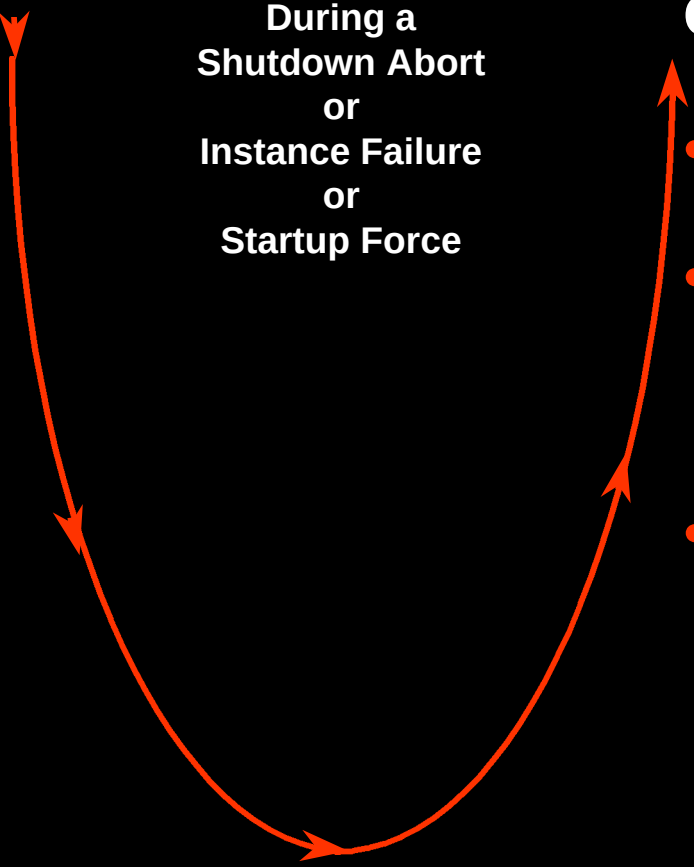
On the way up:

- No instance recovery

Shutdown Options

On the way down:

- Modified buffers are not written to the data files
- Uncommitted changes are not rolled back



On the way up:

- Redo logs used to reapply changes
- Undo segments used to roll back uncommitted changes
- Resources released

Inconsistent Database (dirty database)

Managing an Instance by Monitoring Diagnostic Files

Diagnostic files contain information about significant events encountered while the instance is operational.

- Used to resolve problems or to better manage the database on a day-to-day basis.
- Several types of diagnostic files exist:
  - `alertSID.log` file
  - Background trace files
  - User trace files

Alert Log File

The `alertSID.log` file records the commands and Results of major events while the database is operational.

- It is used for day-to-day operational information or diagnosing database errors.
- Each entry has a time stamp associated with it.
- The DBA manages the `alertSID.log` file.
- Its location is defined by `BACKGROUND_DUMP_DEST`.

Background Trace Files

Background trace files support information errors detected by any background process.

- They are used to diagnose and troubleshoot errors.
- They are created when a background process encounters an errors
- Their location is defined by `BACKGROUND_DUMP_DEST`

User Trace File

A user trace file is produced by the user process connected to the Oracle server through the server process.

- A user trace file contains statistics for traced SQL statements or user error messages.
- It is created when a user encounters user session errors.
- It can also be generated by a you or a server process.
- Its location is defined by `USER_DUMP_DEST`.
- Its size is defined by `MAX_DUMP_FILE_SIZE` and defaults to `10M`.

Enabling or Disabling User Tracing

User tracing is enabled or disabled at the session or instance level by using the following commands and parameter:

- Session level using the `ALTER SESSION` command:
  `ALTER SESSION SET SQL_TRACE = TRUE`
- Session level by executing DBMS procedure:
  `dbms_system.SET_SQL_TRACE_IN_SESSION`
- Instance level by setting the initialization parameter:

  `SQL_TRACE = TRUE`

Summary

In this lesson, you should have learned how to:

- Create and manage initialization parameter files
- Create and manage OMF files
- Start up and shut down an instance
- Monitor and use diagnostic files

Practice 3 Overview

This practice covers the following topics:

- Creating an `SPFILE`
- Starting up and shutting down the database in different modes

4 Creating a Database

ORACLE

Objectives

After completing this lesson, you should be able to do the following:

- Understand the prerequisites necessary for database creation
- Create a database using Oracle Database Configuration Assistant
- Create a database manually

Managing and Organizing a Database

- Creating a database is the first step in managing a database system
- A database may have been created automatically as part of Oracle9*i* Server installation, or you can create a new one later
- Oracle Data Migration Assistant is used to migrate from an earlier version of the database

Creation Prerequisites

To create a new database, you must have the following:

- A privileged account authenticated in one of the following ways:
  - By the operating system
  - Using a password file
- Sufficient memory to start the instance
- Sufficient disk space for the planned database

Planning Database File Locations

- Keep at least two active copies of a database control file on at least two different devices.
- Multiplex the redo log files and put group members on different disks.
- Separate data files whose data:
  - Will participate in disk resource contention across different physical disk resources
  - Have different life spans
  - Have different administrative characteristics

Creating a Database

An Oracle database can be created using:

- Oracle Database Configuration Assistant
- The `CREATE DATABASE` command

Operating System Environment

On Unix, set the following environment variables:

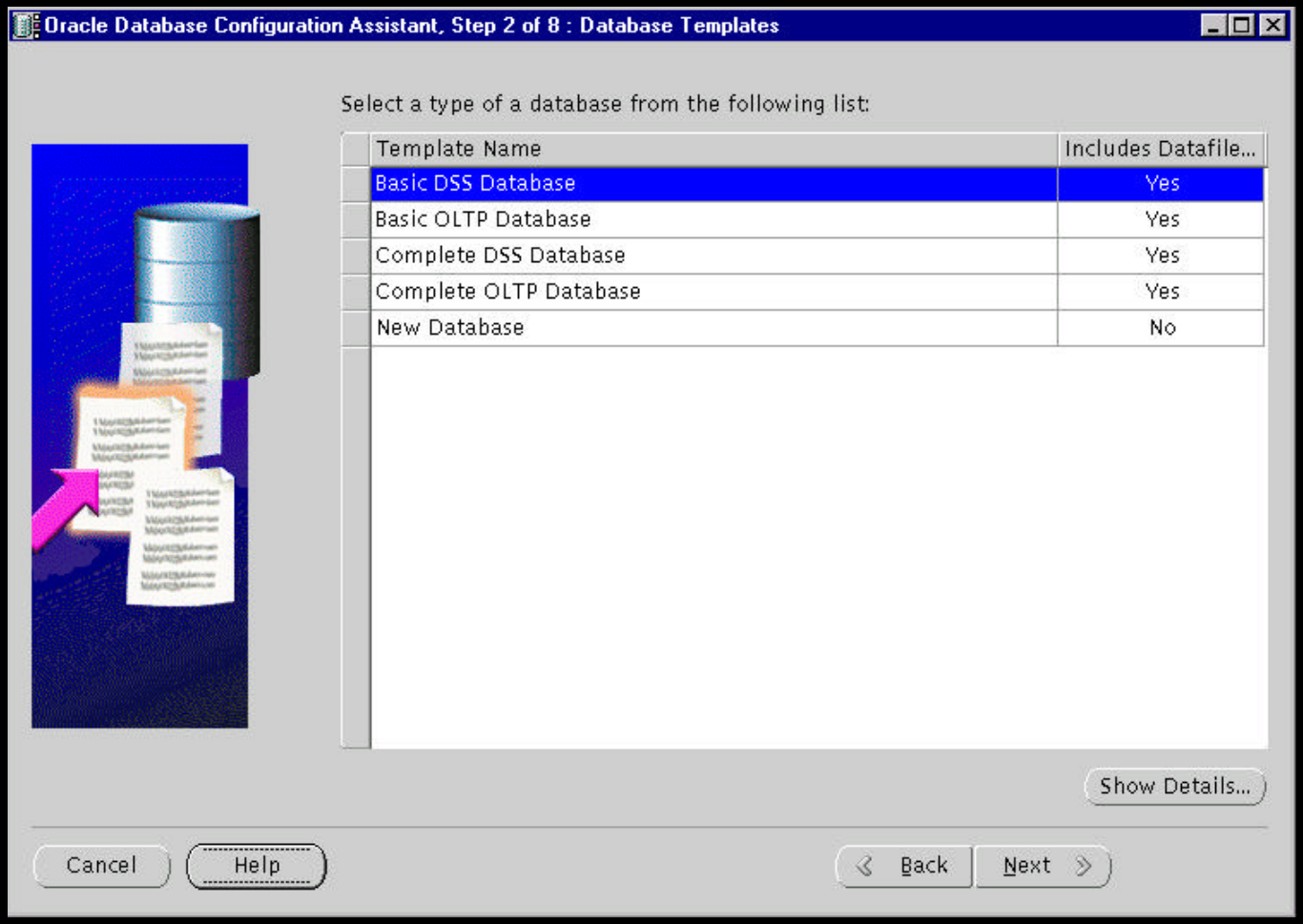
- ORACLE_BASE
- ORACLE_HOME
- ORACLE_SID
- ORA_NLS33
- PATH
- LD_LIBRARY_PATH

Using the Database Configuration Assistant

The Database Configuration Assistant allows you to:

- Create a database
- Configure database options
- Delete a database
- Manage templates
  - Create new template using pre-defined template settings
  - Create new template from an existing database
  - Delete database template

Create a Database



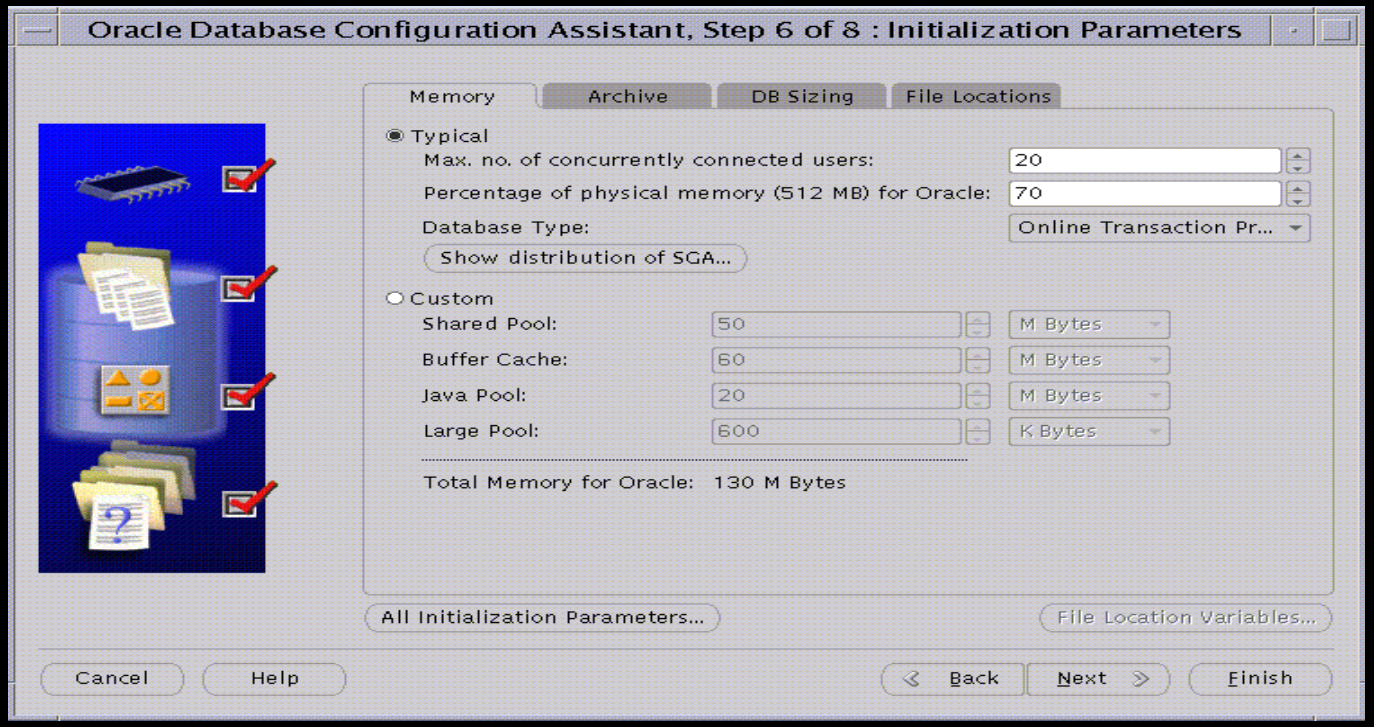
Database Information

Specify:

- Global database name and `SID`
- The features you want to use for your database, such as:
  - Oracle Spatial
  - Oracle OLAP Services
  - Example Schemas
- Mode in which you want the database to operate
  - Dedicated server mode
  - Shared server mode

Typical or Custom Install

Choose between typical or custom install



Other Parameters

- Archive Parameters
  - Use for database recovery
  - May also be used for a standby database
- Data Block Sizing
  - Sets the default database block size
  - Helps to determine the `SORT_AREA_SIZE`
- File Locations
  - Specify paths for trace files
  - Specify paths for parameter files
- Database storage
  - Specify storage parameters

Complete Database Creation

Complete database creation using the following options:

- Create database
- Save as a database template
- Generate database creation scripts

Creating a Database Manually

- Decide on a unique instance and database name
- Choose a database character set
- Set the operating system variables
- Edit / Create the initialization parameter file
- Start the instance (`nomount`)
- Execute the `CREATE DATABASE` command
- Run scripts to generate the data dictionary and accomplish post creation steps

Preparing the Parameter File

- Create the new `initSID.ora`

```
$ cp init.ora $ORACLE_HOME/dbs/initdb01.ora
```

- Modify the `initSID.ora` by editing the parameters

Creating SPFILE

Create the SPFILE from initSID.ora

```
CREATE SPFILE FROM PFILE;
```

Starting the Instance

- Connect as SYSDBA
- Start the instance in NOMOUNT stage

```
STARTUP NOMOUNT
```

Creating the Database

```
@crdbdb01.sql
SQL> create database db01
  2   logfile
  3     GROUP 1 ('/u01/oradata/db01/log_01_db01.rdo') SIZE 15M,
  4     GROUP 2 ('/u01/oradata/db01/log_02_db01.rdo') SIZE 15M,
  5     GROUP 3 ('/u01/oradata/db01/log_03_db01.rdo') SIZE 15M
  6   datafile '/u01/oradata/db01/system_01_db01.dbf' SIZE 100M
  7   undo tablespace UNDO
  8     datafile '/u01/oradata/db01/undo_01_db01.dbf' SIZE 40M
  9   default temporary tablespace TEMP
 10     tempfile '/u01/oradata/db01/temp_01_db01.dbf' SIZE 20M
 11     extent management local uniform size 128k
 12   character set AL32UTF8
 13   national character set AL16UTF16
 14   set time_zone = 'America/New_York'
 15  ;
```

Creating a Database Using OMF

- Define the OMF initialization parameters in the parameter file
  - DB_CREATE_FILE_DEST
  - DB_CREATE_ONLINE_DEST_*n*

```
STARTUP NOMOUNT
CREATE DATABASE
DEFAULT TEMPORARY TABLESPACE TEMP;
```

Troubeshooting

Creation of the database fails if:

- **There are syntax errors in the SQL script**
- **Files that should be created already exist**
- **Operating system errors such as file or directory permission or insufficient space errors occur**

After Database Creation

The database contains:

- Datafiles, control files, and redo log files
- User SYS with the password `change_on_install`
- User `SYSTEM` with the password `manager`
- Internal tables (but no data dictionary views)

Summary

In this lesson, you should have learned to:

- Identify the prerequisites required to create a database
- Create a database using the Oracle Database Configuration Assistant
- Create a database manually

5

Data Dictionary Contents and Usage

Objectives

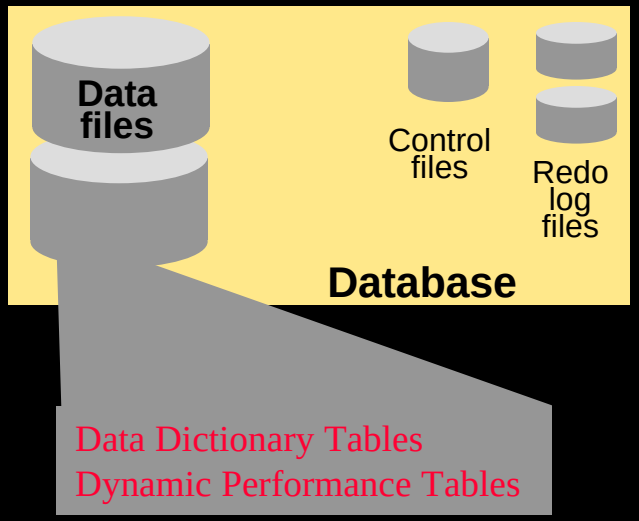
After completing this lesson, you should be able to do the following:

- Identify key data dictionary components
- Identify the contents and uses of the data dictionary
- Query the data dictionary

Data Dictionary

During database creation, the Oracle server creates additional object structures within the data files.

- Data dictionary tables
- Dynamic performance tables



Data Dictionary

The data dictionary is a set of read-only tables and views that record, verify, and provide information about its associated database.

- Describes the database and its objects
- Includes two types of objects:
  - Base tables
    - Store description of database
    - Created with `CREATE DATABASE`
  - Data Dictionary views
    - Summarize base table information
    - Created using `catalog.sql` script

Data Dictionary Contents

The data dictionary provides information about:

- Logical and physical database structure
- Definitions and space allocations of objects
- Integrity constraints
- Users
- Roles
- Privileges
- Auditing

How the Data Dictionary Is Used

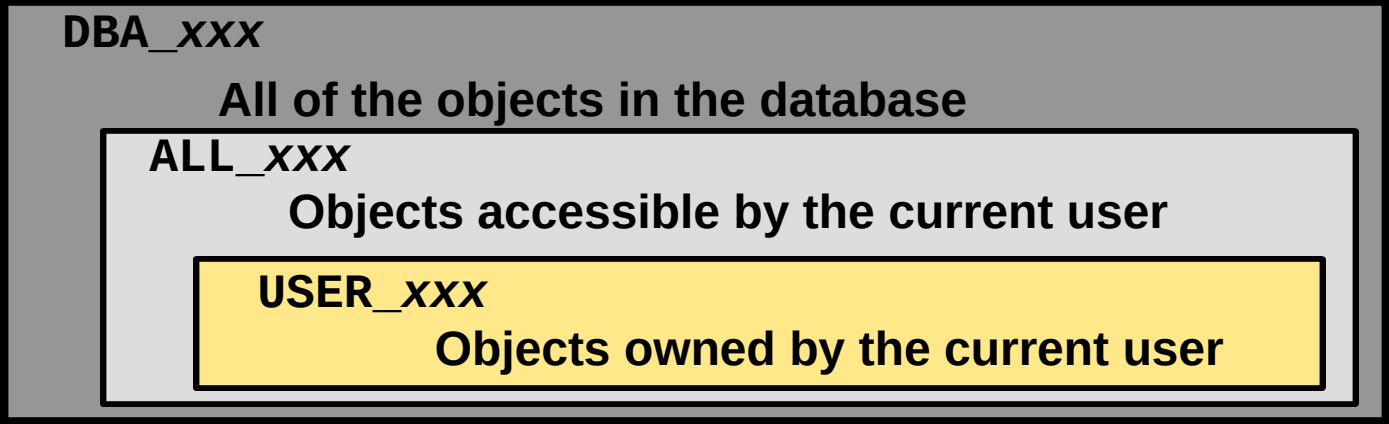
The data dictionary has three primary uses:

- The Oracle server uses it to find information about:
  - Users
  - Schema objects
  - Storage structures
- The Oracle server modifies it when a DDL statement is executed.
- Users and DBAs can use it as a read-only reference for information about the database.

Data Dictionary View Categories

The data dictionary consists of three main sets of static views distinguished from each other by their scope:

- **DBA**: What is in all the schemas
- **ALL**: What the user can access
- **USER**: What is in the user's schema



Dynamic Performance Tables

Dynamic performance views record current database activity.

- Views are continually updated while the database is operational
- Information is accessed from:
  - Memory
  - Control file
- DBA uses dynamic views to monitor and tune the database
- Dynamic views are owned by SYS user
- DML is not allowed

Querying the Data Dictionary and Dynamic Performance Views

Data dictionary and dynamic performance views can be queried for information.

- A listing of views available can be retrieved by querying the `DICTIONARY` view.
- A listing of the columns and its contents can be accessed using `DESCRIBE` and `SELECT`.
- Column comments are available to retrieve more insight into what a column content means within a particular view.

Data Dictionary Examples

- General Overview
  - `DICTIONARY, DICT_COLUMNS`
- Schema objects
  - `DBA_TABLES, DBA_INDEXES, DBA_TAB_COLUMNS, DBA_CONSTRAINTS`
- Space allocation
  - `DBA_SEGMENTS, DBA_EXTENTS`
- Database structure
  - `DBA_TABLESPACES, DBA_DATA_FILES`

Summary

In this lesson, you should have learned how to:

- Use the data dictionary views to get information about the database and instance
- Obtain information about data dictionary views from `DICTIONARY` and `DICT_COLUMNS`

Practice 5 Overview

This practice covers the following topics:

- Identify the components and contents of the data dictionary
- Query the data dictionary

6

Maintaining the Control File

Objectives

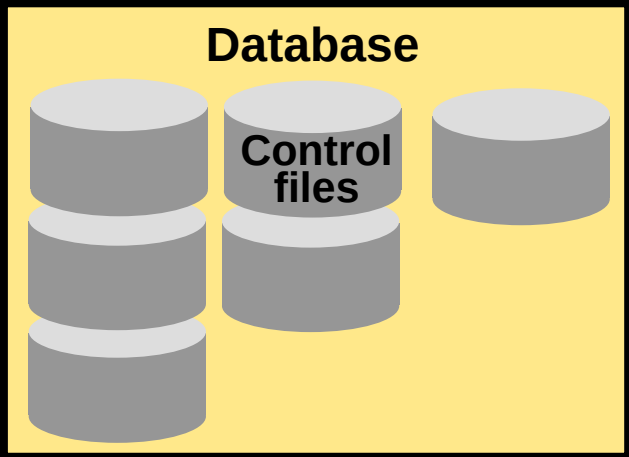
After completing this lesson, you should be able to do the following:

- Explain the uses of the control file
- List the contents of the control file
- Multiplex and manage the control file
- Manage the control file with Oracle Managed Files
- Obtain control file information

Control File

The control file is a binary file that defines the current state of the physical database..

- **Loss of the control file requires recovery**
- **Is read at `MOUNT` stage**
- **Is required to operate**
- **Is linked to a single database**
- **Should be multiplexed**
- **Maintains integrity of database**
- **Sized initially by `CREATE DATABASE`**



Control File Contents

A control file contains the following entries:

- Database name and identifier
- Time stamp of database creation
- Tablespace names
- Names and locations of data files and redo log files
- Current redo log file sequence number
- Checkpoint information
- Begin and end of undo segments
- Redo log archive information
- Backup information

Multiplexing the Control File Using SPFILE

- Alter the SPFILE

```
SQL> ALTER SYSTEM SET control files =
'$HOME/ORADATA/u01/ctrl01.ctl',
'$HOME/ORADATA/u02/ctrl02.ctl' SCOPE=SPFILE;
```

- Shutdown normal:

```
SQL> startup
```

- Create additional control files

```
$ cp $HOME/ORADATA/u01/ctrl01.ctl
     $HOME/ORADATA/u02/ctrl02.ctl
```

- Start the database:

```
SQL> startup
```

Multiplexing the Control File Using `init.ora`

- Shut down the database in a normal state:

```
SQL> shutdown normal
```

- Copy the existing control file to a new name and location:

```
$ cp control01.ctl .../DISK3/control02.ctl
```

- Add the new control file name to `init.ora`:

```
CONTROL_FILES = (/DISK1/control01.ctl,
                 /DISK3/control02.ctl)
```

- Start the database:

```
SQL> startup
```

Managing Control Files with OMF

- Control files are OMF created if the `CONTROL_FILES` parameter is not specified.
- OMF control files are located at `DB_CREATE_ONLINE_LOG_DEST_N`.
- Control file names are uniquely generated and displayed in the `alertSID.log` file when the files are created.

Obtaining Control File Information

Information about control file status and locations can be retrieved by querying the data dictionary.

- `V$CONTROLFILE`: Lists the name and status of all control files associated with the instance.
- `V$PARAMETER`: Lists status and location of all parameters.
- `V$CONTROLFILE_RECORD_SECTION`: Provides information about the control file record sections.
- `SHOW PARAMETERS CONTROL_FILES`: List the name, status, and location of the control files.

Summary

In this lesson, you should have learned how to:

- Multiplex the control file when using an `SPFILE`
- Multiplex the control file when using an `init.ora`
- Manage the control files using OMF

Practice 6 Overview

This practice covers the following topics:

- Starting the database without a control file
- Multiplexing an existing control file

7 Maintaining Redo Log Files

Objectives

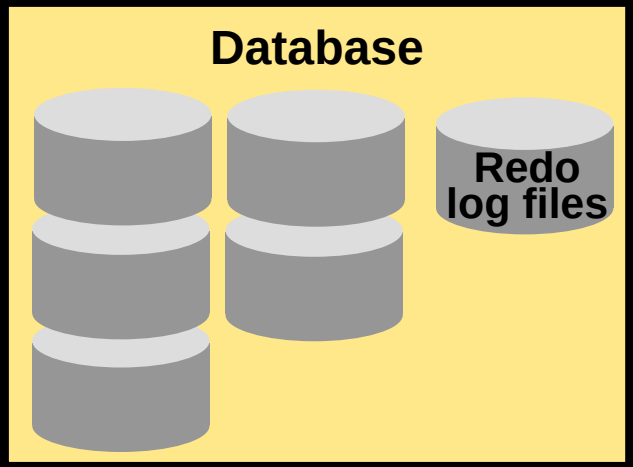
After completing this lesson, you should be able to do the following:

- Explain the purpose of online redo log files
- Outline the structure of online redo log files
- Control log switches and checkpoints
- Multiplex and maintain online redo log files
- Manage online redo logs files with OMF

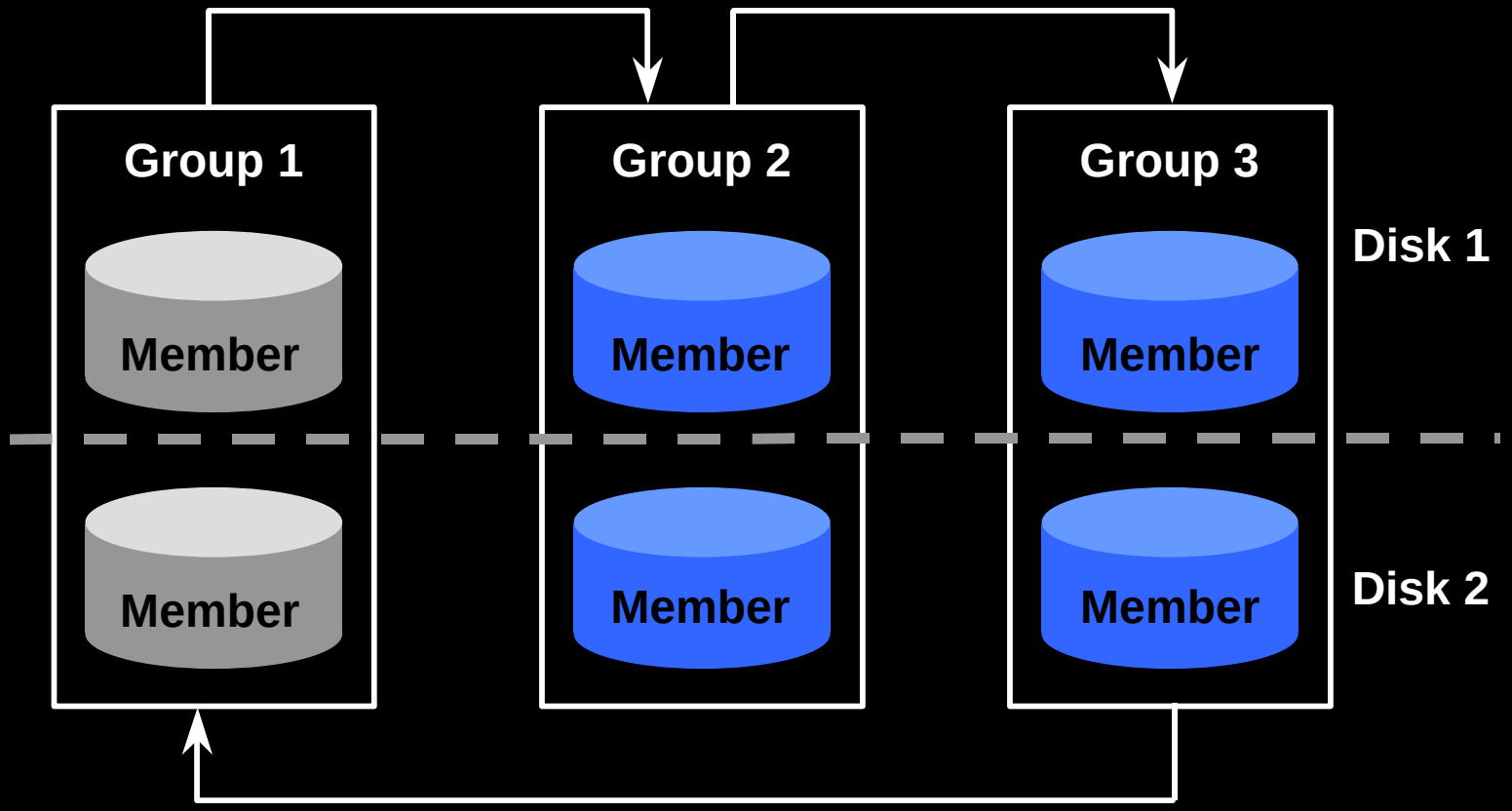
Using Redo Log Files

Redo log files record all changes made to data and provide a recovery mechanism from a system or media failure.

- Redo log files are organized into groups.
- An Oracle database requires at least two groups.
- Each redo log within a group is called a member.



Structure of Redo Log Files



How Redo Logs Work

- Redo logs are used in a cyclic fashion.
- When a redo log file is full, LGWR will move to the next log group.
  - This is called a log switch
  - Checkpoint operation also occurs
  - Information is written to the control file

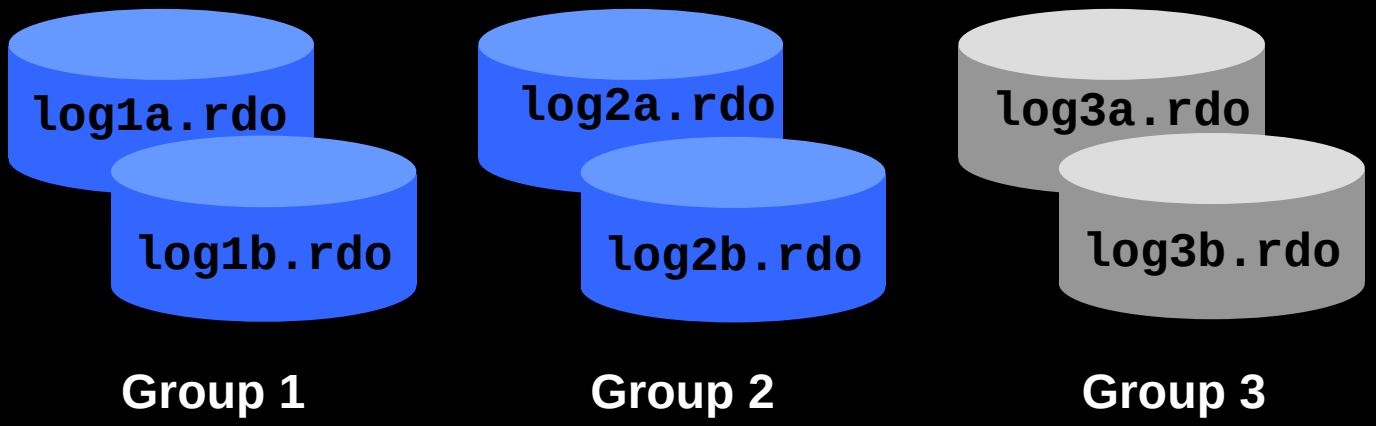
Forcing Log Switches and Checkpoints

- Log switches can be forced using the `ALTER SYSTEM SWITCH LOGFILE` command.
- Checkpoints can be forced using:
  - Setting `FAST_START_MTTR_TARGET` parameter
  - `ALTER SYSTEM CHECKPOINT` command

```
ALTER SYSTEM CHECKPOINT;
```

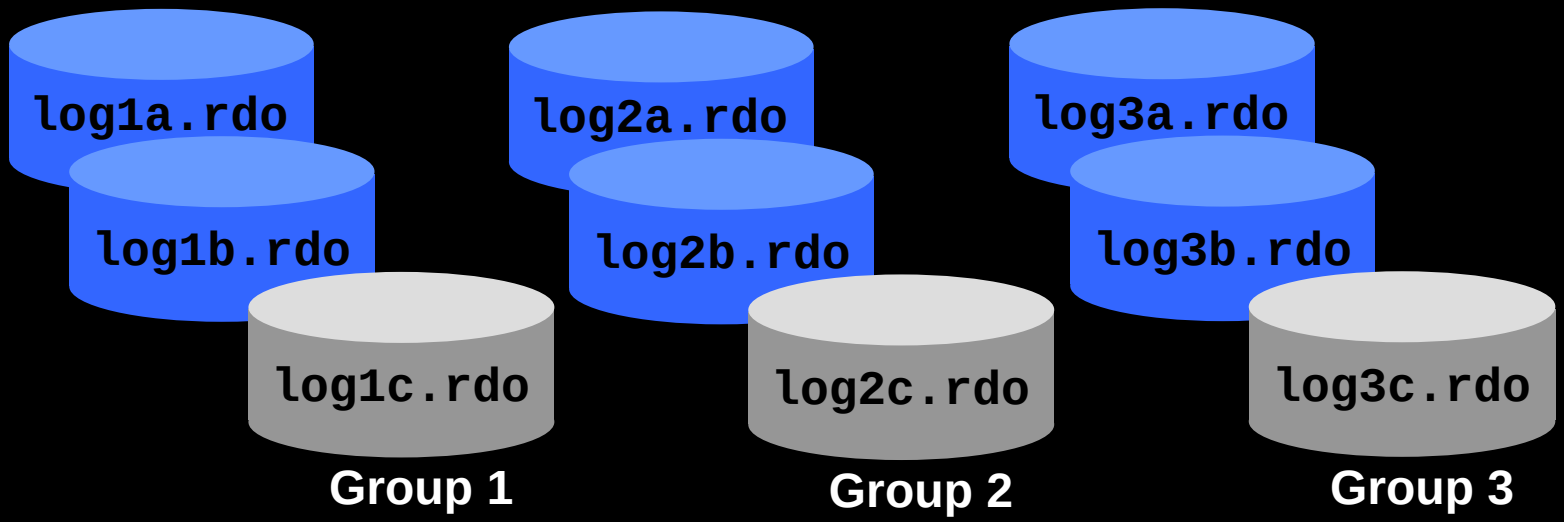
Adding Online Redo Log Groups

```
ALTER DATABASE ADD LOGFILE GROUP 3
('$HOME/ORADATA/u01/log3a.rdo',
 '$HOME/ORADATA/u02/log3b.rdo')
SIZE 1M;
```



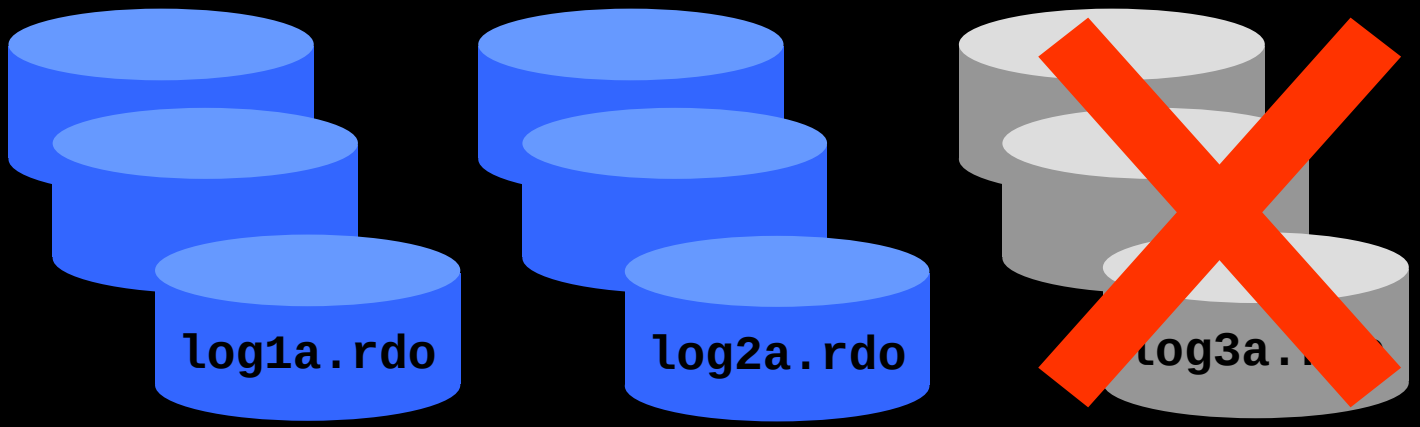
Adding Online Redo Log Members

```
ALTER DATABASE ADD LOGFILE MEMBER
'$HOME/ORADATA/u04/log1c.rdo' TO GROUP 1,
'$HOME/ORADATA/u04/log2c.rdo' TO GROUP 2,
'$HOME/ORADATA/u04/log3c.rdo' TO GROUP 3;
```



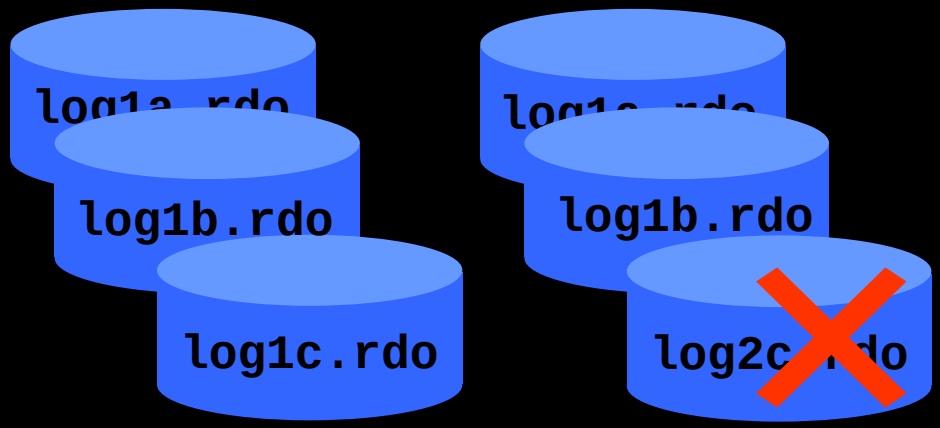
Dropping Online Redo Log Groups

```
ALTER DATABASE DROP LOGFILE GROUP 3;
```



Dropping Online Redo Log Members

```
ALTER DATABASE DROP LOGFILE MEMBER
'$HOME/ORADATA/u04/log3c.rdo';
```



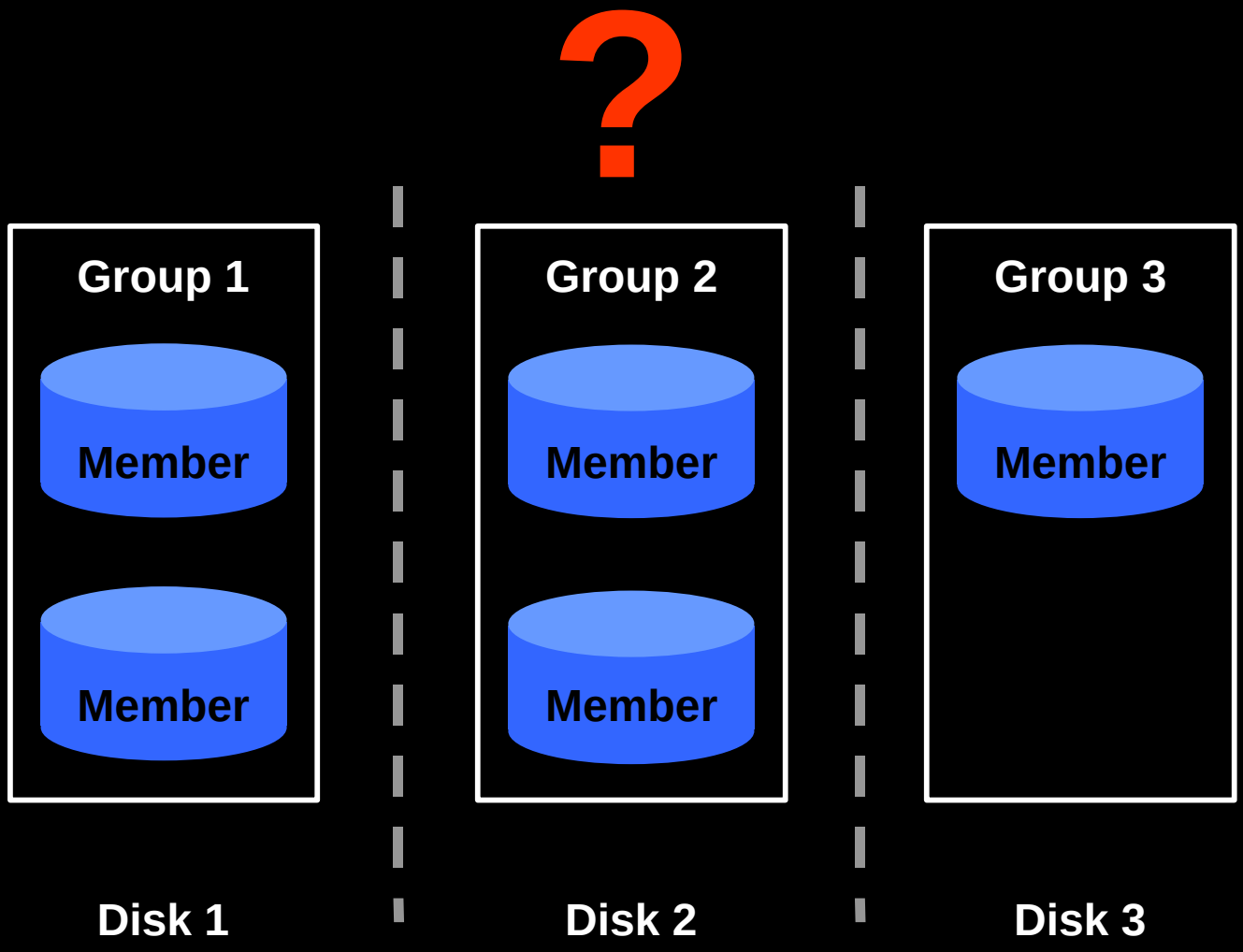
Clearing, Relocating, or Renaming Online Redo Log Files

- Clearing online redo log files:

```
ALTER DATABASE CLEAR LOGFILE
'$HOME/ORADATA/u01/log2a.rdo';
```

- Relocating or renaming online redo log files can be accomplished by adding new members and dropping old members.

Online Redo Log Configuration



Managing Online Redo Logs with OMF

- A complete group can be added with no file specification:

```
ALTER DATABASE ADD LOGFILE;
```

- If a group is dropped, all the corresponding OMF files are deleted at the OS level:

```
ALTER DATABASE DROP LOGFILE GROUP 3;
```

Obtaining Group and Member Information

Information about group and members can be obtained by querying the data dictionary.

- V$LOG
- V$LOGFILE

Archived Redo Log Files

Filled online redo log files can be archived.

- Two advantages exist to archiving redo logs:
  - Recovery: A database backup, together with online and archived redo log files can guarantee recovery of all committed transactions.
  - Backup: Can be performed while the database is open.
- By default a database is created in `NOARCHIVELOG` mode.

Archived Redo Log Files

- Archiving redo log files is accomplished by ARCn (Archiver) or manually through SQL statements.
- An entry in the control file recording the archive log name, log sequence number, and high and low SCN number is made whenever a redo log is successfully archived.
- A filled redo log file cannot be reused until a checkpoint has taken place and the redo log file has been backed up the ARCn process.
- Archived redo log files can be multiplexed.
- Archived redo log files must be maintained by the DBA.

Summary

In this lesson, you should have learned how to:

- Explain the use of online redo log files
- Obtain redo log information
- Control log switches and checkpoints
- Multiplex and maintain online redo log files
- Manage online redo log files with OMF

Practice 7 Overview

This practice covers the following topics:

- Creating and adding redo log file groups and members.
- Dropping redo log file groups and members.

8

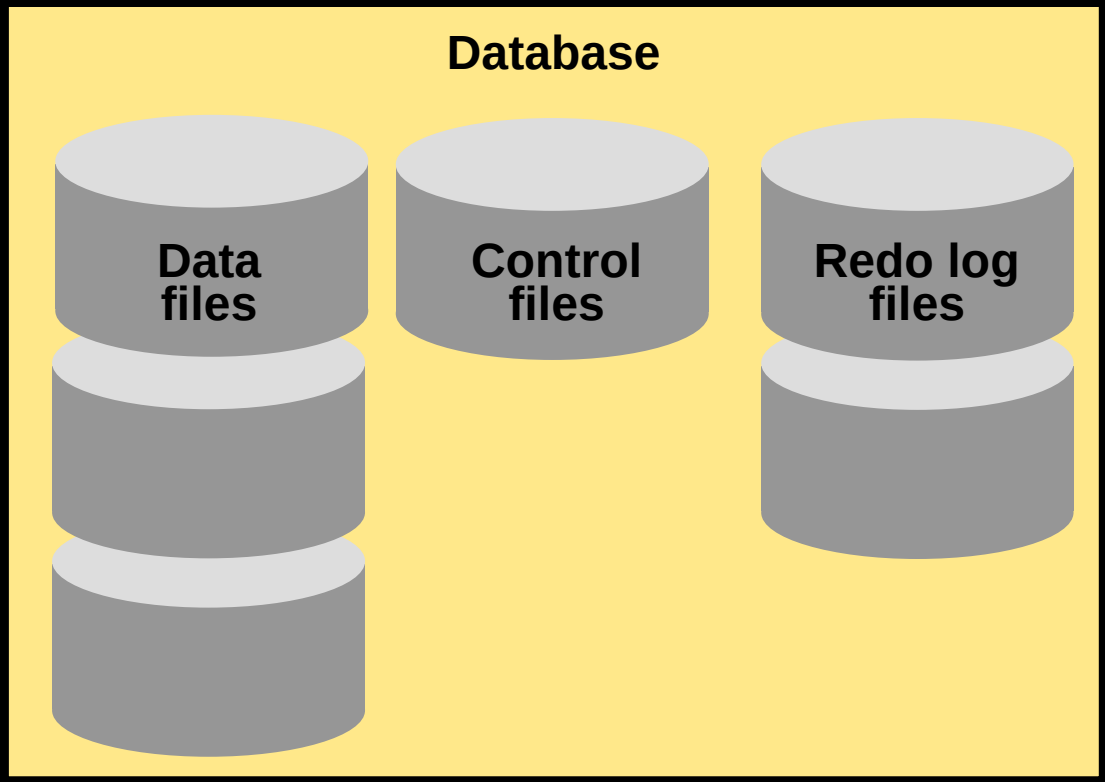
Managing Tablespaces and Data files

Objectives

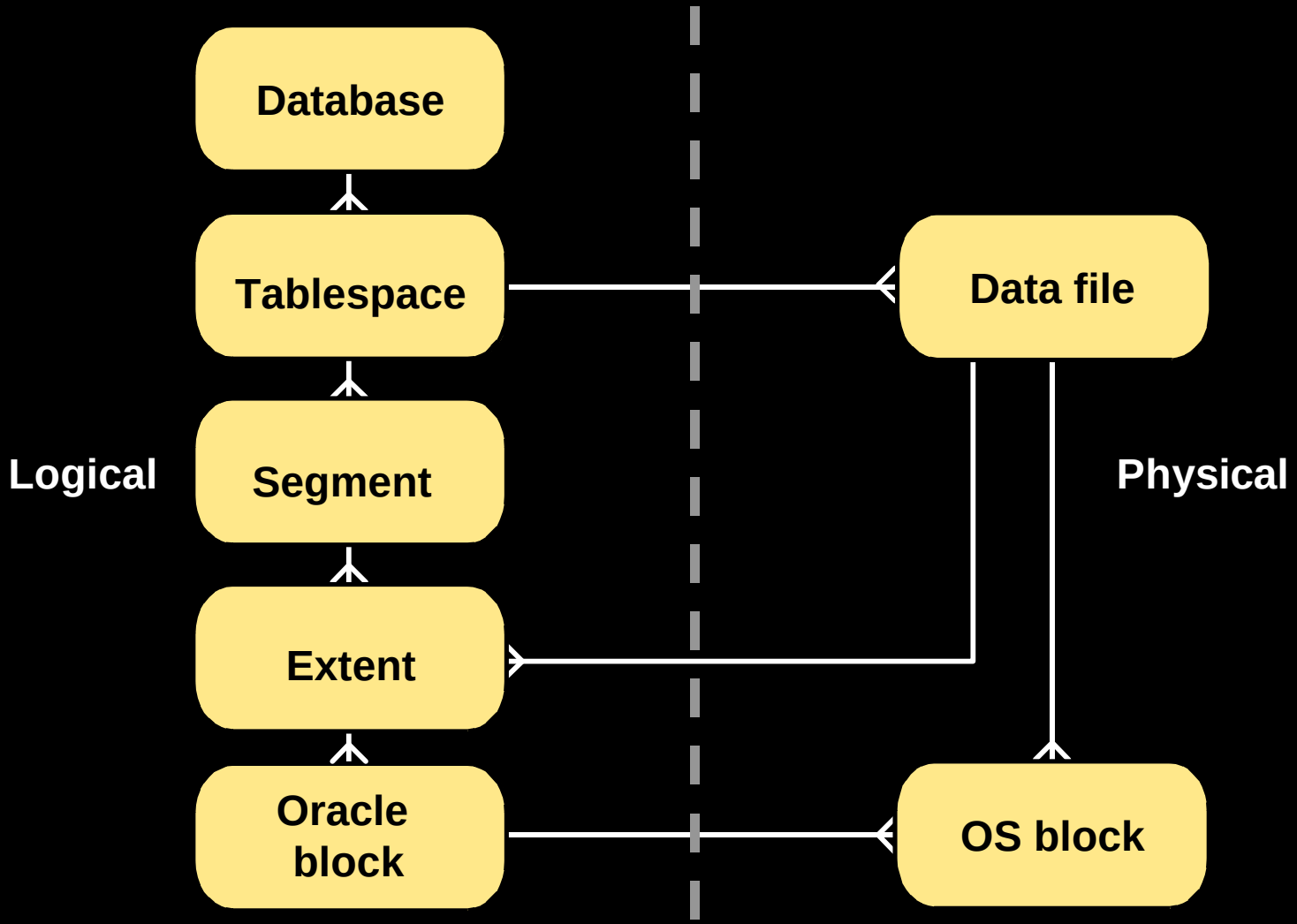
After completing this lesson, you should be able to do the following:

- Describe the logical structure of the database
- Create tablespaces
- Change the size of tablespaces
- Allocate space for temporary segments
- Change the status of tablespaces
- Change the storage settings of tablespaces
- Implement Oracle Managed Files

Overview



Database Storage Hierarchy



SYSTEM and Non-SYSTEM Tablespaces

- SYSTEM tablespace:
  - Created with the database
  - Contains the data dictionary
  - Contains the SYSTEM undo segment
- Non-SYSTEM tablespaces:
  - Separate segments
  - Ease space administration
  - Control amount of space allocated to a user

Creating Tablespaces

```
CREATE TABLESPACE userdata
   DATAFILE '/u01/oradata/userdata01.dbf' SIZE 100M
   AUTOEXTEND ON NEXT 5M MAXSIZE 200M;
```

Space Management in Tablespaces

- **Locally managed tablespaces:**
  - **Free extents recorded in bitmap**
  - **Each bit corresponds to a block or group of blocks**
  - **Bit value indicates free or used**
- **Dictionary-managed tablespaces:**
  - **Default method**
  - **Free extents recorded in data dictionary tables**

Locally Managed Tablespaces

```
CREATE TABLESPACE userdata
  DATAFILE '/u01/oradata/userdata01.dbf' SIZE 500M
  EXTENT MANAGEMENT LOCAL UNIFORM SIZE 256K;
```

- Reduced contention on data dictionary tables
- No undo generated when space allocation or deallocation occurs
- No coalescing required

Dictionary Managed Tablespaces

```
CREATE TABLESPACE userdata
  DATAFILE '/u01/oradata/userdata01.dbf' SIZE 500M
  EXTENT MANAGEMENT DICTIONARY
  DEFAULT STORAGE ( initial 1M NEXT 1M );
```

- Extents are managed in the data dictionary
- Each segment stored in the tablespace can have a different storage clause
- Coalescing required

Changing the Storage Settings

```
ALTER TABLESPACE userdata
  MINIMUM EXTENT 2M;
```

```
ALTER TABLESPACE userdata
  DEFAULT STORAGE (
    INITIAL    2M
    NEXT       2M
    MAXEXTENTS 999 );
```

Undo Tablespace

- Used to store undo segments
- Cannot contain any other objects
- Extents are locally managed
- Can only use the `DATAFILE` and `EXTENT MANAGEMENT` clauses of the `CREATE TABLESPACE` command

```
CREATE UNDO TABLESPACE undo1
  DATAFILE '/u01/oradata/undo101.dbf' SIZE 40M;
```

Temporary Tablespace

- Used for sort operations
- Cannot contain any permanent objects
- Locally managed extents recommended

```
CREATE TEMPORARY TABLESPACE temp
  TEMPFILE '/u01/oradata/temp01.dbf' SIZE 500M
  EXTENT MANAGEMENT LOCAL UNIFORM SIZE 10M;
```

Default Temporary Tablespace

- Allows you to specify a databasewide default temporary tablespace
- Eliminates the use of the `SYSTEM` tablespace for storing temporary data
- Can be created using the `CREATE DATABASE` or `ALTER DATABASE` command.
- When created with the `CREATE DATABASE` command, the default temporary tablespace is locally managed

Restrictions on Default Temporary Tablespace

- It cannot be dropped until after a new default is made available.
- It cannot be taken offline.
- You cannot alter the default temporary tablespace to a permanent tablespace.

Offline Status

- Offline tablespace is not available for data access.
- Some tablespaces must be online:
  - SYSTEM
  - Tablespaces with active undo segments
  - Default temporary
- To take a tablespace offline:

```
ALTER TABLESPACE userdata OFFLINE;
```

- To bring a tablespace online:

```
ALTER TABLESPACE userdata ONLINE;
```

Read-Only Tablespaces

```
ALTER TABLESPACE userdata READ ONLY;
```

- Tablespace available only for read operations
- Objects can be dropped from tablespace
- To create a read-only tablespace on a removable media drive:
  - ALTER TABLESPACE…READ ONLY;
  - Move the data file to the WORM drive
  - ALTER TABLESPACE…RENAME DATAFILE…;

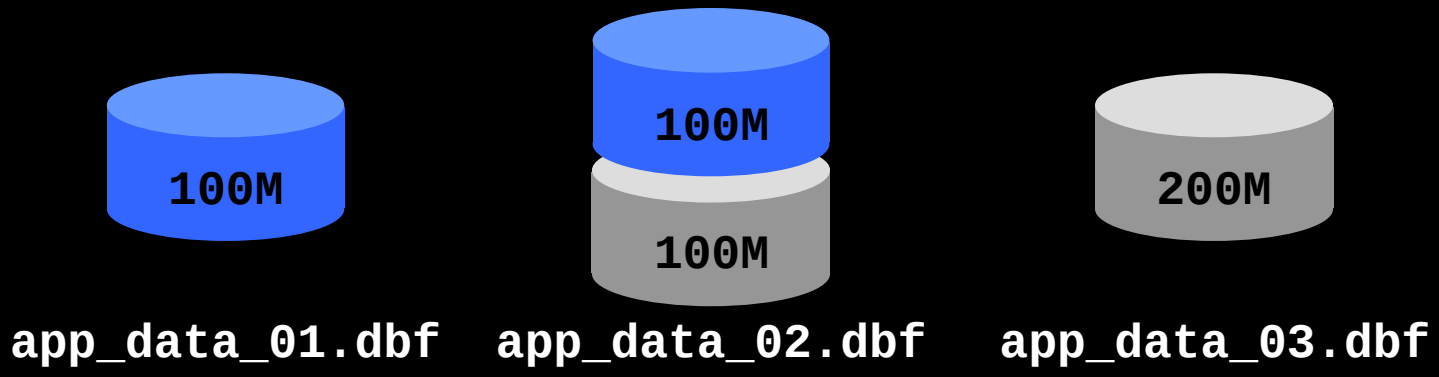
Dropping Tablespaces

- Tablespace removed from data dictionary
- Optionally, contents removed from data dictionary
- OS files can be deleted with the optional `AND DATAFILES` clause:

```
DROP TABLESPACE userdata
   INCLUDING CONTENTS AND DATAFILES;
```

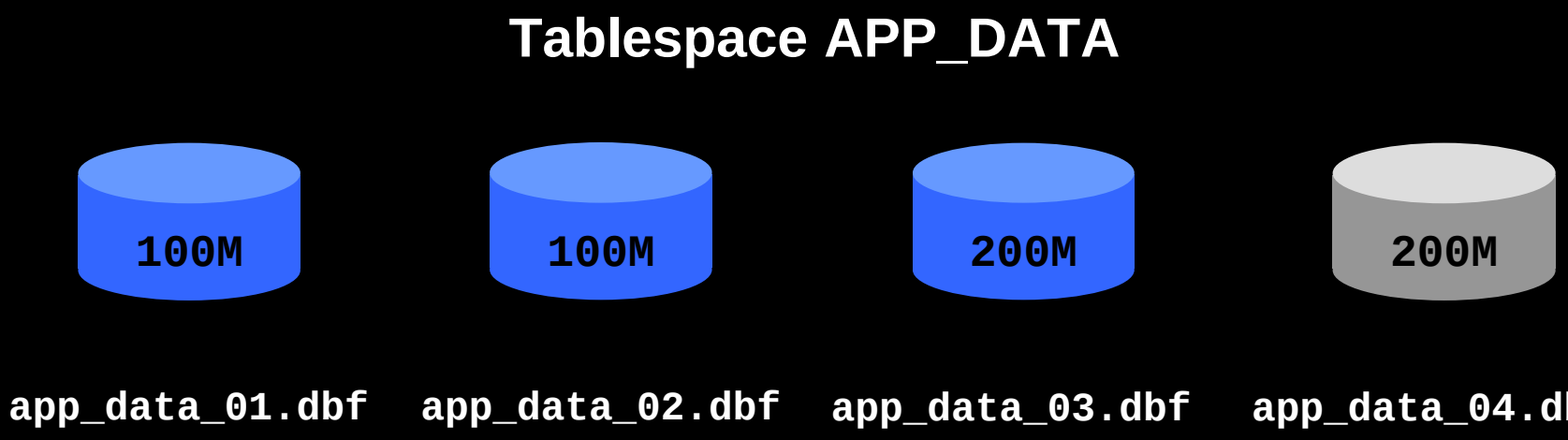
Resizing a Tablespace

- Add a data file
- Change the size of a data file:
  - Automatically
  - Manually



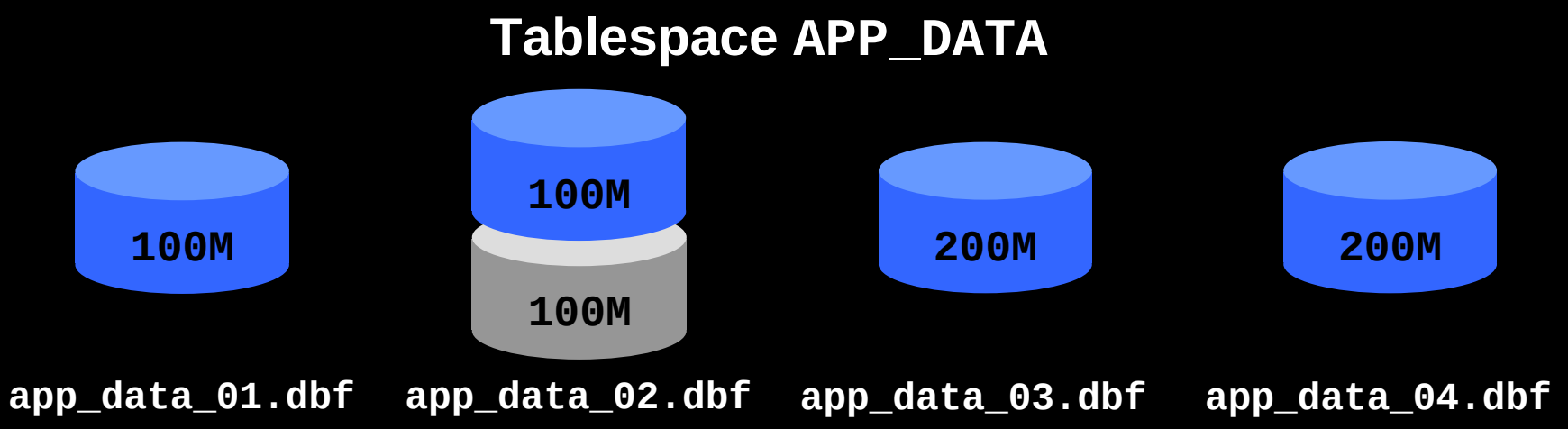
Enabling Automatic Extension of Data Files

```
ALTER DATABASE DATAFILE
  '/u01/oradata/userdata02.dbf' SIZE 200M
  AUTOEXTEND ON NEXT 10M MAXSIZE 500M;
```



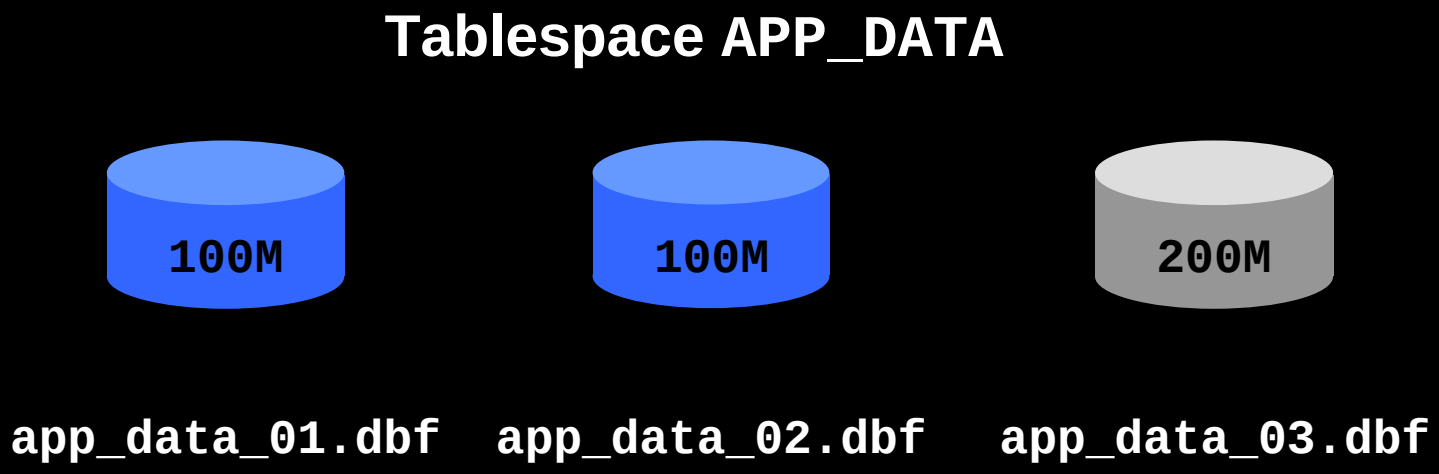
Changing the Size of Data Files Manually

```
ALTER DATABASE
   DATAFILE '/u03/oradata/userdata02.dbf'
   RESIZE 200M;
```



Adding Data Files to a Tablespace

```
ALTER TABLESPACE app_data
   ADD DATAFILE '/u01/oradata/userdata03.dbf'
   SIZE 200M;
```



Moving Data Files: ALTER TABLESPACE

- The tablespace must be offline.
- The target data files must exist.

```
ALTER TABLESPACE userdata
  RENAME
    DATAFILE   '/u01/oradata/userdata01.dbf'
    TO         '/u01/oradata/userdata01.dbf';
```

Moving Data Files: ALTER DATABASE

- The database must be mounted.
- The target data file must exist.

```
ALTER DATABASE RENAME
   FILE '/u01/oradata/system01.dbf'
     TO '/u03/oradata/system01.dbf';
```

Configuring Oracle Managed Files for Tablespace Creation

- Creating a tablespace with OMF requires the configuration of one initialization parameter.
- `DB_CREATE_FILE_DEST`: Set to give the default location for data files.
- The initialization parameter can be set in an initialization file or set dynamically with the `ALTER SYSTEM` command:

```
ALTER SYSTEM SET
 db_create_file_dest = '/u01/oradata/db01';
```

Creating Tablespaces with OMF

- With OMF configured the `DATAFILE` clause of the `CREATE TABLESPACE` command is not required.

```
CREATE TABLESPACE apps2_data DATAFILE SIZE 20M;
```

- The data file is created in the file system specified by `DB_CREATE_FILE_DEST`.
- By default files are 100M in size and set to autoextend with an unlimited restriction.
- When the tablespace is dropped, all files are also deleted at the OS level.
- An OMF can be added to an existing tablespace.

Obtaining Tablespace Information

- Tablespace information:
  - DBA_TABLESPACES
  - V$TABLESPACE
- Data file information:
  - DBA_DATA_FILES
  - V$DATAFILE
- Temp file information:
  - DBA_TEMP_FILES
  - V$TEMPFILE

Summary

In this lesson, you should have learned how to:

- Use tablespaces to separate data
- Resize tablespaces by:
  - Adding data files
  - Extending data files
- Use locally managed tablespaces
- Use temporary tablesapces
- Implement Oracle Managed Files

Practice 8 Overview

This practice covers the following topics:

- Creating tablespaces
- Modifying tablespaces
- Configuring and creating a tablespace with OMF

9

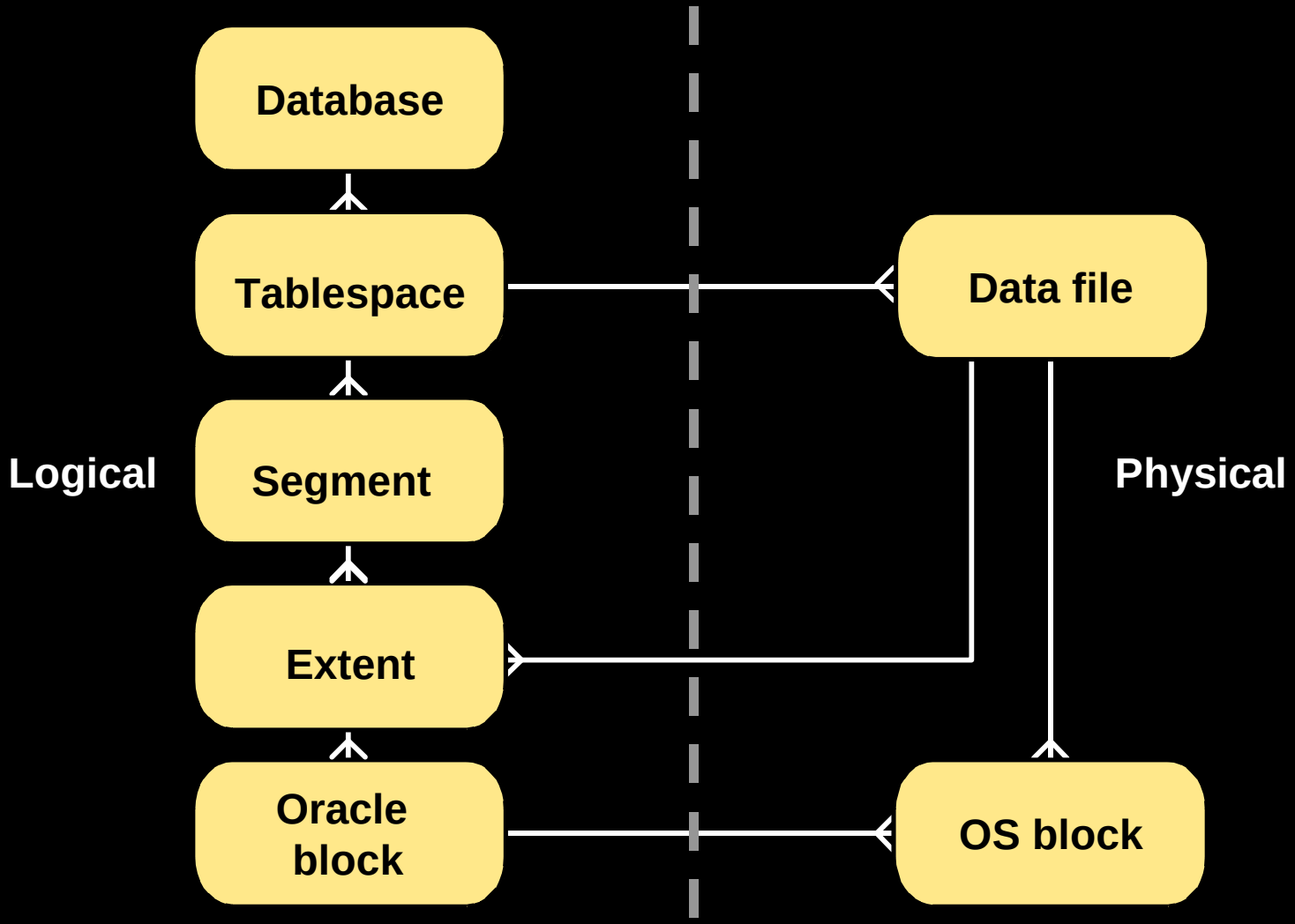
Storage Structure and Relationships

Objectives

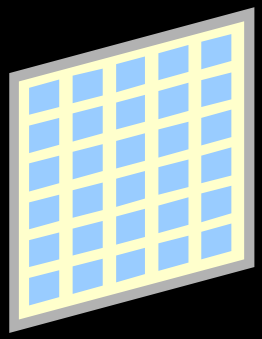
After completing this lesson, you should be able to do the following:

- Describe the logical structure of the database
- List the segment types and their uses
- List the keywords that control block space usage
- Obtain information about storage structures from the data dictionary
- List the criteria for separating segments

Overview



Types of Segments



Table

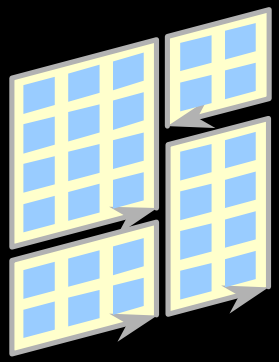
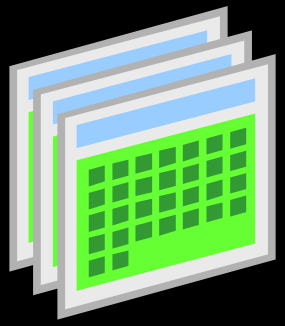
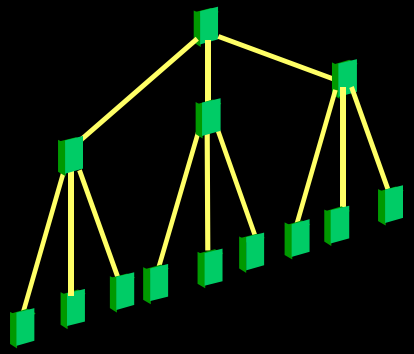


Table partition

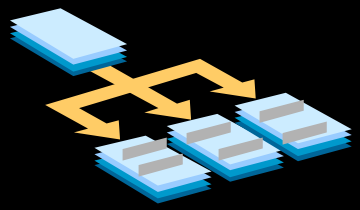


Cluster

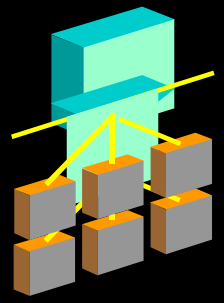


Index

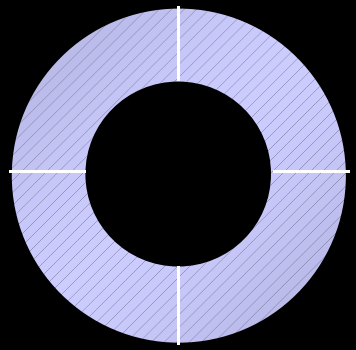
Types of Segments



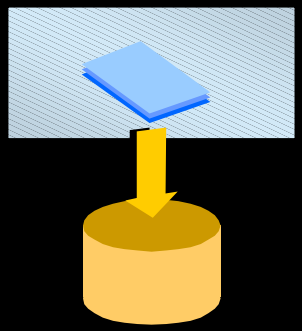
Index-organized table



Index partition

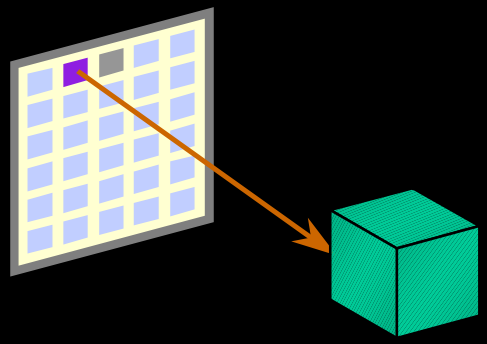


Undo segment



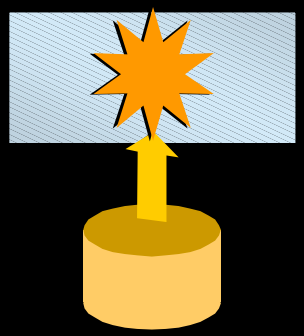
Temporary segment

Types of Segments



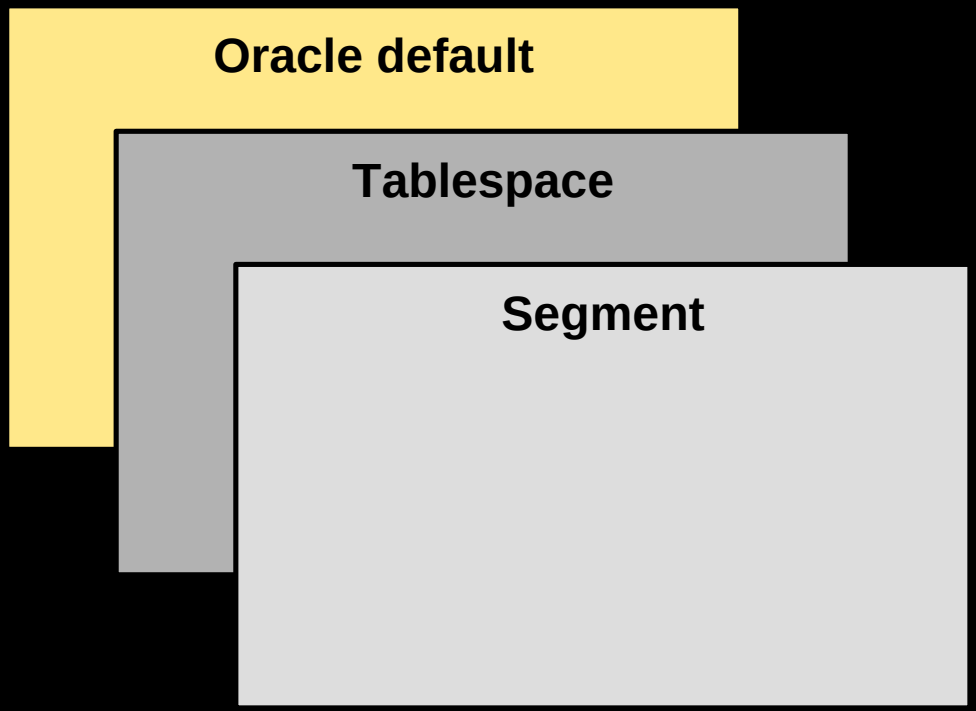
LOB segment

Nested table



Bootstrap segment

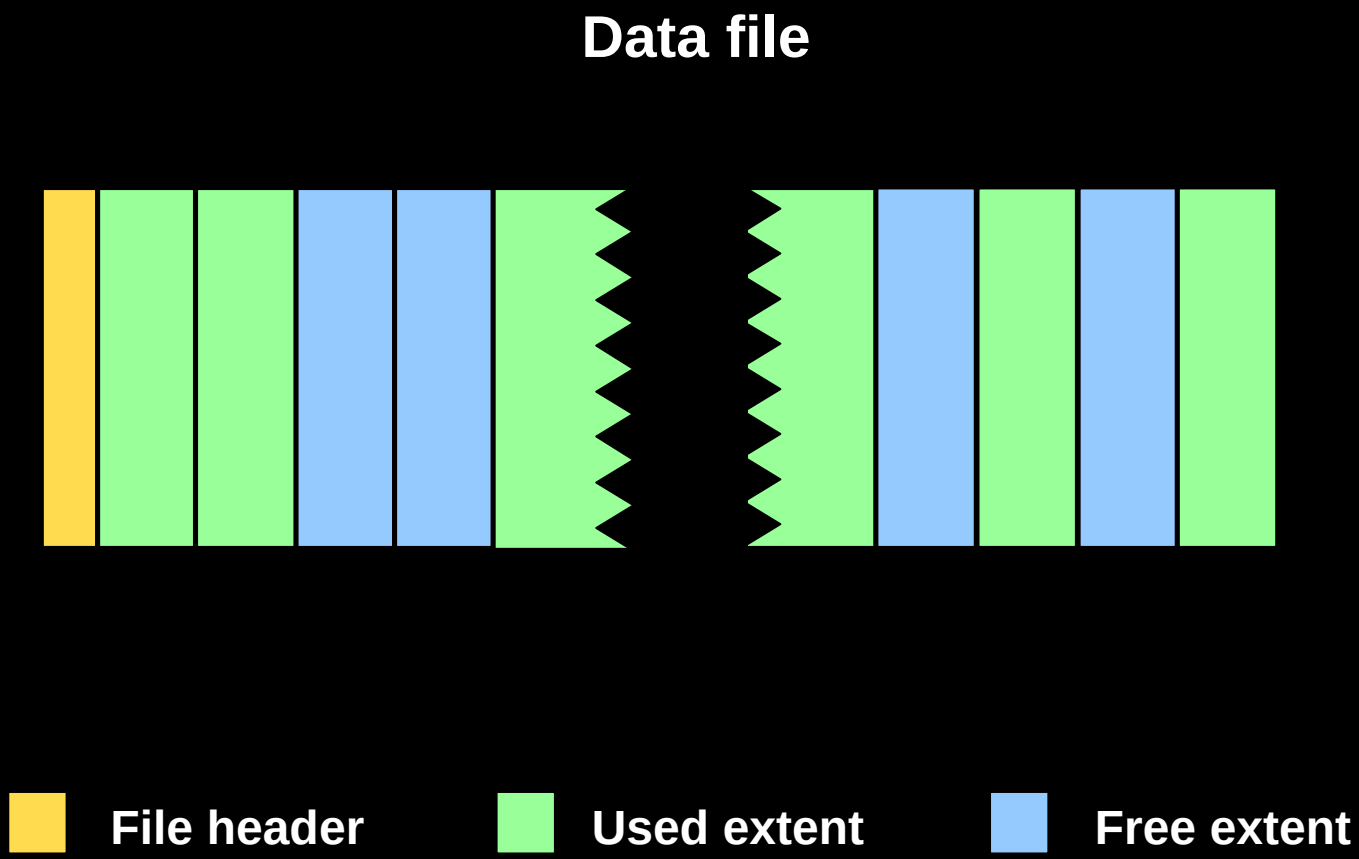
Storage Clause Precedence



Extent Allocation and Deallocation

- Allocated when the segment is:
  - Created
  - Extended
  - Altered
- Deallocated when the segment is:
  - Dropped
  - Altered
  - Truncated

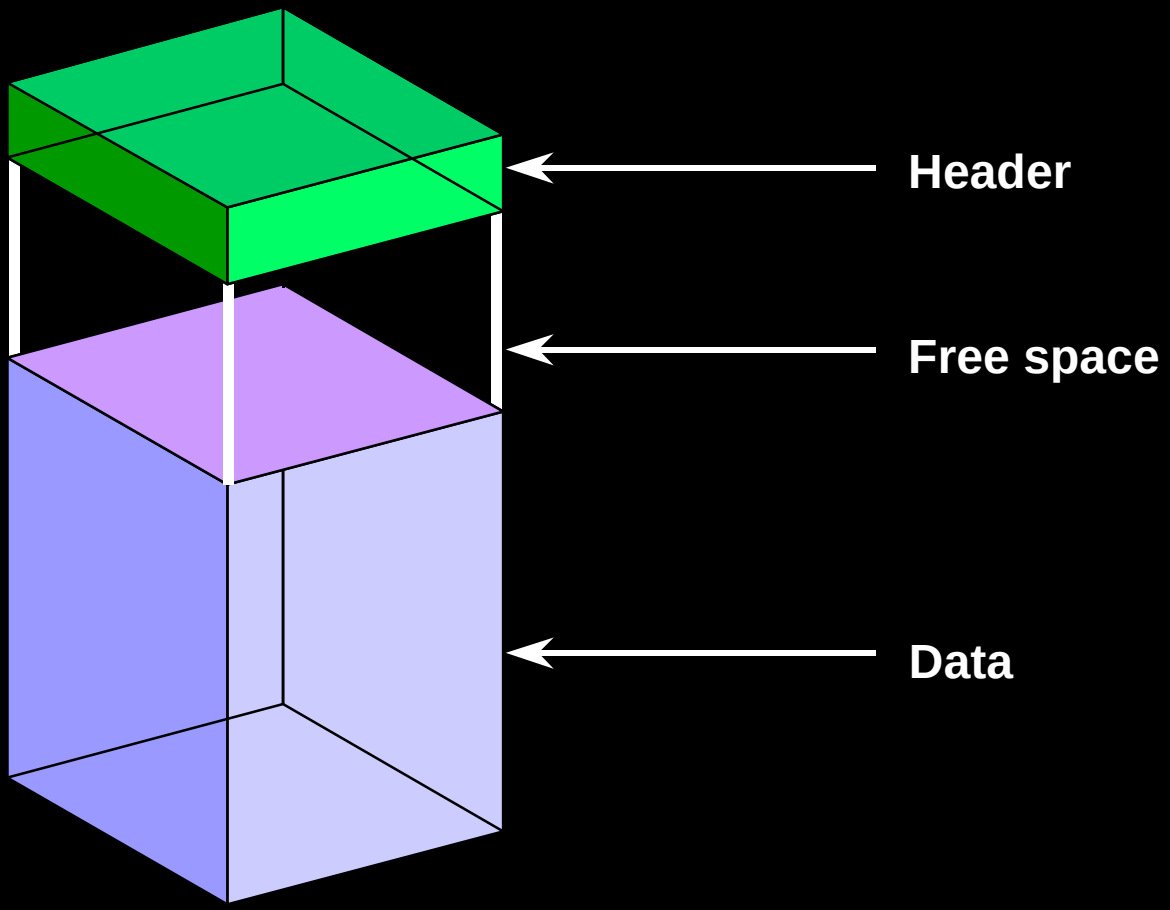
Used and Free Extents



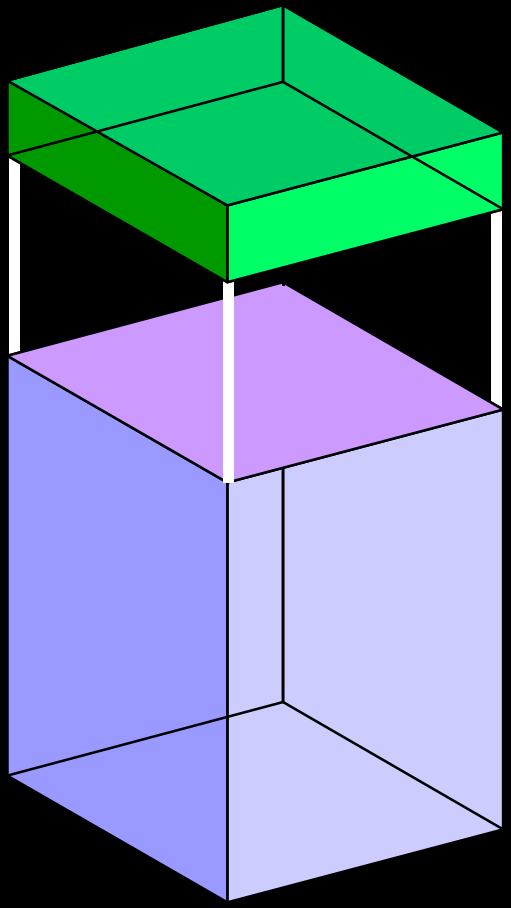
Database Block

- Minimum unit of I/O
- Consists of one or more OS blocks
- Set at tablespace creation
- `DB_BLOCK_SIZE` is the default block size

Database Block Contents



Block Space Utilization Parameters



INITRANS

MAXTRANS

PCTFREE

PCTUSED

Data Block Management

Two methods are available for managing data blocks:

- Automatic Segment-Space Management
- Manual Configuration

Automatic Segment-Space Management

- It is method of managing free space inside database segments
- Tracking in-segment free and used space is done using bitmaps as opposed to free lists
- This method provides:
  - Ease of management
  - Better space utilization
  - Better performance for concurrent INSERT operations
- Restriction: Can not be used for tablespaces which will contain LOBs.

Automatic Segment-Space Management

- Bitmap segments contain a bitmap that describes the status of each block in the segment with respect to its available space.
- The map is contained in a separate set of blocks referred to as bitmapped blocks (BMBs).
- When inserting a new row, the server searches the map for a block with sufficient space.
- As the amount of space available in a block changes, its new state is reflected in the bitmap.

Configuring Automatic Segment-Space Management

- Automatic segment-space management can be enabled at the tablespace level only, for locally managed tablespaces.

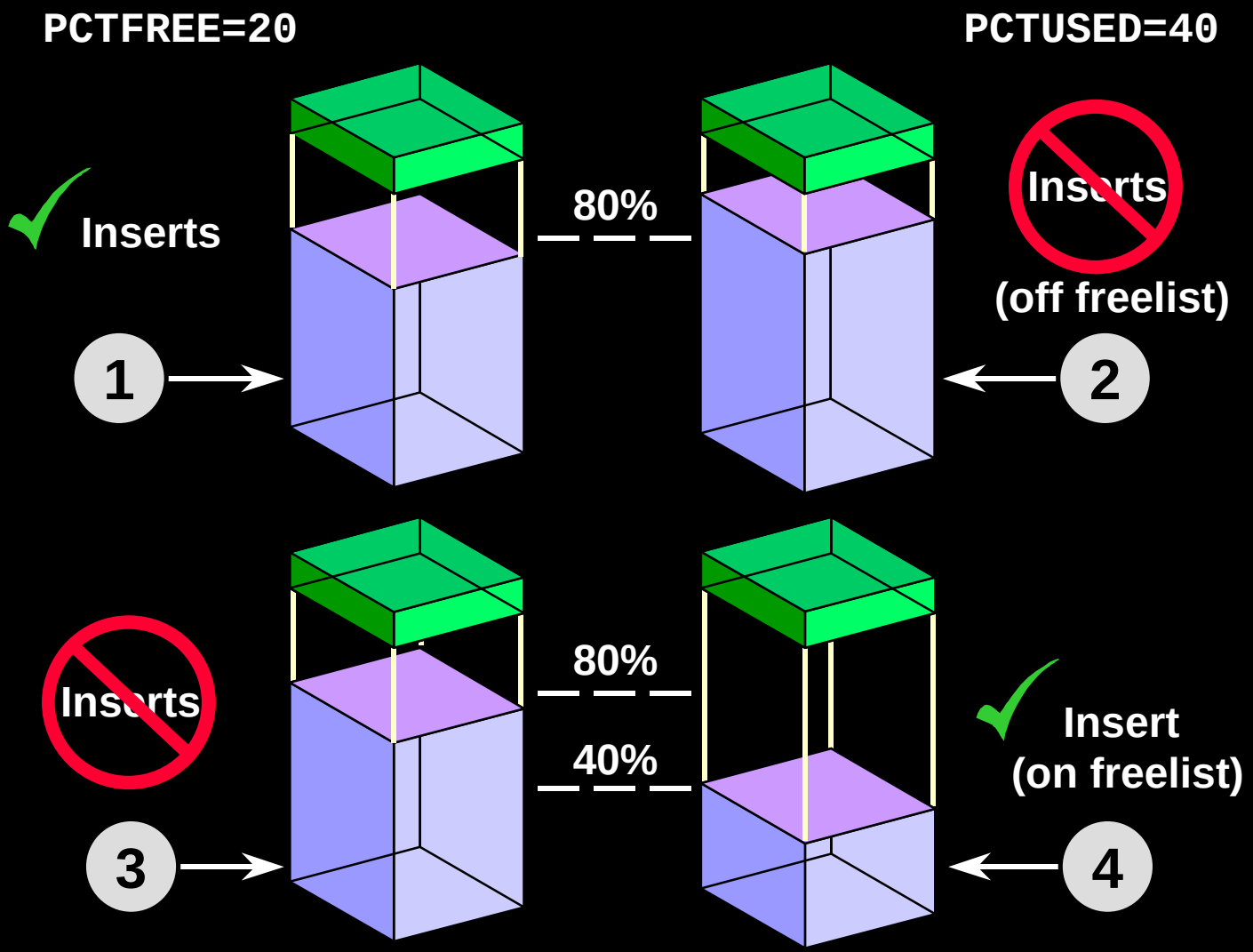
```
CREATE TABLESPACE data02
DATAFILE '/u01/oradata/data02.dbf' SIZE 5M
EXTENT MANAGEMENT LOCAL UNIFORM SIZE 64K
SEGMENT SPACE MANAGEMENT AUTO;
```

- After a tablespace is created, the specifications apply to all segments created in the tablespace.

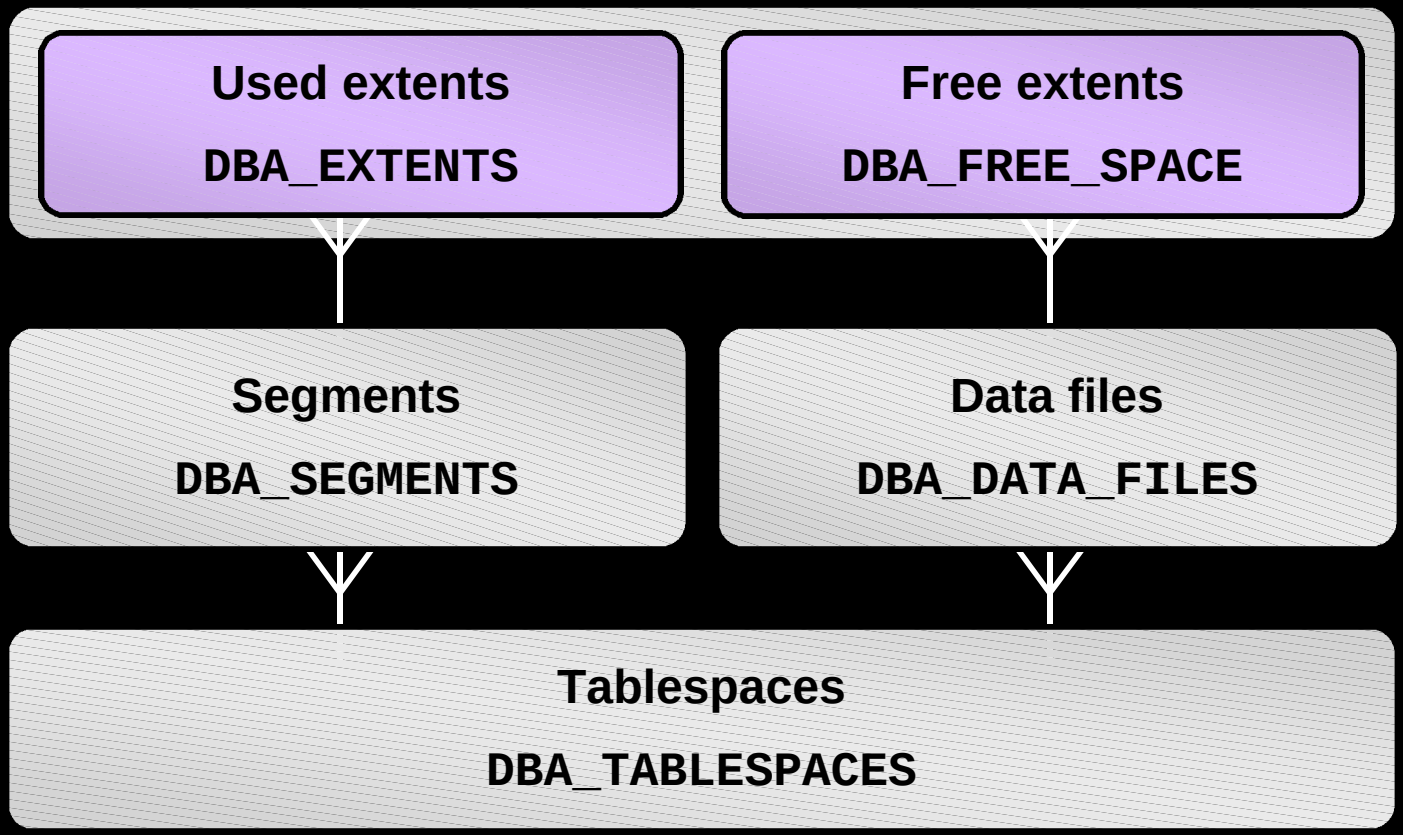
Manual Data Block Management

- Allows you to configure data blocks manually using parameters such as:
  - `PCTFREE`
  - `PCTUSED`
  - `FREELIST`
- Only method available in previous Oracle versions

Block Space Usage



Data Dictionary Views



Obtaining Storage Information

- Data Dictionary Views
  - DBA_TABLESPACES
  - DBA_DATA_FILES
  - DBA_SEGMENTS
  - DBA_EXTENTS
  - DBA_FREE_SPACE

Summary

In this lesson, you should have learned how to:

- Use tablespaces to:
  - Separate segments to ease administration
  - Control user's space allocation
- Categorize segments by the type of information stored in the segment
- Determine extent sizes using the storage clause
- Control block space utilization

Practice 9 Overview

This practice covers the following topics:

- Creating an `SPFILE`
- Starting up and shutting down the database in different modes

10

Managing Undo Data

Objectives

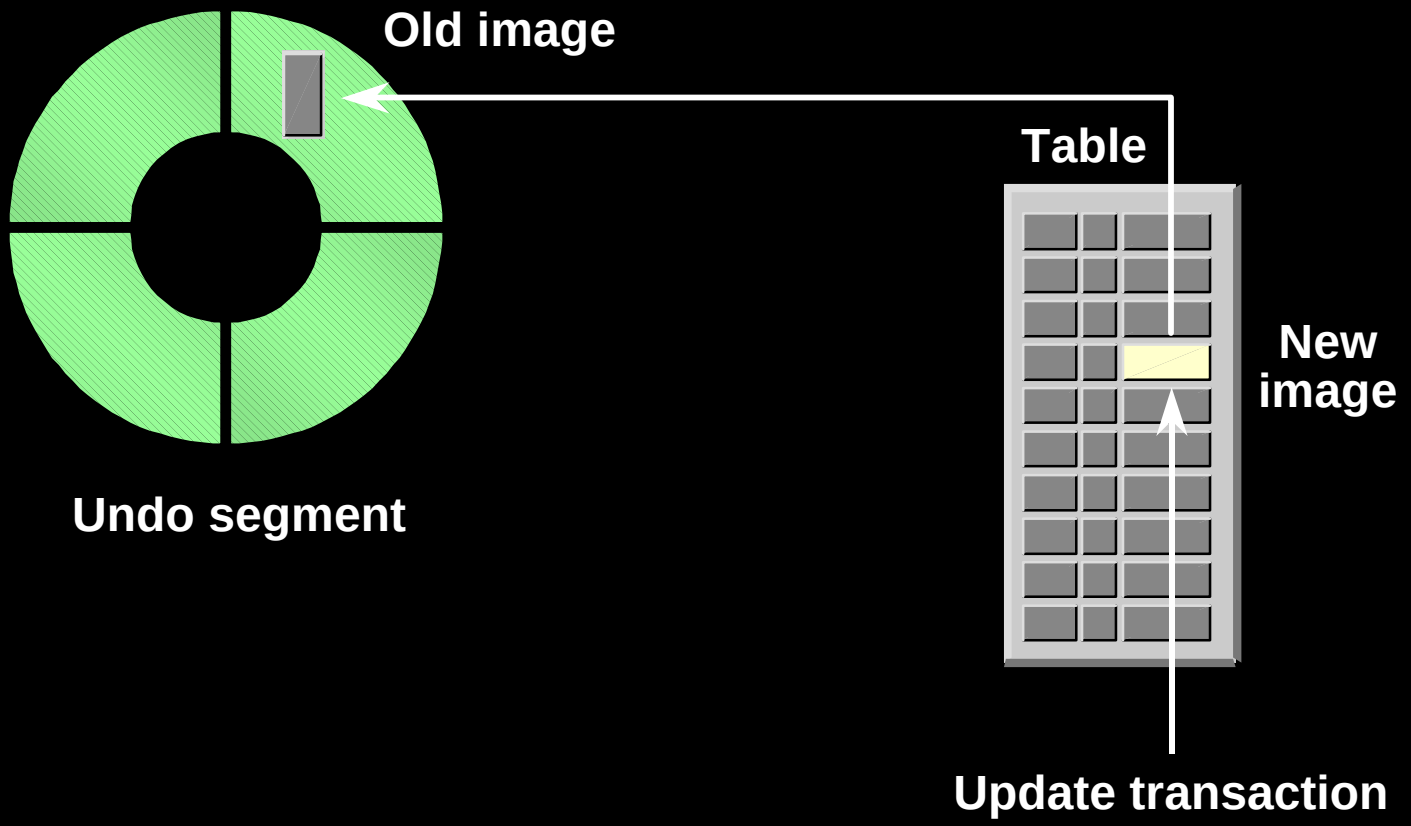
After completing this lesson, you should be able to do the following:

- Describe the purpose of undo data
- Implement Automatic Undo Management
- Create and configure undo segments
- Obtain undo segment information from the data dictionary

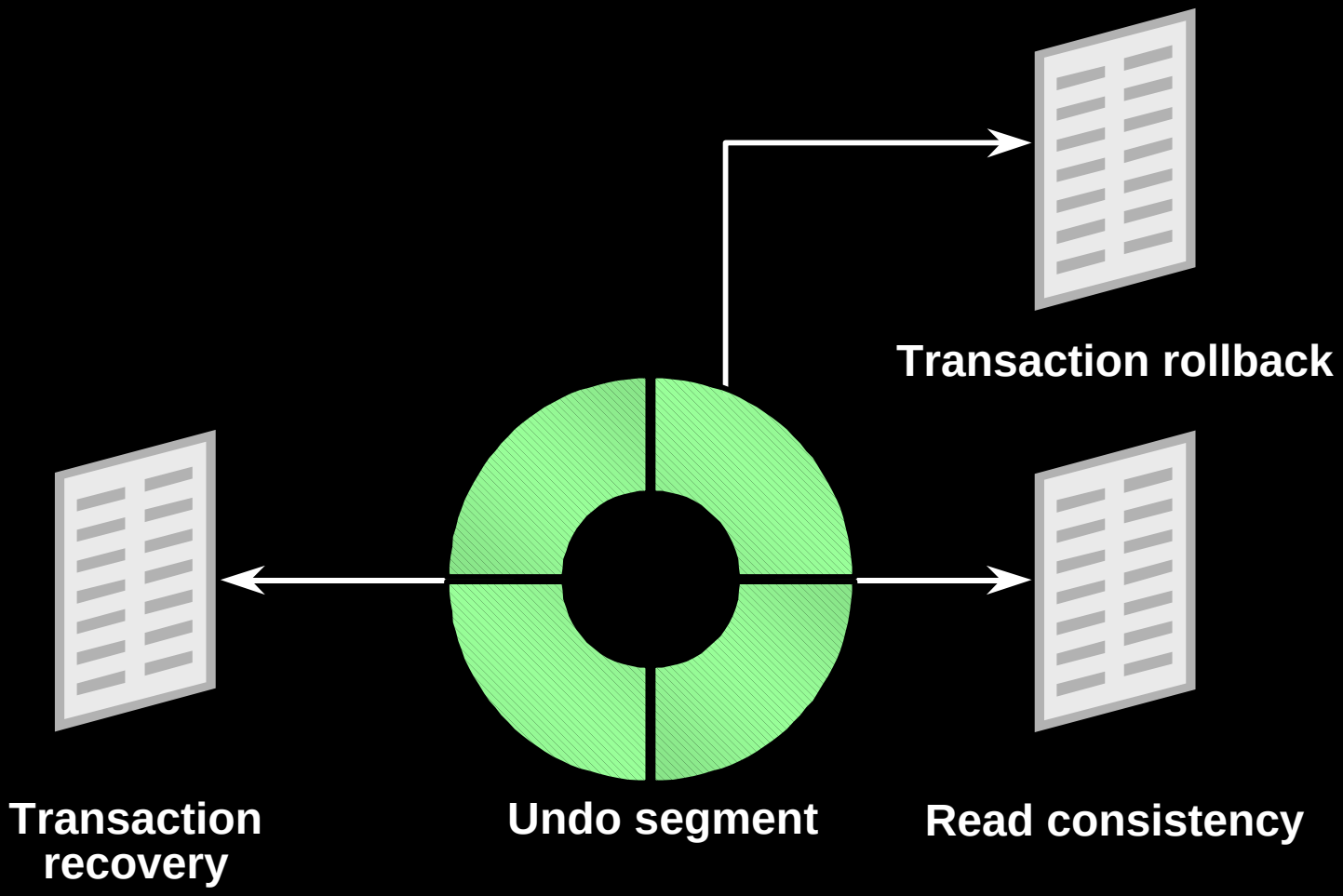
Managing Undo Data Overview

- Two methods for managing undo data exists
  - Automatic Undo Management
  - Manual Undo Management
- This lesson discusses Automatic Undo Management
- The term *undo* replaces what was known in previous versions of Oracle as *rollback*

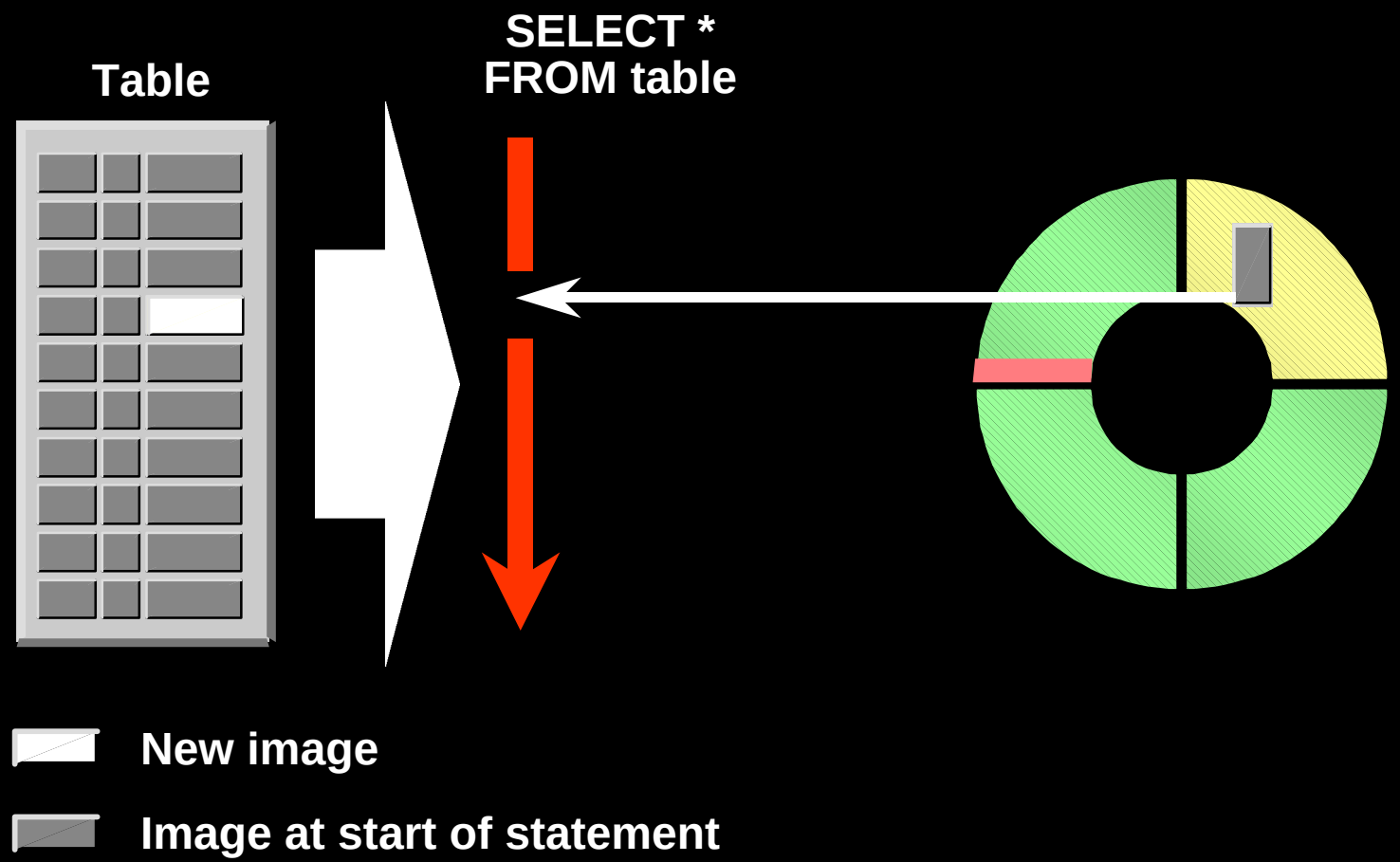
Undo Segment



Undo Segments: Purpose



Read Consistency



Types of Undo Segments

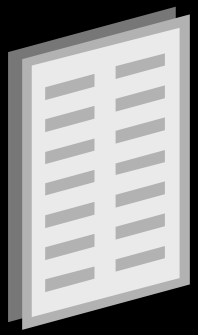
- **SYSTEM: Used for objects in the SYSTEM tablespace**
- **Non-SYSTEM: Used for objects in other tablespaces:**
  - **Auto Mode: Requires an UNDO tablespace**
  - **Manual Mode:**
    - **Private: Acquired by a single instance**
    - **Public: Acquired by any instance**
- **Deferred: Used when tablespaces are taken offline immediate, temporary, or for recovery**

Automatic Undo Management: Concepts

- Undo data is managed using an `UNDO` tablespace
- You allocate one `UNDO` tablespace per instance with enough space for the workload of the instance.
- The Oracle server automatically maintains undo data within the `UNDO` tablespace.

Automatic Undo Management: Configuration

- Configure two parameters in the initialization file:
  - UNDO_MANAGEMENT
  - UNDO_TABLESPACE
- Create at least one UNDO tablespace.



Initialization file

UNDO Tablespace

Automatic Undo Management: Initialization Parameters

- **UNDO_MANAGEMENT: Specifies whether the system should use AUTO or MANUAL mode.**
- **UNDO_TABLESPACE: Specifies a particular UNDO tablespace to be used.**

```
UNDO_MANAGEMENT=AUTO
UNDO_TABLESPACE=UNDOTBS
```

Automatic Undo Management: UNDO Tablespace

- You may create the UNDO tablespace with the database by adding a clause in the CREATE DATABASE command

```
CREATE DATABASE db01
. . .
UNDO TABLESPACE undo1 DATAFILE 'undo1db01.dbf'
SIZE 20M AUTOEXTEND ON
```

- Or create it later by using the CREATE UNDO TABLESPACE command

```
CREATE UNDO TABLESPACE undo1
DATAFILE 'undo1db01.dbf' SIZE 20M;
```

Automatic Undo Management: Altering an UNDO Tablespace

- The ALTER TABLESPACE command can make changes to UNDO tablespaces.
- The following example adds another data file to the UNDO tablespace:

```
ALTER TABLESPACE undotbs
ADD DATAFILE 'undotbs2.dbf' SIZE 30M
AUTOEXTEND ON;
```

Automatic Undo Management: Switching UNDO Tablespaces

- You may switch from using one UNDO tablespace to another
- Only one UNDO tablespace can be in assigned to an instance at a time
- More than one UNDO tablespace may exist within an instance, but only one can be active
- Use the ALTER SYSTEM command for dynamic switching between UNDO tablespaces

```
ALTER SYSTEM SET UNDO_TABLESPACE=UNDOTBS2;
```

Automatic Undo Management: Dropping an UNDO Tablespace

- The DROP TABLESPACE command drops an UNDO tablespace.

```
DROP TABLESPACE UNDOTBS2;
```

- An UNDO tablespace can only be dropped if it is currently not in use by any instance.
- To drop an active UNDO tablespace:
  - Switch to a new UNDO tablespace
  - Drop the tablespace after all current transactions are complete

Automatic Undo Management: Other Parameters

- **UNDO_SUPPRESS_ERRORS**

  Set to TRUE, this parameter suppresses errors while attempting to execute manual operations in AUTO mode.

- **UNDO_RETENTION**

  Controls the amount of undo data to retain for consistent read

Undo Data Statistics

```
SELECT end_time,begin_time,undoblks
FROM   v$undostat;

END_TIME            BEGIN_TIME          UNDO
------------------- ------------------- -----
22-JAN-01 13:44:18 22-JAN-01 13:43:04    19
22-JAN-01 13:43:04 22-JAN-01 13:33:04  1474
22-JAN-01 13:33:04 22-JAN-01 13:23:04  1347
22-JAN-01 13:23:04 22-JAN-01 13:13:04  1628
22-JAN-01 13:13:04 22-JAN-01 13:03:04  2249
22-JAN-01 13:03:04 22-JAN-01 12:53:04  1698
22-JAN-01 12:53:04 22-JAN-01 12:43:04  1433
22-JAN-01 12:43:04 22-JAN-01 12:33:04  1532
22-JAN-01 12:33:04 22-JAN-01 12:23:04  1075
```

Automatic Undo Management: Sizing an UNDO Tablespace

Determining a size for the UNDO tablespace requires three pieces of information

- (UR) UNDO_RETENTION in seconds
- (UPS) Number of undo data blocks generated per second
- (DBS) Overhead varies based on extent and file size (db_block_size)

```
UndoSpace = [UR * (UPS * DBS)] + (DBS * 24)
```

Automatic Undo Management
Undo Quota

- Long transactions and improperly written transactions can consume valuable resources
- With undo quota users can be grouped and a maximum undo space limit can be assigned to the group
- UNDO_POOL, a Resource Manager directive, defines the amount of space allowed for a resource group
- When a group exceeds its limit no new transactions are possible, for the group, until undo space is freed by current transactions either completing or aborting

Obtaining Undo Segments Information

- Data Dictionary Views
  - DBA_ROLLBACK_SEGS
- Dynamic Performance Views
  - V$ROLLNAME
  - V$ROLLSTAT
  - V$UNDOSTAT
  - V$SESSION
  - V$TRANSACTION

Summary

In this lesson, you should have learned how to:

- Configure Automatic Undo Management
- Create an Undo Tablespace
- Properly size an Undo Tablespace

Practice 10 Overview

This practice covers the following topics:

- Creating an `UNDO` tablespace
- Switching between `UNDO` tablespaces
- Dropping an `UNDO` tablepsace

11

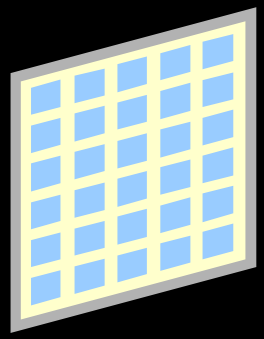
Managing Tables

Objectives

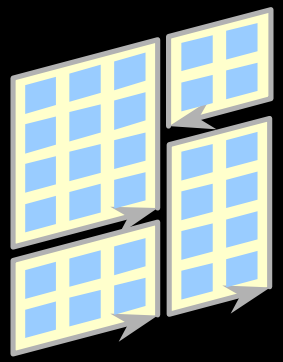
After completing this lesson, you should be able to do the following:

- Identify the various methods of storing data
- Outline Oracle data types
- Distinguish between an extended versus a restricted ROWID
- Outline the structure of a row
- Create regular and temporary tables
- Manage storage structures within a table
- Reorganize, truncate, drop a table
- Drop a column within a table

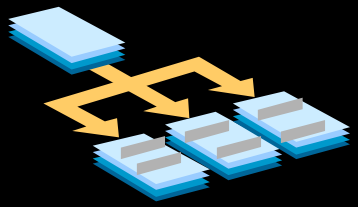
Storing User Data



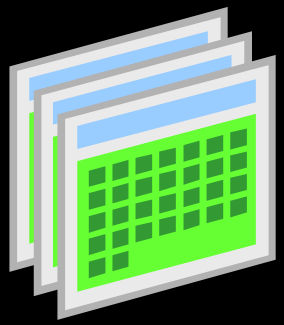
Regular table



Partitioned table

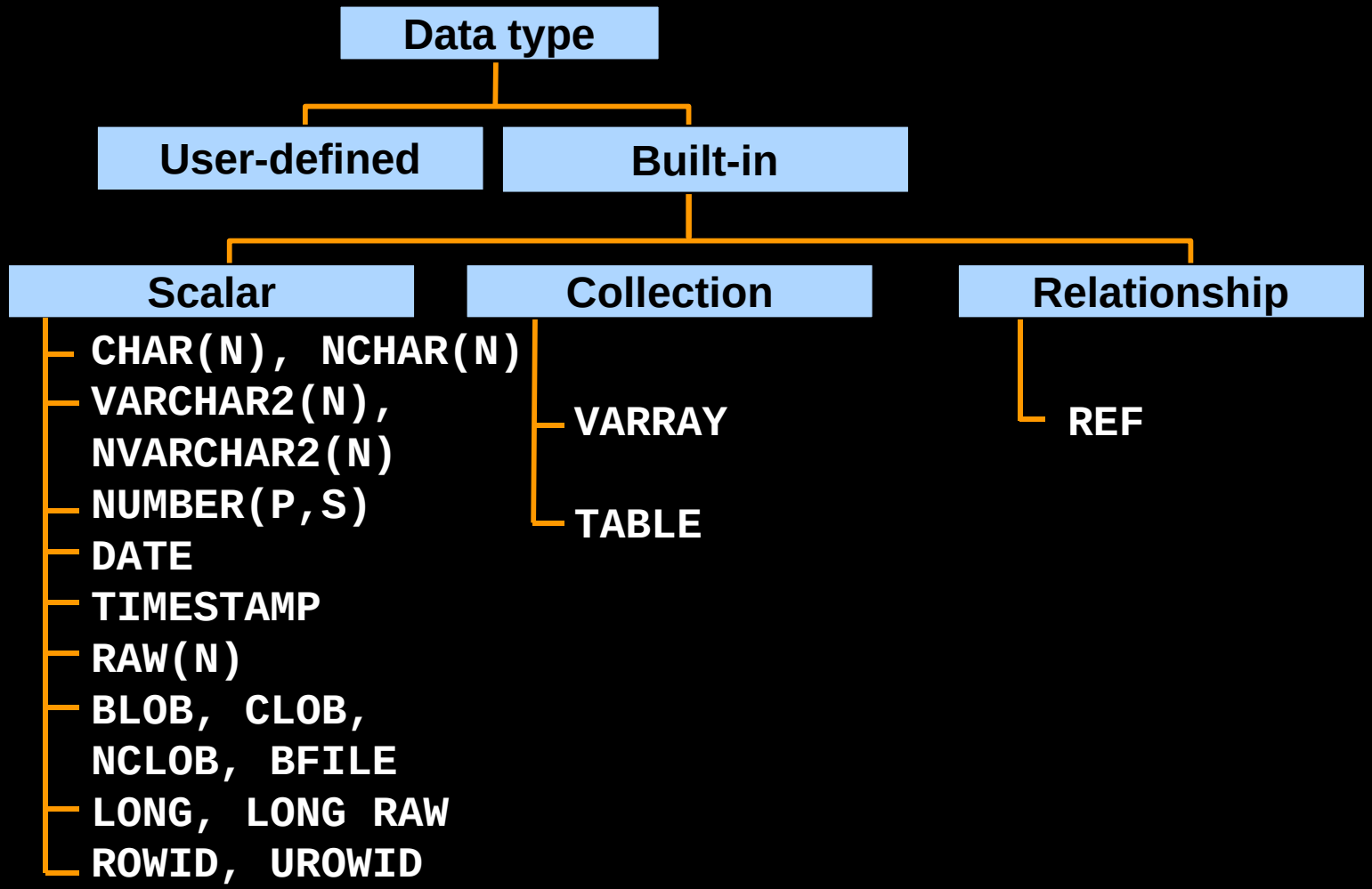


Index-organized table



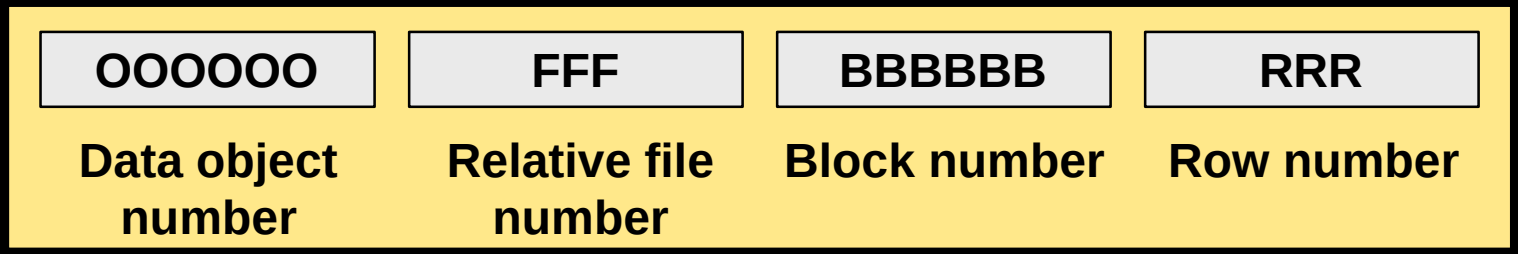
Cluster

Oracle Data Types

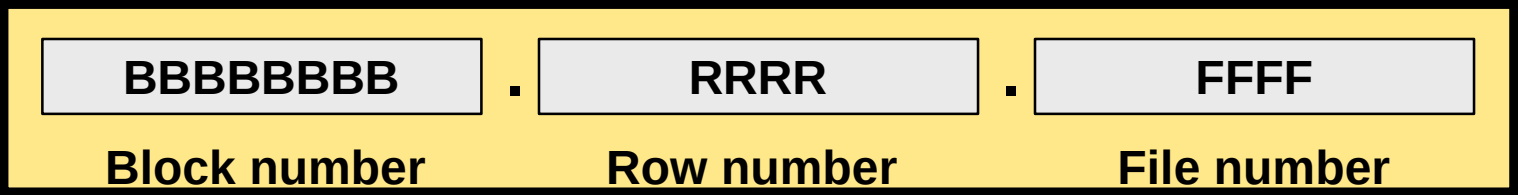


ROWID Format

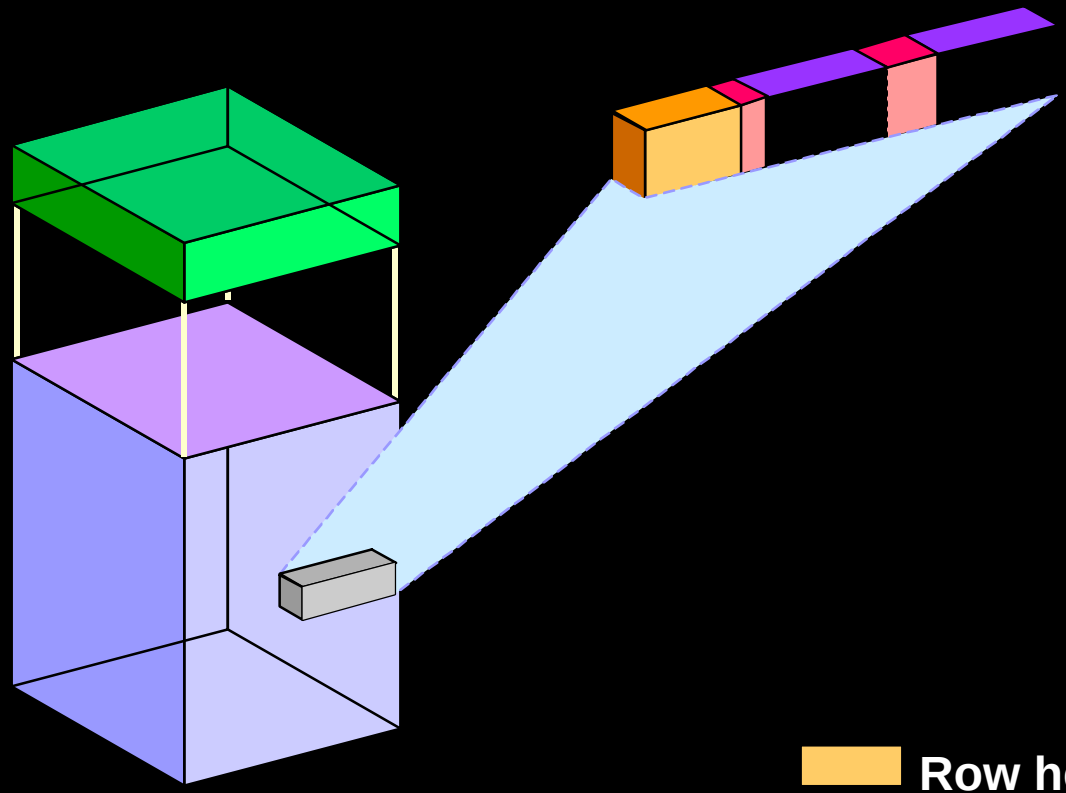
Extended ROWID Format



Restricted ROWID Format



Structure of a Row



Database block

Row header

Column length

Column value

Creating a Table

```
CREATE TABLE hr.employees(
    employee_id  NUMBER(6),
    first_name VARCHAR2(20),
    last_name VARCHAR2(25)
    email  VARCHAR2(25)
    phone_number VARCHAR2(20)
    hire_date DATE DEFAULT SYSDATE
    job_id   VARCHAR2(10)
    salary  NUMBER(8,2)
    commission_pct  NUMBER (2,2)
    manager_id  NUMBER(6)
    department_id  NUMBER(4)
    );
```

Creating Temporary Tables

- Created using the `GLOBAL TEMPORARY` clause

```
CREATE GLOBAL TEMPORARY TABLE
hr.employees_temp
AS SELECT * FROM hr.employees;
```

- Tables retain data only for the duration of a transaction or session
- DML locks are not acquired on the data
- DMLs do not generate redo logs
- Can create indexes, views, and triggers on temporary tables

Creating a Table: Guidelines

- Place tables in separate tablespaces.
- Use locally-managed tablespaces to avoid fragmentation.
- Use few standard extent sizes for tables to reduce tablespace fragmentation.

Changing Storage Parameters

```
ALTER TABLE hr.employees
PCTFREE 30
PCTUSED 50
STORAGE(NEXT 500K
MINEXTENTS 2
MAXEXTENTS 100);
```

Manually Allocating Extents

```
ALTER TABLE hr.employees
ALLOCATE EXTENT(SIZE 500K
DATAFILE '/DISK3/DATA01.DBF');
```

Nonpartitioned Table Reorganization

```
ALTER TABLE hr.employees
MOVE TABLESPACE data1;
```

- Moves data into a new segment while preserving indexes, constraints, privileges, and so on the table
- Is being used to move a table to a different tablespace or reorganize extents

Truncating a Table

```
TRUNCATE TABLE hr.employees;
```

- Truncating a table deletes all rows in a table and releases used space.
- Corresponding indexes are truncated.

Dropping a Table

```
DROP TABLE hr.department
CASCADE CONSTRAINTS;
```

Dropping a Column

Removing a column from a table:

```
ALTER TABLE hr.employees
DROP COLUMN comments
CASCADE CONSTRAINTS CHECKPOINT 1000;
```

- Removes the column length and data from each row, freeing space in the data block
- Dropping a column in a large table takes a considerable amount of time

Using the UNUSED Option

- Mark a column as unused

```
ALTER TABLE hr.employees
SET UNUSED COLUMN comments CASCADE CONSTRAINTS;
```

- Drop unused columns

```
ALTER TABLE hr.employees
DROP UNUSED COLUMNS CHECKPOINT 1000;
```

- Continue to drop column operation

```
ALTER TABLE hr.employees
DROP COLUMNS CONTINUE CHECKPOINT 1000;
```

Obtaining Table Information

Information about tables can be obtained by querying the data dictionary.

- `DBA_TABLES`
- `DBA_OBJECTS`

Summary

In this lesson, you should have learned how to:

- Distinguish between an extended versus a restricted ROWID
- Outline the structure of a row
- Create regular and temporary tables
- Manage storage structures within a table
- Reorganize, truncate, drop a table
- Drop a column within a table

Practice 11 Overview

This practice covers the following topics:

- Creating a table
- View, mark as unused, and drop columns within a table
- Allocate extents manually
- Truncate a table
- Obtaining table information

12

Managing Indexes

Objectives

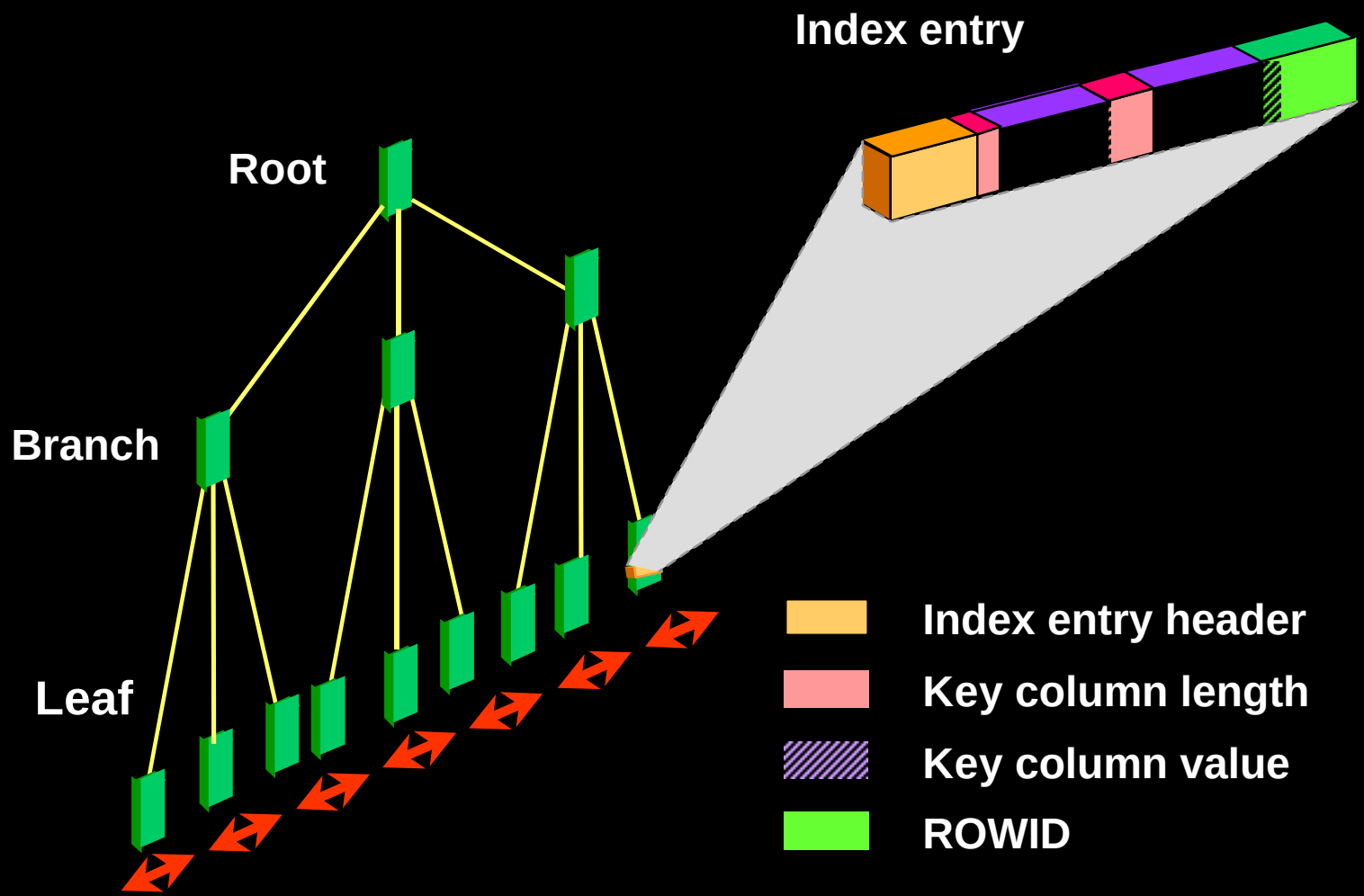
After completing this lesson, you should be able to do the following:

- List the different types of indexes and their uses
- Create various types of indexes
- Reorganize indexes
- Drop indexes
- Get index information from the data dictionary
- Monitor the usage of an index

Classification of Indexes

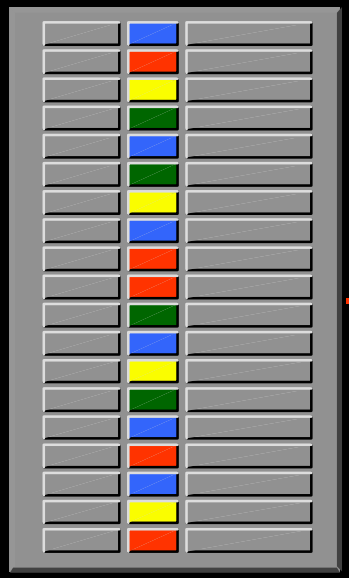
- Logical
  - Single column or concatenated
  - Unique or nonunique
  - Function-based
  - Domain
- Physical
  - Partitioned or nonpartitioned
  - B-tree
    - Normal or reverse key
  - Bitmap

B-Tree Index



Bitmap Index

Table



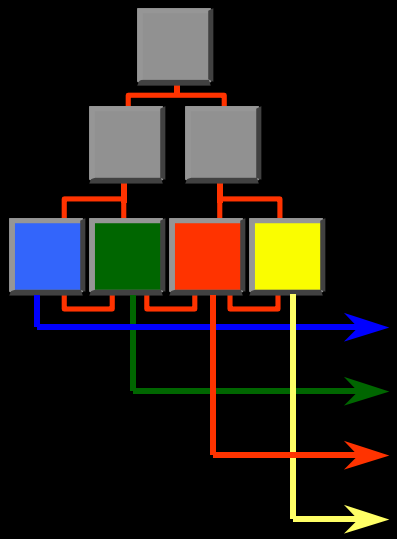
File 3

Block 10

Block 11

Block 12

Index



key	start ROWID	end ROWID	bitmap
<Blue,	10.0.3,	12.8.3,	10001001000100101 00>
<Green,	10.0.3,	12.8.3,	00010100001001000 00>
<Red,	10.0.3,	12.8.3,	01000000110000010 01>
<Yellow,	10.0.3,	12.8.3,	00100010000010000 10>

ORACLE

Comparing B-Tree and Bitmap Indexes

B-tree	Bitmap
Suitable for high-cardinality columns	Suitable for low-cardinality columns
Updates on keys relatively inexpensive	Updates to key columns very expensive
Inefficient for queries using OR predicates	Efficient for queries using OR predicates
Useful for OLTP	Useful for data warehousing

Creating Normal B-Tree Indexes

```
CREATE INDEX hr.employees_last_name_idx
ON hr.employees(last_name)
PCTFREE 30
STORAGE(INITIAL 200K NEXT 200K
PCTINCREASE 0   MAXEXTENTS 50)
TABLESPACE indx;
```

Creating Indexes: Guidelines

- Balance query and DML needs
- Place in separate tablespace
- Use uniform extent sizes: Multiples of five blocks or `MINIMUM EXTENT` size for tablespace
- Consider `NOLOGGING` for large indexes
- `INITRANS` should generally be higher on indexes than on the corresponding tables.

Creating Bitmap Indexes

Use the parameter CREATE_BITMAP_AREA_SIZE to specify the amount of memory allocated for bitmap creation.

```
CREATE BITMAP INDEX orders_region_id_idx
ON orders(region_id)
PCTFREE 30
STORAGE(INITIAL 200K NEXT 200K
PCTINCREASE 0   MAXEXTENTS 50)
TABLESPACE indx;
```

Changing Storage Parameters for Indexes

```
ALTER INDEX employees_last_name_idx
STORAGE(NEXT 400K
MAXEXTENTS 100);
```

Allocating and Deallocating Index Space

```
ALTER INDEX orders_region_id_idx
ALLOCATE EXTENT (SIZE 200K
DATAFILE '/DISK6/indx01.dbf');
```

```
ALTER INDEX orders_id_idx
DEALLOCATE UNUSED;
```

Rebuilding Indexes

Use the ALTER INDEX command to:

- Move an index to a different tablespace
- Improve space utilization by removing deleted entries
- Change a reverse key index to a normal B-tree index and vice versa

```
ALTER INDEX orders_region_id_idx REBUILD
TABLESPACE indx02;
```

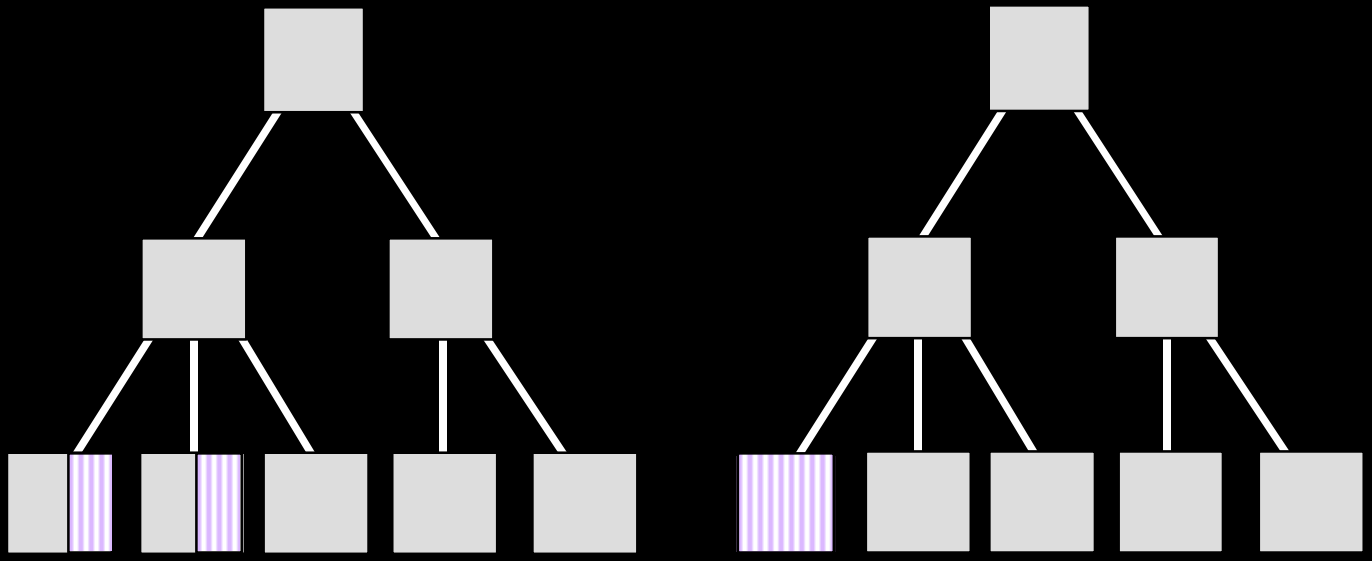
Online Rebuild of Indexes

- Rebuilding indexes can be done with minimal table locking

```
ALTER INDEX orders_id_idx REBUILD ONLINE;
```

- Some restrictions still apply

Coalescing Indexes

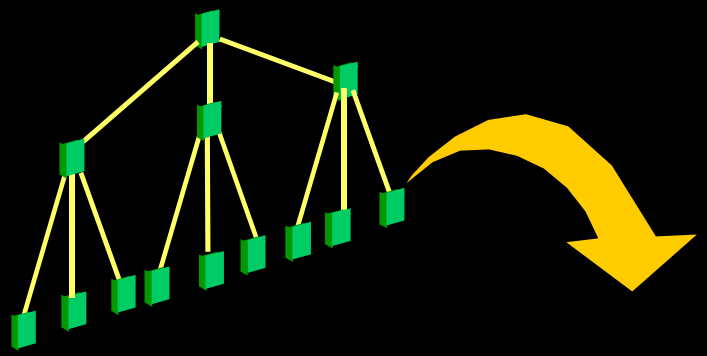


Before coalescing

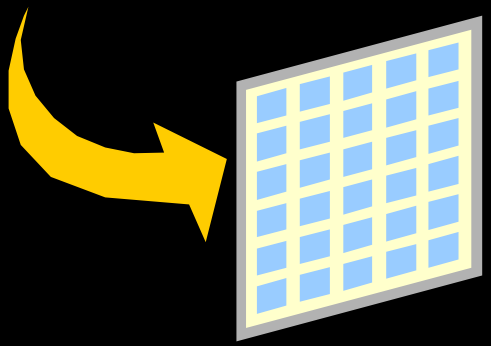
After coalescing

```
ALTER INDEX orders_id_idx COALESCE;
```

Checking Index Validity



```
ANALYZE INDEX orders_region_id_idx
VALIDATE STRUCTURE;
```



INDEX_STATS

Dropping Indexes

- Drop and re-create an index before bulk loads.
- Drop indexes that are infrequently needed and build them when necessary.
- Drop and re-create invalid indexes.

```
DROP INDEX hr.deptartments_name_idx;
```

Identifying Unused Indexes

- To start monitoring the usage of an index

```
ALTER INDEX summit.orders_id_idx
MONITORING USAGE
```

- To stop monitoring the usage of an index

```
ALTER INDEX summit.orders_id_idx
NOMONITORING USAGE
```

Obtaining Index Information

Information about indexes can be obtained by querying the data dictionary.

- `DBA_INDEXES`: Provides information on the indexes
- `DBA_IND_COLUMNS`: Provides information on the columns indexed
- `DBA_IND_EXPRESSIONS`: Provides information on function based indexes
- `V$OBJECT_USAGE`: Provides information on the usage of an index

Summary

In this lesson, you should have learned how to:

- Create different types of indexes
- Reorganize indexes
- Drop indexes
- Get index information from the data dictionary
- Begin and end monitoring usage of indexes

Practice 12 Overview

This practice covers the following topics:

- Creating an index on columns of a table
- Moving the index to another tablespace
- Dropping an index
- Obtain index information

13

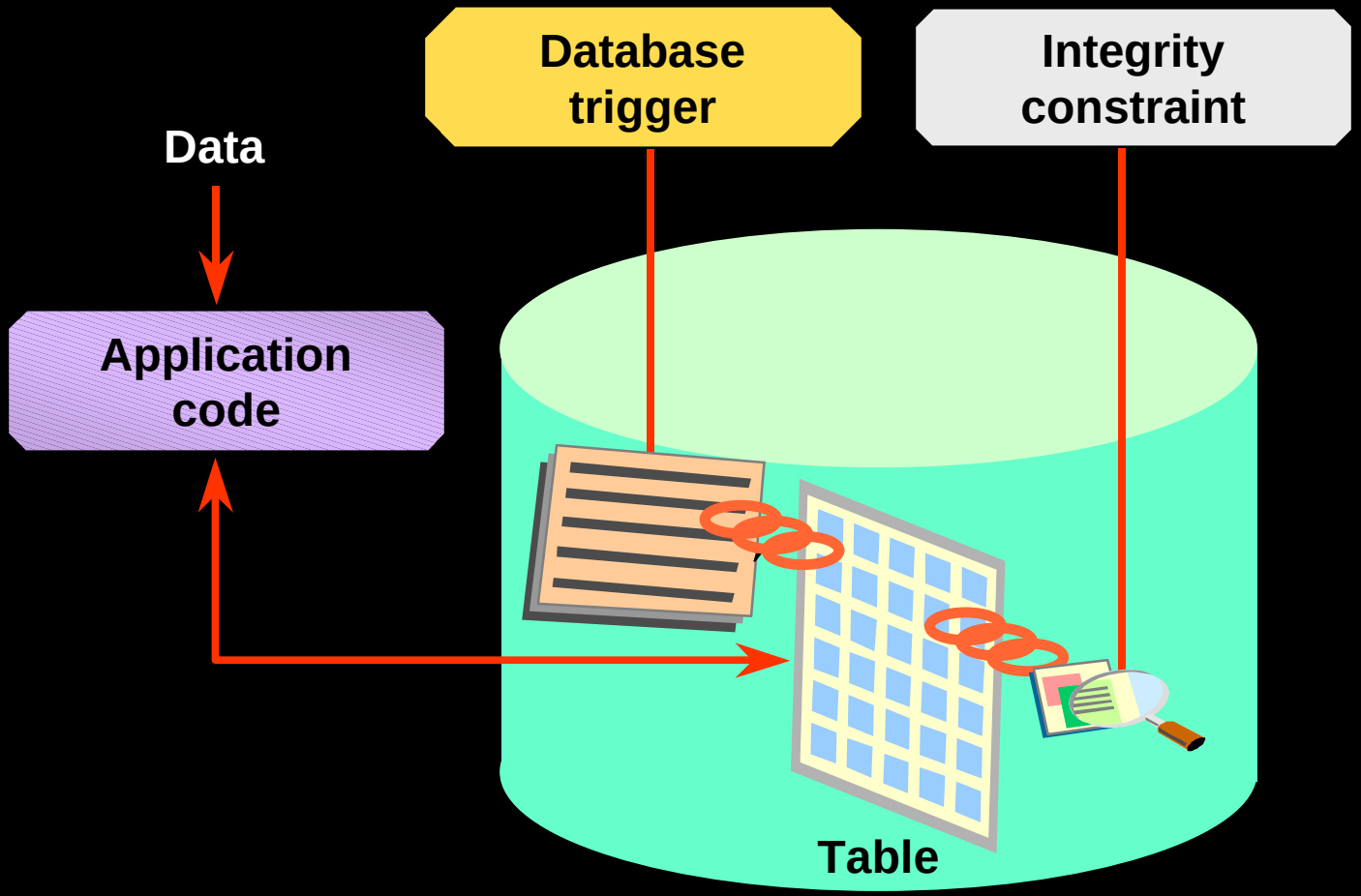
Maintaining Data Integrity

Objectives

After completing this lesson, you should be able to do the following:

- Implement data integrity constraints
- Maintain integrity constraints
- Obtain constraint information from the data dictionary

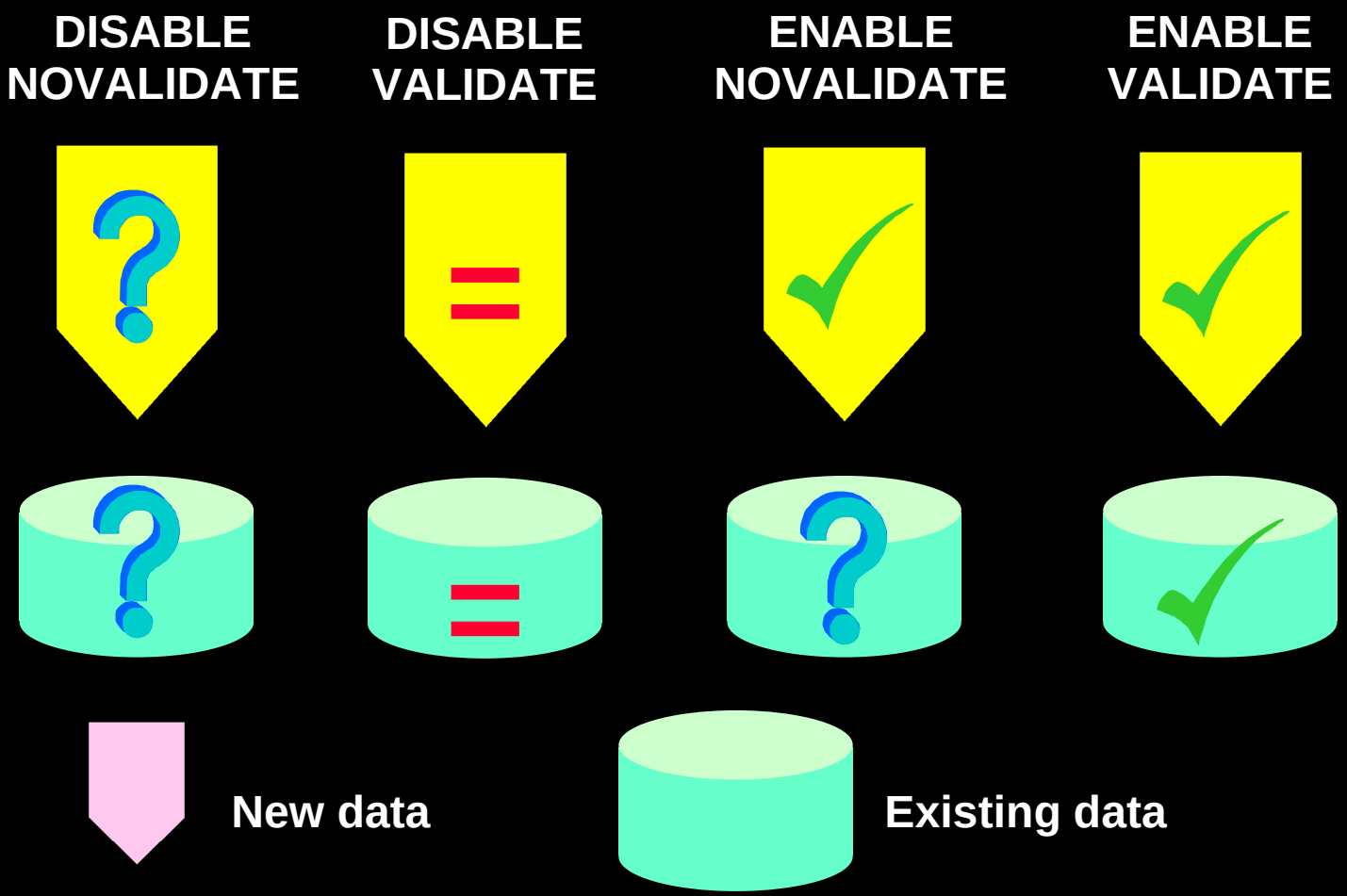
Data Integrity



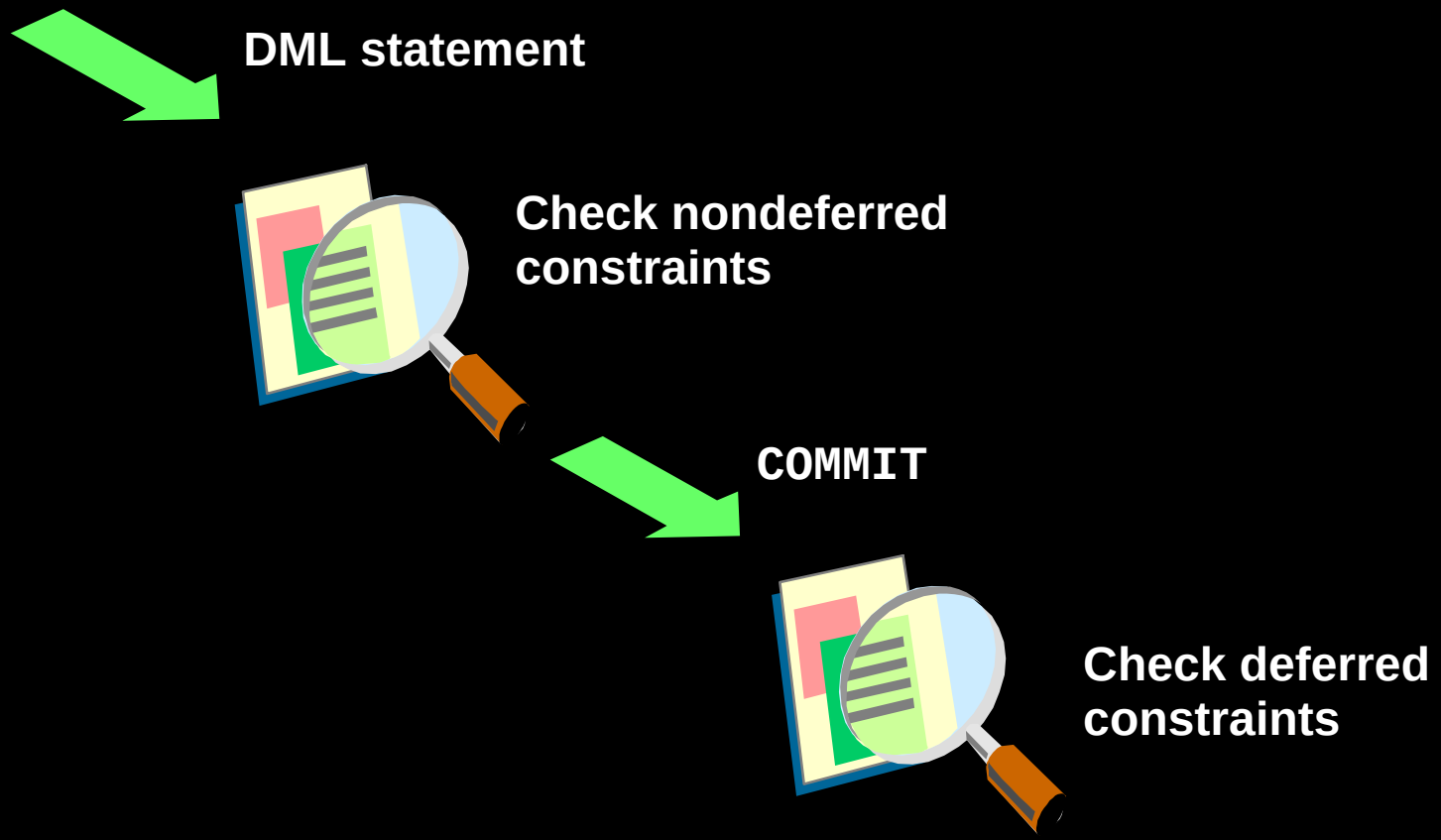
Types of Constraints

Constraint	Description
NOT NULL	Specifies that a column cannot contain null values
UNIQUE	Designates a column or combination of columns as unique
PRIMARY KEY	Designates a column or combination of columns as the table's primary key
FOREIGN KEY	Designates a column or combination of columns as the foreign key in a referential integrity constraint
CHECK	Specifies a condition that each row of the table must satisfy

Constraint States



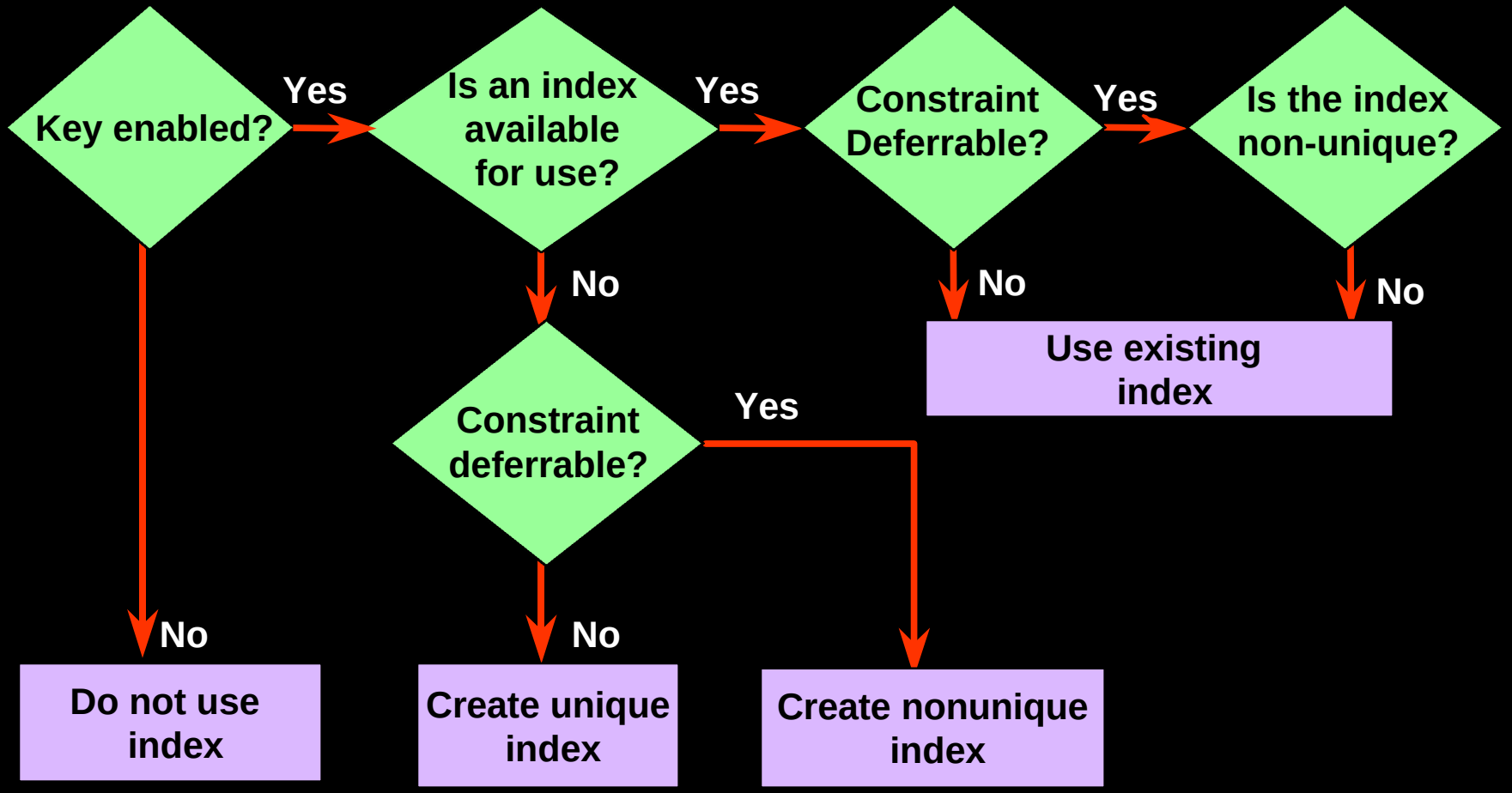
Constraint Checking



Defining Constraints as Immediate or Deferred

- Use the `SET CONSTRAINTS` statement to make constraints either `DEFERRED` or `IMMEDIATE`
- The `ALTER SESSION` statement also has clauses to `SET CONSTRAINTS` to `DEFERRED` or `IMMEDATE`

Primary and Unique Key Enforcement



Foreign Key Considerations

Desired Action	Appropriate Solution
Drop parent table	Cascade constraints
Truncate parent table	Disable or drop foreign key
Drop tablespace containing parent table	Use the `CASCADE CONSTRAINTS` clause
Perform DML on child table	Ensure the tablespace containing the parent key key is online

Defining Constraints While Creating a Table

```
CREATE TABLE hr.employee(
id NUMBER(7)
     CONSTRAINT employee_id_pk PRIMARY KEY
     DEFERRABLE
     USING INDEX
       STORAGE(INITIAL 100K NEXT 100K)
       TABLESPACE indx,
last_name VARCHAR2(25)
     CONSTRAINT employee_last_name_nn NOT NULL,
dept_id NUMBER(7))
TABLESPACE users;
```

Guidelines for Defining Constraints

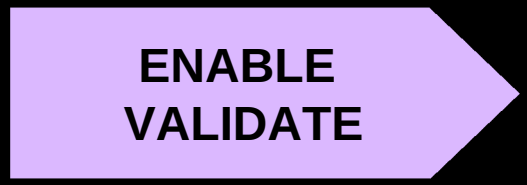
- Primary and unique constraints:
  - Place indexes in a separate tablespace
  - Use nonunique indexes if bulk loads are frequent
- Self-referencing foreign keys:
  - Define or enable foreign keys after initial load
  - Defer constraint checking

Enabling Constraints

- No locks on table
- Primary and unique keys must use nonunique indexes

```
ALTER TABLE hr.departments
ENABLE NOVALIDATE CONSTRAINT dept_pk;
```

Enabling Constraints



- Locks table
- Can use unique or nonunique indexes
- Needs valid table data

```
ALTER TABLE hr.employees
ENABLE VALIDATE CONSTRAINT emp_dept_fk;
```

Using the EXCEPTIONS Table

- Create the EXCEPTIONS table by running the `utlexcpt1.sql` script
- Execute the ALTER TABLE statement with EXCEPTIONS option
- Use subquery on EXCEPTIONS to locate rows with invalid data
- Rectify the errors
- Reexecute ALTER TABLE to enable the constraint.

Obtaining Constraint Information

Data Dictionary Views

- `DBA_CONSTRAINTS`
- `DBA_CONS_COLUMNS`

Summary

In this lesson, you should have learned how to:

- Implement data integrity
- Use an appropriate strategy for creating and maintaining constraints
- Obtain information from the data dictionary

Practice 13 Overview

This practice covers the following topics:

- Creating constraints
- Enabling unique constraints
- Creating an Exceptions table
- Identifying existing constraint violations in a table, correcting the errors and re-enabling the constraints

14

Managing Password Security and Resources

Objectives

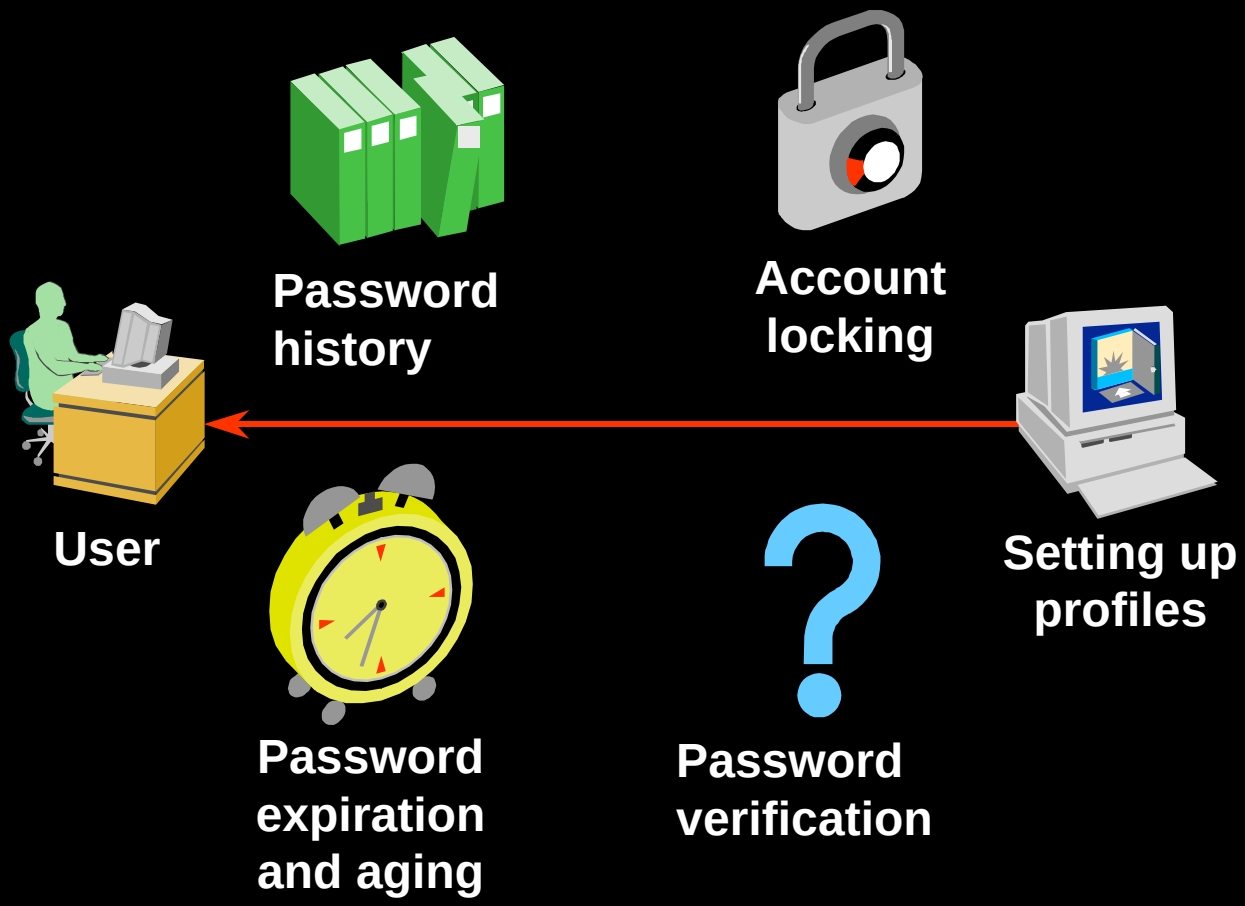
After completing this lesson, you should be able to do the following:

- Manage passwords using profiles
- Administer profiles
- Control use of resources using profiles
- Obtain information about profiles, password management, and resources

Profiles

- A profile is a named set of password and resource limits
- Profiles are assigned to users by the `CREATE USER` or `ALTER USER` command
- Can be enabled or disabled
- Can relate to the `DEFAULT` profile

Password Management

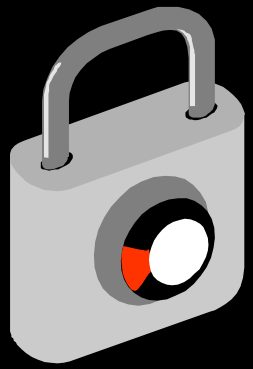


Enabling Password Management

- Set up password management by using profiles and assign them to users.
- Lock, unlock, and expire accounts using the `CREATE USER` or `ALTER USER` command.
- Password limits are always enforced.

Password Account Locking

Parameter	Description
FAILED_LOGIN_ATTEMPTS	Number of failed login attempts before lockout of the account
PASSWORD_LOCK_TIME	Number of days the account is locked after the specified number of failed login attempts



Password Expiration and Aging

Parameter	Parameter
PASSWORD_LIFE_TIME	Lifetime of the password in days after which the password expires
PASSWORD_GRACE_TIME	Grace period in days for changing the password after the first successful login after the password has expired

Password History

Parameter	Description
PASSWORD_REUSE_TIME	Number of days before a password can be reused
PASSWORD_REUSE_MAX	Maximum number of times a password can be reused

Password Verification

Parameter	Description
PASSWORD_VERIFY_FUNCTION	PL/SQL function that makes a password complexity check before a password is assigned

User-Provided Password Function

Function must be created in the SYS schema and must have the following specification:

```
function_name(
    userid_parameter IN VARCHAR2(30),
    password_parameter IN VARCHAR2(30),
    old_password_parameter IN VARCHAR2(30))
RETURN BOOLEAN
```

Password Verification Function VERIFY_FUNCTION

- Minimum length is four characters.
- Password should not be equal to username.
- Password should have at least one alphabetic, one numeric, and one special character.
- Password should differ from the previous password by at least three letters.

Creating a Profile: Password Settings

```
CREATE PROFILE grace_5 LIMIT
  FAILED_LOGIN_ATTEMPTS 3
  PASSWORD_LOCK_TIME UNLIMITED
  PASSWORD_LIFE_TIME 30
  PASSWORD_REUSE_TIME 30
  PASSWORD_VERIFY_FUNCTION verify_function
  PASSWORD_GRACE_TIME 5;
```

Altering a Profile: Password Setting

```
ALTER PROFILE default
FAILED_LOGIN_ATTEMPTS 3
PASSWORD_LIFE_TIME 60
PASSWORD_GRACE_TIME 10;
```

Dropping a Profile: Password Setting

```
DROP PROFILE developer_prof;
```

```
DROP PROFILE developer_prof CASCADE;
```

Resource Management

- Resource management limits can be enforced at the session level, the call level, or both.
- Limits can be defined by profiles using the `CREATE PROFILE` command.
- Enable resource limits with the:
  - `RESOURCE_LIMIT` initialization parameter
  - `ALTER SYSTEM` command

Enabling Resource Limits

- Set the initialization parameter `RESOURCE_LIMIT` to `TRUE`
- Enforce the resource limits by enabling the parameter with the `ALTER SYSTEM` command

```
ALTER SYSTEM SET RESOURCE_LIMIT=TRUE;
```

Setting Resource Limits at Session Level

Resource	Description
CPU_PER_SESSION	Total CPU time measured in hundredths of seconds
SESSIONS_PER_USER	Number of concurrent sessions allowed for each username
CONNECT_TIME	Elapsed connect time measured in minutes
IDLE_TIME	Periods of inactive time measured in minutes
LOGICAL_READS_PER_SESSION	Number of data blocks (physical and logical reads)
PRIVATE_SGA	Private space in the SGA measured in bytes (for Shared Server only)

Setting Resource Limits at Call Level

Resource	Description
CPU_PER_CALL	CPU time per call in hundredths of seconds
LOGICAL_READS_PER _CALL	Number of data blocks that can be read per call

Creating a Profile: Resource Limit

```
CREATE PROFILE developer_prof LIMIT
  SESSIONS_PER_USER 2
  CPU_PER_SESSION 10000
  IDLE_TIME 60
  CONNECT_TIME 480;
```

Managing Resources Using the Database Resource Manager

- Provides the Oracle server with more control over resource management decisions
- Elements of the Database Resource Manager
  - Resource consumer group
  - Resource plan
  - Resource allocation method
  - Resource plan directives
- `DBMS_RESOURCE_MANAGER` package is used to create and maintain elements
- Requires `ADMINISTER_RESOURCE_MANAGER` privilege

Managing Resources Using the Database Resource Manager

- Resource plans specify the resource consumer groups belonging to the plan.
- Resource plans contain directives for how resources are to be allocated among consumer groups.

Resource Plan Directives

- The Database Resource Manager provides several means of allocating resources.
  - CPU Method
  - Active Session Pool and Queuing
  - Degree of Parallelism Limit
  - Automatic Consumer Group Switching
  - Maximum Estimated Execution Time
  - Undo Pool

Obtaining Password and Resource Limits Information

Information about password and resource limits can be obtained by querying the data dictionary.

- `DBA_USERS`
- `DBA_PROFILES`

Summary

In this lesson, you should have learned how to:

- Administer passwords
- Administer profiles

Practice Overview

This practice covers the following topics:

- Enabling password management
- Defining profiles and assigning to users
- Disabling password management

15

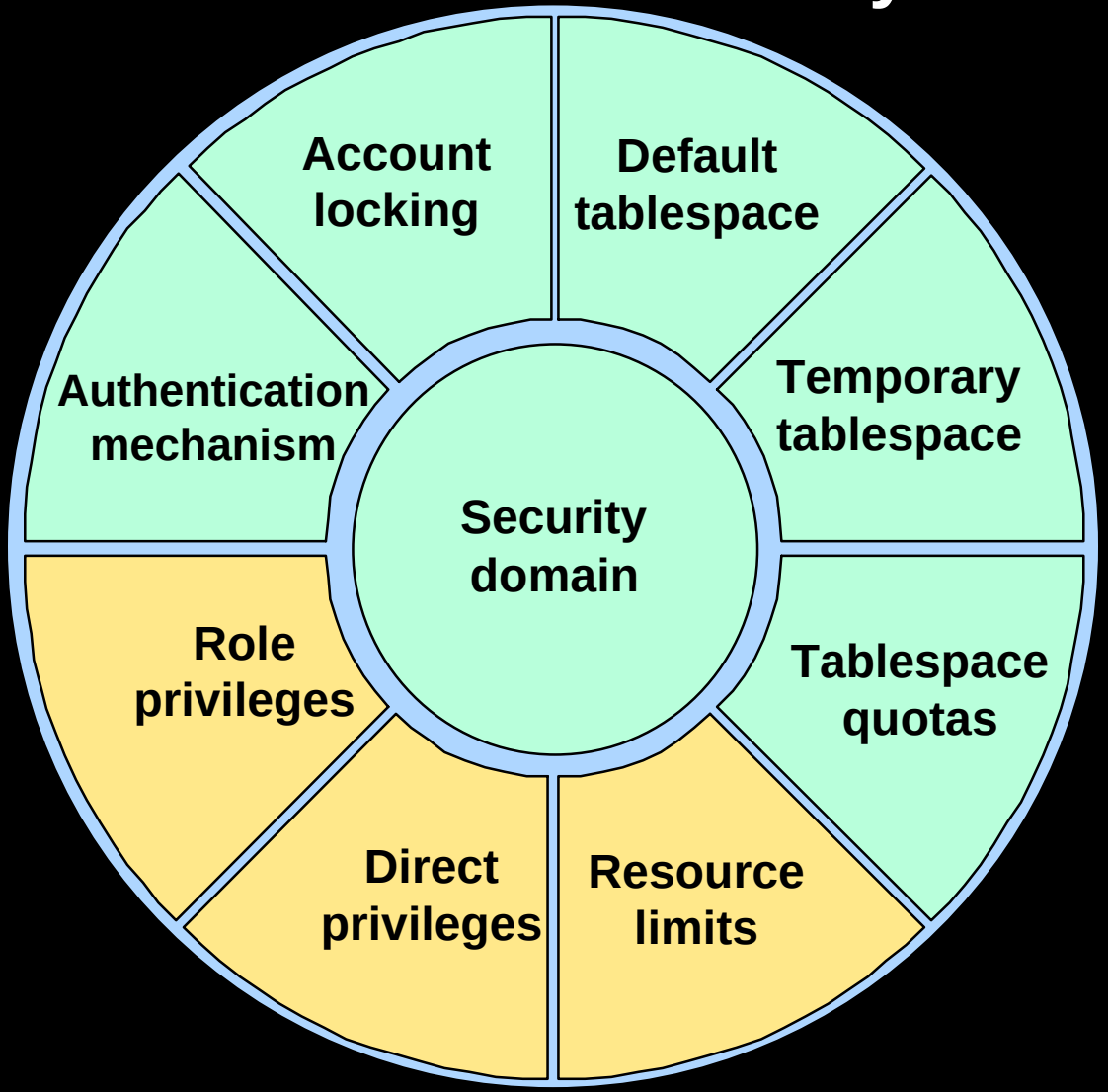
Managing Users

Objectives

After completing this lesson, you should be able to do the following:

- Create new database users
- Alter and drop existing database users
- Monitor information about existing users

Users and Security



Database Schema

- A schema is a named collection of objects
- A user is created, and a corresponding schema is created
- User can be associated only with one schema
- Username and schema are often used interchangeably

Schema Objects

- Tables
- Triggers
- Constraints
- Indexes
- Views
- Sequences
- Stored program units
- Synonyms
- User-defined data types
- Database links

Checklist for Creating Users

- Identify tablespaces in which the user needs to store objects.
- Decide on quotas for each tablespace.
- Assign a default tablespace and temporary tablespace.
- Create a user.
- Grant privileges and roles to the user.

Creating a New User: Database Authentication

Set the initial password:

```
CREATE USER aaron
IDENTIFIED BY soccer
DEFAULT TABLESPACE data
TEMPORARY TABLESPACE temp
QUOTA 15m ON data
PASSWORD EXPIRE;
```

Creating a New User: Operating System Authentication

- `OS_AUTHENT_PREFIX` initialization parameter specifies the format of the usernames
- Defaults to `OPS$`

```
CREATE USER aaron
IDENTIFIED EXTERNALLY
DEFAULT TABLESPACE USERS
TEMPORARY TABLESPACE temp
QUOTA 15m ON data
PASSWORD EXPIRE;
```

Changing User Quota on Tablespace

```
ALTER USER aaron
QUOTA 0 ON USERS;
```

Dropping a User

```
DROP USER aaron;
```

- Use the CASCADE clause to drop all objects in the schema if the schema contains objects.

```
DROP USER aaron CASCADE;
```

- Users currently connected to the Oracle server cannot be dropped

Obtaining User Information

Information about users can be obtained by querying the data dictionary.

- DBA_USERS
- DBA_TS_QUOTAS

Summary

In this lesson, you should have learned how to:

- Create users specifying the appropriate password mechanism
- Control usage of space by users

Practice 15 Overview

This practice covers the following topics:

- Creating users
- Displaying data dictionary information about users
- Removing user quotas

16

Managing Privileges

Objectives

After completing this lesson, you should be able to do the following:

- Identify system and object privileges
- Grant and revoke privileges
- Identify auditing capabilities

Managing Privileges

Two types of Oracle user privileges:

- **System: Enables users to perform particular actions in the database**
- **Object: Enables users to access and manipulate a specific object**

System Privileges

- There are over 100 distinct system privileges
- The `ANY` keyword in the privileges signifies that users have the privilege in any schema
- The `GRANT` command adds a privilege to a user or a group of users
- The `REVOKE` command deletes the privileges

System Privileges: Examples

Category	Examples
INDEX	CREATE ANY INDEX ALTER ANY INDEX DROP ANY INDEX
TABLE	CREATE TABLE CREATE ANY TABLE ALTER ANY TABLE DROP ANY TABLE SELECT ANY TABLE UPDATE ANY TABLE DELETE ANY TABLE
SESSION	CREATE SESSION ALTER SESSION RESTRICTED SESSION
TABLESPACE	CREATE TABLESPACE ALTER TABLESPACE DROP TABLESPACE UNLIMITED TABLESPACE

Granting System Privileges

```
GRANT CREATE SESSION TO emi;
```

```
GRANT CREATE SESSION TO emi WITH ADMIN OPTION;
```

SYSDBA and SYSOPER Privileges

Category	Examples
SYSOPER	STARTUP SHUTDOWN ALTER DATABASE OPEN | MOUNT ALTER DATABASE BACKUP CONTROLFILE TO RECOVER DATABASE ALTER DATABASE ARCHIVELOG
SYSDBA	SYSOPER PRIVILEGES WITH ADMIN OPTION CREATE DATABASE ALTER DATABASE BEGIN/END BACKUP RESTRICTED SESSEION RECOVER DATABASE UNTIL

System Privilege Restrictions

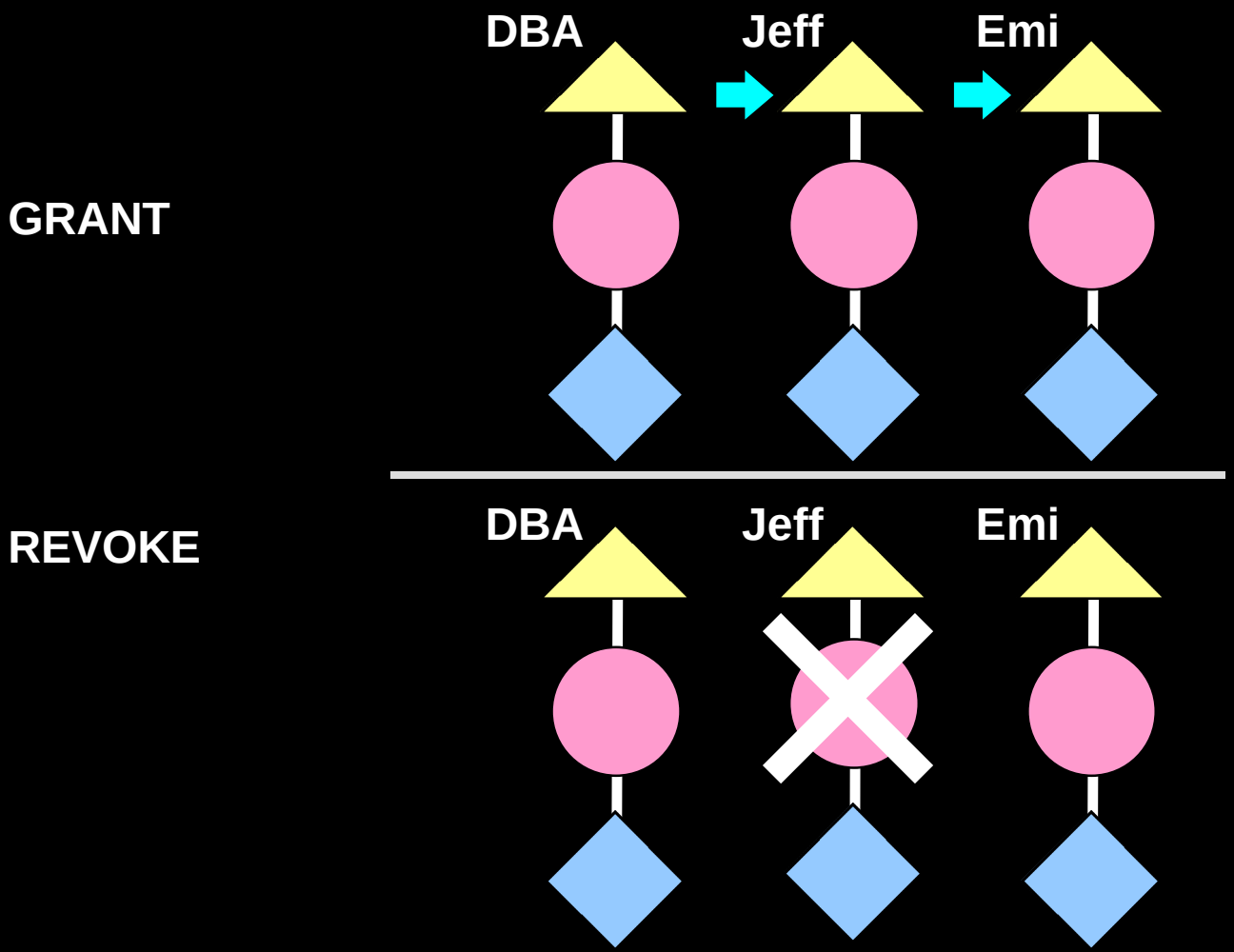
O7_DICTIONARY_ACCESSIBILITY parameter

- Controls restrictions on SYSTEM privileges
- If set to TRUE, access to objects in SYS schema is allowed
- Default is FALSE
  - Ensures that system privileges that allow access to any schema do not allow access to SYS schema

Revoking System Privileges

```
REVOKE CREATE TABLE FROM emi;
```

Revoking System Privileges WITH ADMIN OPTION



Object Privileges

Object priv.	Table	View	Sequence	Procedure
ALTER	√		√	√
DELETE	√	√		
EXECUTE				√
INDEX	√	√		
INSERT	√	√		
REFERENCES	√			
SELECT	√	√	√	
UPDATE	√	√		

Granting Object Privileges

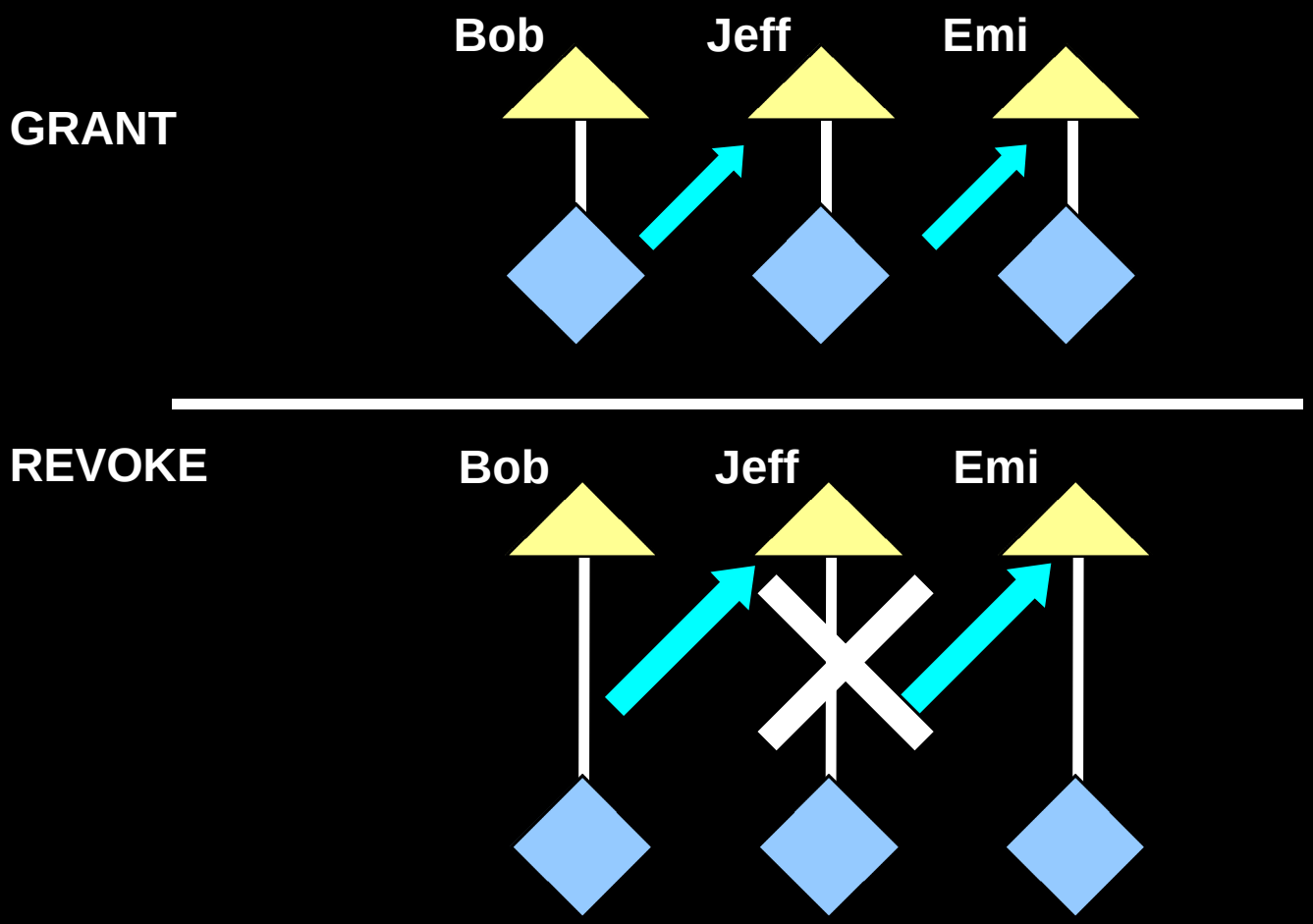
```
GRANT EXECUTE ON dbms_output TO jeff;
```

```
GRANT UPDATE ON emi.customers TO jeff WITH
GRANT OPTION;
```

Revoking Object Privileges

```
REVOKE SELECT ON emi.orders FROM jeff;
```

Revoking Object Privileges WITH GRANT OPTION



Obtaining Privileges Information

- Data Dictionary Views
  - DBA_SYS_PRIVS
  - SESSION_PRIVS
  - DBA_TAB_PRIVS
  - DBA_COL_PRIVS

Auditing

- Auditing is the monitoring of selected user database actions
- Used to
  - Investigate suspicious database activity
  - Gather information about specific database activities

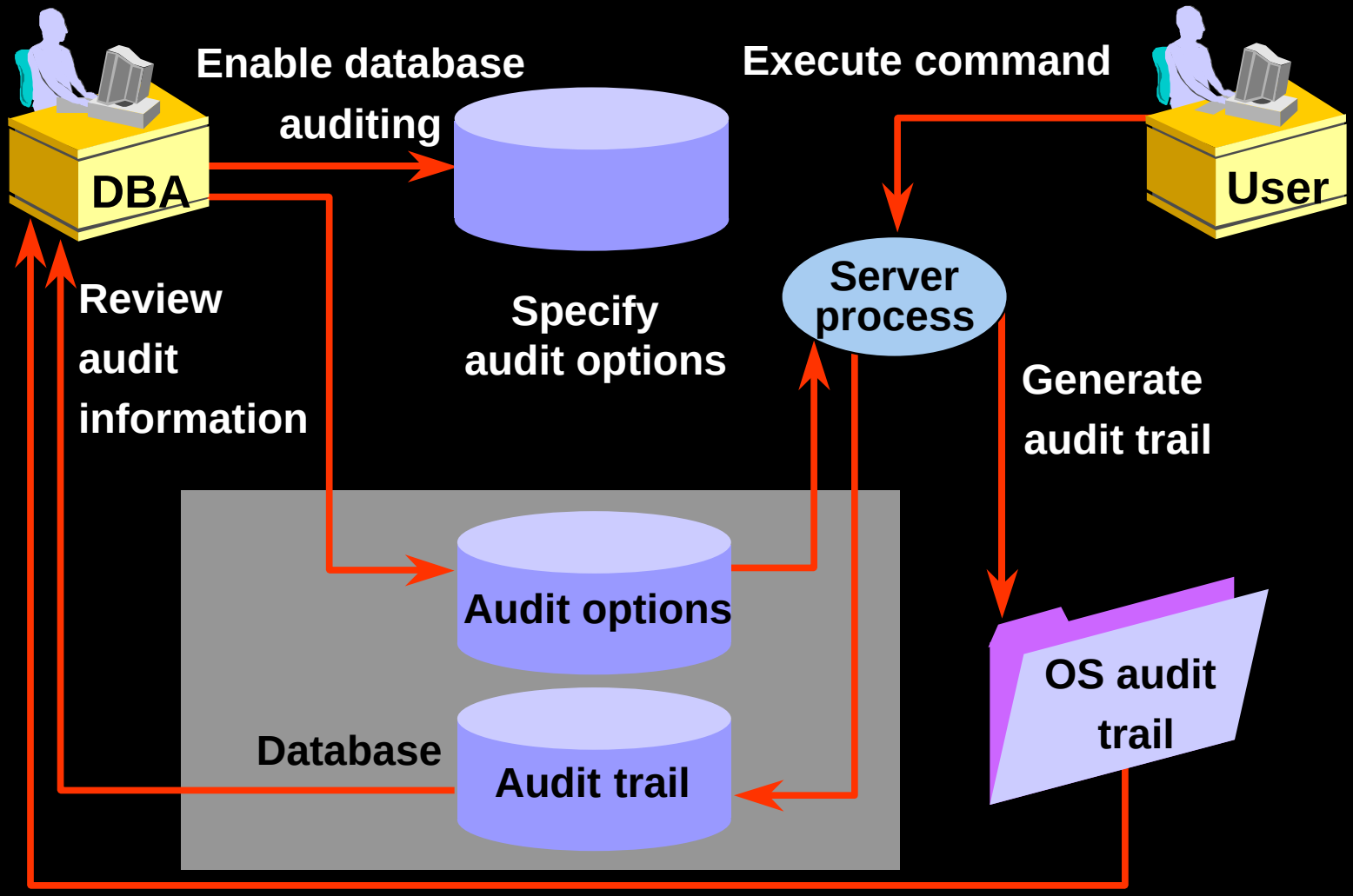
Auditing Guidelines

- Define what you want to audit
  - Audit users, statements, or objects
  - Statement executions
  - Successful statement executions, unsuccessful statement executions or both
- Manage your audit trail
  - Monitor the growth of the audit trail
  - Protect the audit trail from unauthorized access

Auditing Categories

- Audited by default
  - Instance startup and Instance shutdown
  - Administrator privileges
- Database auditing
  - Enabled by DBA
  - Cannot record column values
- Value-based or application auditing
  - Implemented through code
  - Can record column values
  - Used to track changes to tables

Database Auditing



Auditing Options

- **Statement auditing**

```
AUDIT TABLE;
```

- **Privilege auditing**

```
AUDIT create any trigger;
```

- **Schema object auditing**

```
AUDIT SELECT ON emi.orders;
```

Auditing Options

Fine-Grained Auditing

- **Provides the monitoring of data access based on content**
- **Implemented using the `DBMS_FGA` package**

Viewing Auditing Options

Data Dictionary Views

- `ALL_DEF_AUDIT_OPTS`
- `DBA_STMT_AUDIT_OPTS`
- `DBA_PRIV_AUDIT_OPTS`
- `DBA_OBJ_AUDIT_OPTS`

Obtaining Audit Records

- Data Dictionary Views
  - DBA_AUDIT_TRAIL
  - DBA_AUDIT_EXISTS
  - DBA_AUDIT_OBJECT
  - DBA_AUDIT_SESSION
  - DBA_AUDIT_STATEMENT

Summary

In this lesson, you should have learned how to:

- Control system and object privileges
- Use database auditing

Practice 16 Overview

This practice covers the following topics:

- Creating user and granting system privileges
- Granting Object privileges to users
- Enabling Auditing

17

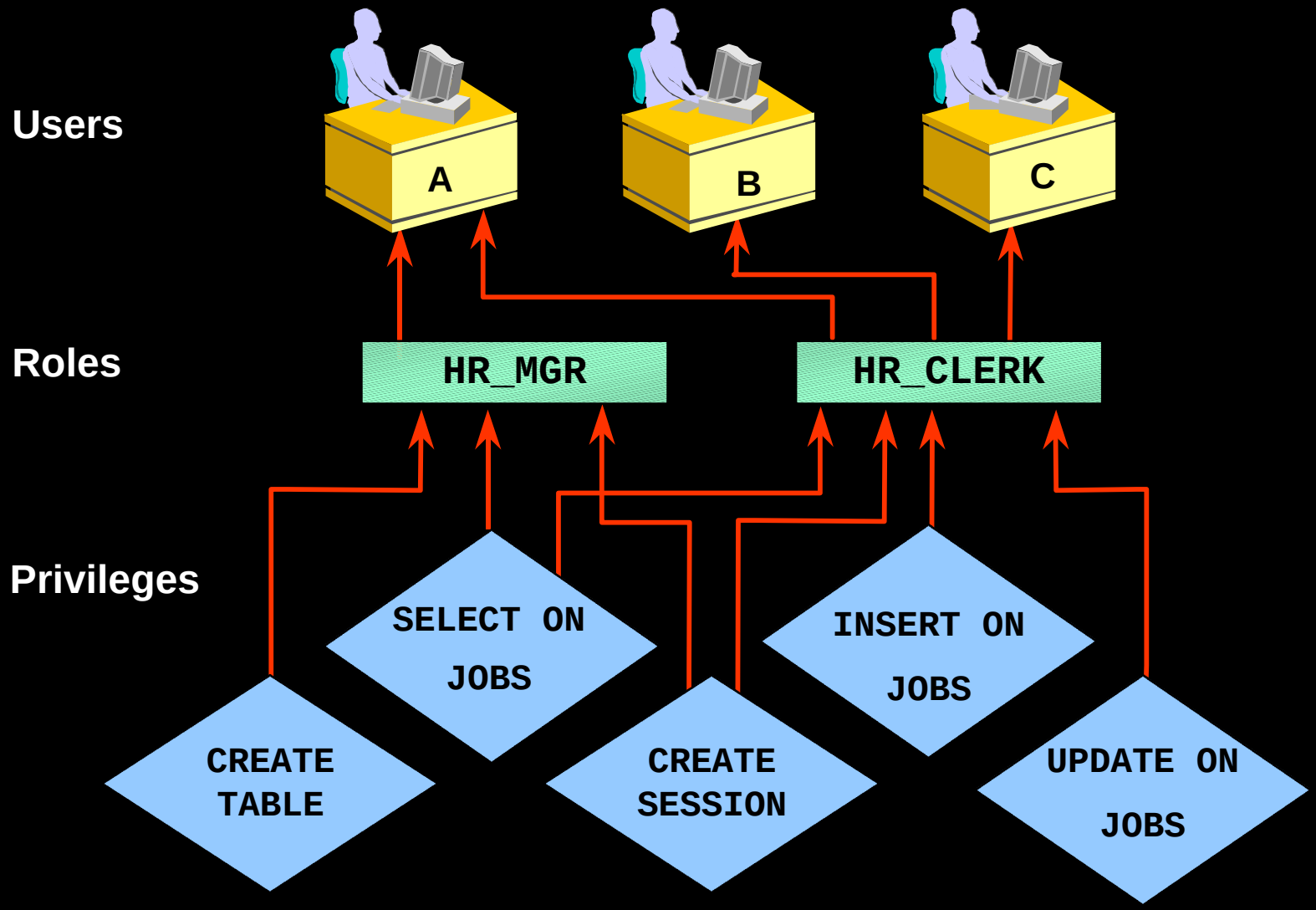
Managing Roles

Objectives

After completing this lesson, you should be able to do the following:

- Create and modify roles
- Control availability of roles
- Remove roles
- Use predefined roles
- Display role information from the data dictionary

Roles



Benefits of Roles

- Easier privilege management
- Dynamic privilege management
- Selective availability of privileges
- Can be granted through the operating system
- Improved performance

Creating Roles

```
CREATE ROLE oe_clerk;
```

```
CREATE ROLE hr_clerk
      IDENTIFIED BY bonus;
```

```
CREATE ROLE hr_manager
      IDENTIFIED EXTERNALLY;
```

Predefined Roles

Role Name	Description
CONNECT, RESOURCE, DBA	These roles are provided for backward compatibility
EXP_FULL_DATABASE	Privileges to export the database
IMP_FULL_DATABASE	Privileges to import the database
DELETE_CATALOG_ROLE	DELETE privileges on data dictionary tables
EXECUTE_CATALOG_ROLE	EXECUTE privilege on data dictionary packages
SELECT_CATALOG_ROLE	SELECT privilege on data dictionary tables

Modifying Roles

```
ALTER ROLE oe_clerk
      IDENTIFIED BY order;
```

```
ALTER ROLE hr_clerk
      IDENTIFIED EXTERNALLY;
```

```
ALTER ROLE hr_manager
      NOT IDENTIFIED;
```

Assigning Roles

```
GRANT oe_clerk TO scott;
```

```
GRANT hr_clerk TO hr_manager;
```

```
GRANT hr_manager TO scott WITH ADMIN
OPTION;
```

Establishing Default Roles

```
ALTER USER scott
      DEFAULT ROLE hr_clerk, oe_clerk;
```

```
ALTER USER scott DEFAULT ROLE ALL;
```

```
ALTER USER scott DEFAULT ROLE ALL EXCEPT
hr_clerk;
```

```
ALTER USER scott DEFAULT ROLE NONE;
```

Application Roles

- Application roles can be enabled only by authorized PL/SQL packages
- The USING package clause creates an Application Role

```
CREATE ROLE admin_role
      IDENTIFIED USING hr.employee;
```

Enabling and Disabling Roles

- Disable a role to revoke the role from a user temporarily
- Enable a role to grant it temporarily
- The `SET ROLE` command enables and disables roles
- Default roles are enabled for a user at login.
- A password may be required to enable a role.

Enabling and Disabling Roles

```
SET ROLE hr_clerk;
```

```
SET ROLE oe_clerk IDENTIFIED BY order;
```

```
SET ROLE ALL EXCEPT oe_clerk;
```

Removing Roles from Users

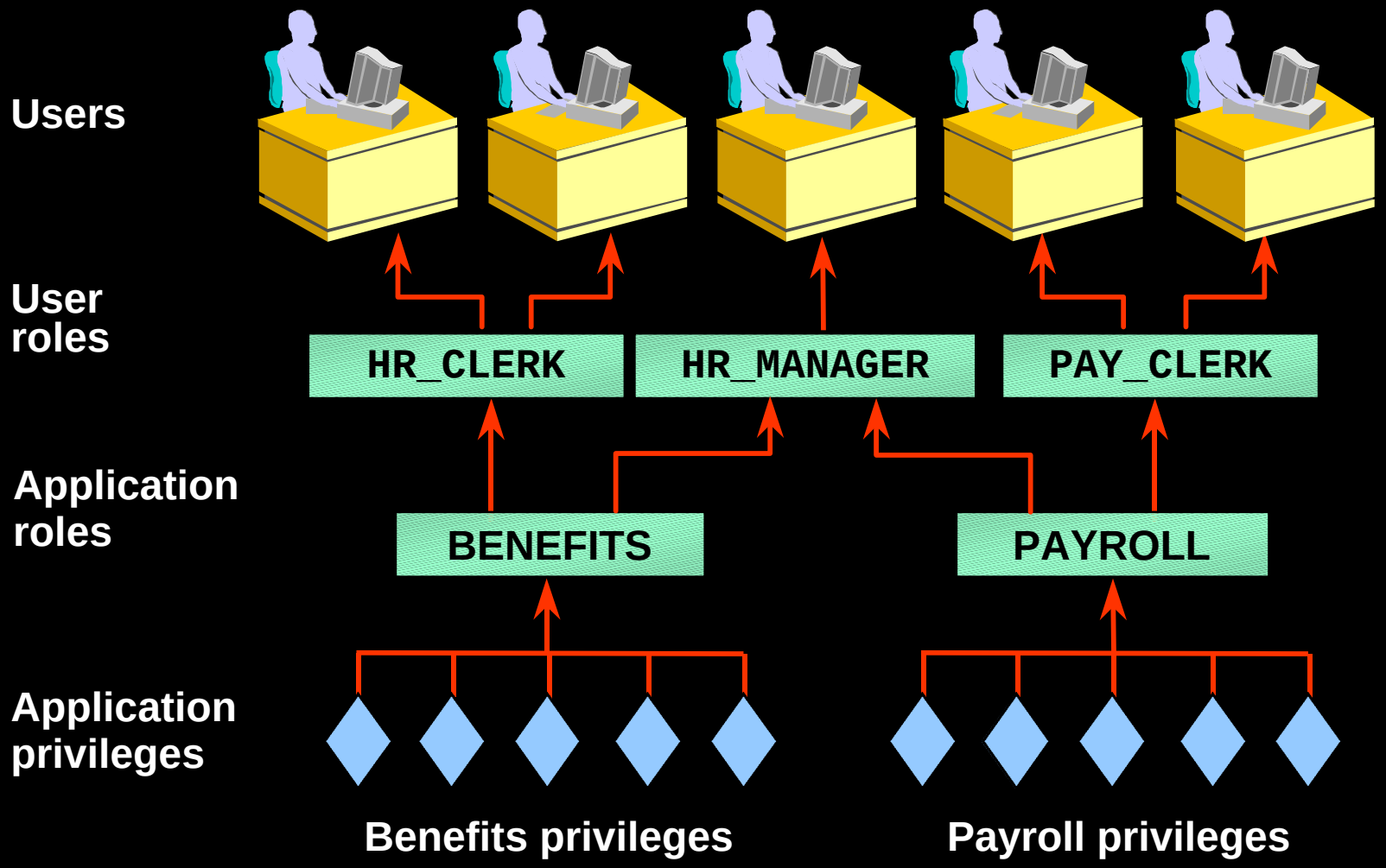
```
REVOKE oe_clerk FROM scott;
```

```
REVOKE hr_manager FROM PUBLIC;
```

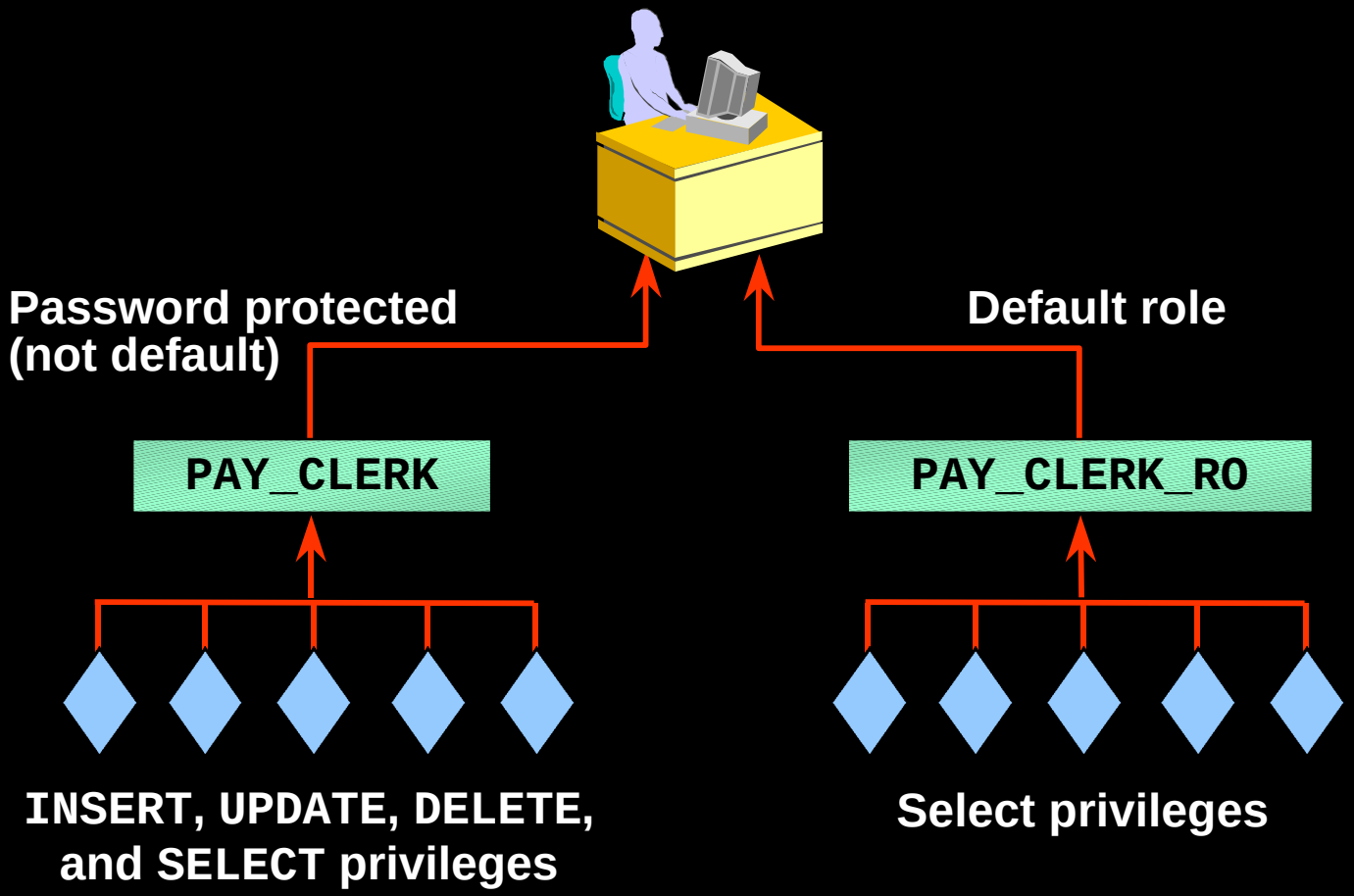
Removing Roles

```
DROP ROLE hr_manager;
```

Guidelines for Creating Roles



Guidelines for Using Passwords and Default Roles



Displaying Role Information

Role View	Description
DBA_ROLES	All roles that exist in the database
DBA_ROLE_PRIVS	Roles granted to users and roles
ROLE_ROLE_PRIVS	Roles that are granted to roles
DBA_SYS_PRIVS	System privileges granted to users and roles
ROLE_SYS_PRIVS	System privileges granted to roles
ROLE_TAB_PRIVS	Object privileges granted to roles
SESSION_ROLES	Roles that the user currently has enabled

Summary

In this lesson, you should have learned how to:

- Create roles
- Assign privileges to roles
- Assign roles to users or roles
- Establish default roles

Practice 17 Overview

This practice covers the following topics:

- Listing system privileges for a role
- Creating, assigning and dropping roles
- Creating Application roles

18

Using Globalization Support

Objectives

After completing this lesson, you should be able to do the following:

- Choose database character set and national character set for a database
- Specify the language-dependent behavior using initialization parameters, environment variables, and the `ALTER SESSION` command
- Use the different types of National Language Support (NLS) parameters
- Explain the influence on language-dependent application behavior
- Obtain information about Globalization Support usage

Globalization Support Features

- Language support
- Territory support
- Character set support
- Linguistic sorting
- Message support
- Date and time formats
- Numeric formats
- Monetary formats

Different Types of Encoding Schemes

Oracle supports different classes of character encoding schemes:

- Single-byte character sets
  - 7-bit
  - 8-bit
- Varying-width multibyte character sets
- Fixed-width multibyte character sets
- Unicode (AL32UFT8, AL16UTF16, UTF8)

Database Character Sets and National Character Sets

Database Character Sets	National Character Sets
Defined at creation time	Defined at creation time
May not be change without re-creation, few exceptions	May not be changed without re-creation, few exceptions
Store data columns of type `CHAR`, `VARCHAR2`, `CLOB`, `LONG`	Store data columns of type `NCHAR`, `NVARCHAR2`, `NCLOB`
Can store varying-width character sets	Can store Unicode using either AL16UTF16 or UTF8

Guidelines for Choosing an Oracle Database Character Set

Considerations

- What language does the database need to support?
- What are interoperability concerns with system resources and applications?
- What are the performance implications?
- What are the restrictions?

Guidelines for Choosing an Oracle National Character Set

- Two choices
  - AL16UTF16
  - UTF8
- Is space an issue?
- Is performance an issue?

Choosing a Unicode Solution
Unicode Database

When Should You Use a Unicode Database?

- **Easy code migration for Java or PL/SQL**
- **Easy data migration from ASCII based data**
- **Evenly distributed multilingual data**
- **InterMedia Text Search**

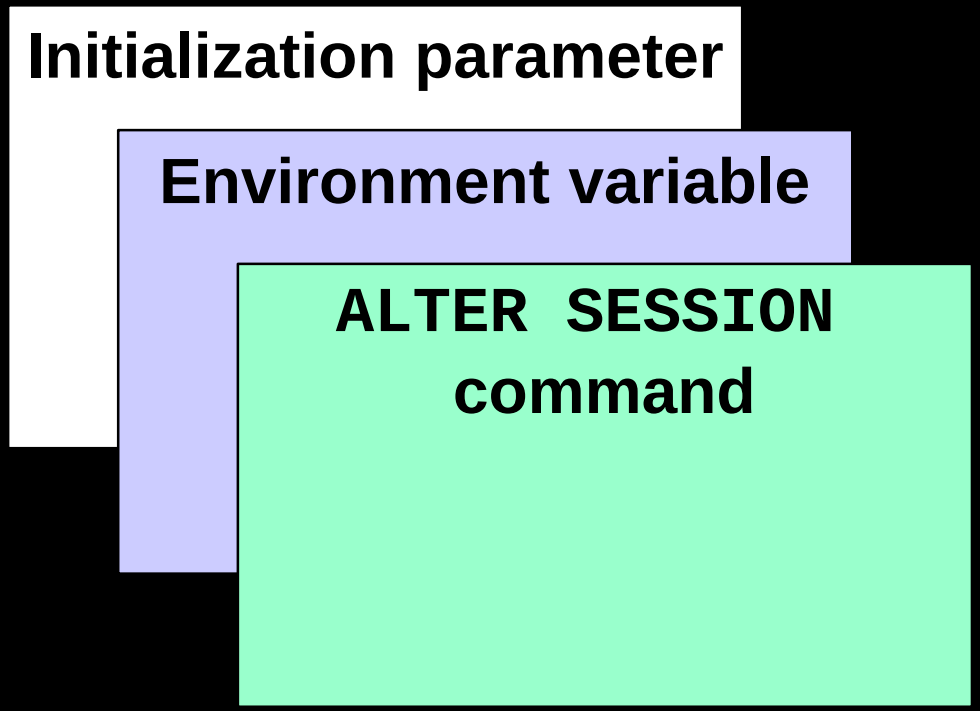
Choosing a Unicode Solution
Unicode Datatype

When should you use a Unicode datatype?

- Adding multilingual support incrementally
- Packaged applications
- Performance

  Single byte database character set with a fixed width national character set
- Better support for UTF-16 with windows clients

Specifying Language-Dependent Behavior



Specifying Language-Dependent Behavior for the Server

NLS_LANGUAGE specifies:

- The language for messages
- Day and month names
- Symbols for A.D, B.C, A.M, P.M.
- The default sorting mechanism

NLS_TERRITORY specifies:

- Day and week numbering
- Default date format, decimal character, group separator, and the default ISO and local currency symbols

Dependent Language and Territory Default Values

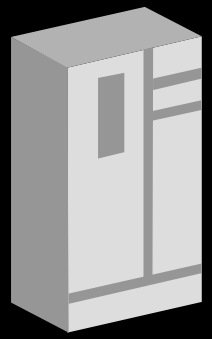
PARAMETER	VALUES
NLS_LANGUAGE	AMERICAN
NLS_DATE_LANGUAGE	AMERICAN
NLS_SORT	BINARY
NLS_TERRITORY	AMERICA
NLS_CURRENCY	$
NLS_ISO_CURRENCY	AMERICA
NLS_DATE_FORMAT	DD-MON-RR
NLS_NUMERIC_CHARACTERS	,.

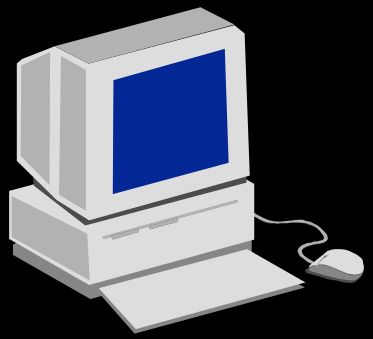
Specifying Language-Dependent Behavior for the Session

- Environment variable:
  `NLS_LANG=French_France.UTF8`
- Additional environment variables:
  - `NLS_DATE_FORMAT`
  - `NLS_DATE_LANGUAGE`
  - `NLS_SORT`
  - `NLS_NUMERIC_CHARACTERS`
  - `NLS_CURRENCY`
  - `NLS_ISO_CURRENCY`
  - `NLS_CALENDAR`

Character Sets in Client-Server Architecture

```
NLS_LANG=<language>_<territory>.<charset>
NLS_NCHAR=<ncharset>
```





```
CREATE DATABASE ...
CHARACTER SET <charset>
NATIONAL CHARACTER SET
<ncharset>
...
```

Specifying Language-Dependent Behavior for the Session

```
ALTER SESSION SET NLS_DATE_FORMAT='DD.MM.YYYY';
```

```
DBMS_SESSION.SET_NLS('NLS_DATE_FORMAT',
'''DD.MM.YYYY''') ;
```

Linguistic Sorting

Oracle provides three types of sorting

- Binary sorting, sorted according to the binary values of the encoded characters
- Monolingual sorting
  - Sorts in two passes
  - Based on a character's assigned major and minor values
- Multilingual sorting
  - Based on the new ISO 14651 and,
  - Unicode 3.0 Standard for multilingual collation

NLS Sorting

- NLS_SORT specifies the type of sort for character data
  - Is defined by the NLS_LANG environment variable
  - May be overridden at the session level
- NLSSORT function
  - Specifies the type of sort for character data
  - Allows sorts to defined at the query level

Using NLS Parameters in SQL Functions

```
SELECT TO_CHAR(hire_date,'DD.Mon.YYYY',
       'NLS_DATE_LANGUAGE=FRENCH')
FROM   employees;
```

```
SELECT ename, TO_CHAR(sal,'9G999D99',
       'NLS_NUMERIC_CHARACTERS=''.,''')
FROM   emp;
```

Linguistic Index Support

- Linguistic indexing
- High performance with local sorting

```
CREATE INDEX list_word ON
   list (NLSSORT(word, 'NLS_SORT = French_M'));
```

- NLS_COMP parameter for linguistic comparisons

Import and Loading Data Using NLS

- Data will be converted from export file character set to the database character set during the import.
- LOADER:
  - Conventional: Data is converted into the session character set specified by `NLS_LANG`.
  - DIRECT: Data is converted directly into the database character set.

Obtaining Information About Character Sets

NLS_DATABASE_PARAMETERS:

- **PARAMETER (NLS_CHARACTERSET, NLS_NCHAR_CHARACTERSET)**
- **VALUE**

Obtaining Information About NLS Settings

NLS_INSTANCE_PARAMETERS:

- **PARAMETER (initialization parameters that have been explicitly set)**
- **VALUE**

NLS_SESSION_PARAMETERS:

- **PARAMETER (session parameters)**
- **VALUE**

Obtaining Information About NLS Settings

V$NLS_VALID_VALUES:

- **PARAMETER (LANGUAGE, SORT, TERRITORY, CHARACTERSET)**
- **VALUE**

V$NLS_PARAMETERS:

- **PARAMETER (NLS session parameters, NLS_CHARACTERSET)**
- **VALUE**

Globalization Support Utilities

- Character Set Scanner
  - Scans the database to determine if the character set can be changed
  - Reports are provided detailing possible problems and fixes
- Oracle Locale Builder
  - Easy to use graphical interface
  - For viewing, modifying, and creating locale definitions

Summary

In this lesson, you should have learned how to:

- Choose a database character set and a national character set for the database
- Use the various types of National Language Support parameters for the server, or the session

Practice 18 Overview

This practice covers the following topics:

- Checking the database and national character set
- Identifying valid NLS values
- Setting NLS parameters