Basic Introduction

What we will learn in this lecture?

- What is Data?
- What is Database ?
- What is DBMS/ RDBMS?
- What Is the Table?
- What is SQL and PL/SQL?
- Types of SQL statements
- What is the relational Database?
- What is Normalization ?
- Problems without normalization.
- Types of hosting oracle database 12c/ 18c

What is Data?

facts or figures ,Pieces of information. (Unprocessed , Unorganized)

What is Database?

It is organized collection of information.

What is DBMS?

Database management system to store and retrieve and modify data in the database.

And because Oracle is relational database, then we have RDBMS which is:
Relational database management system.

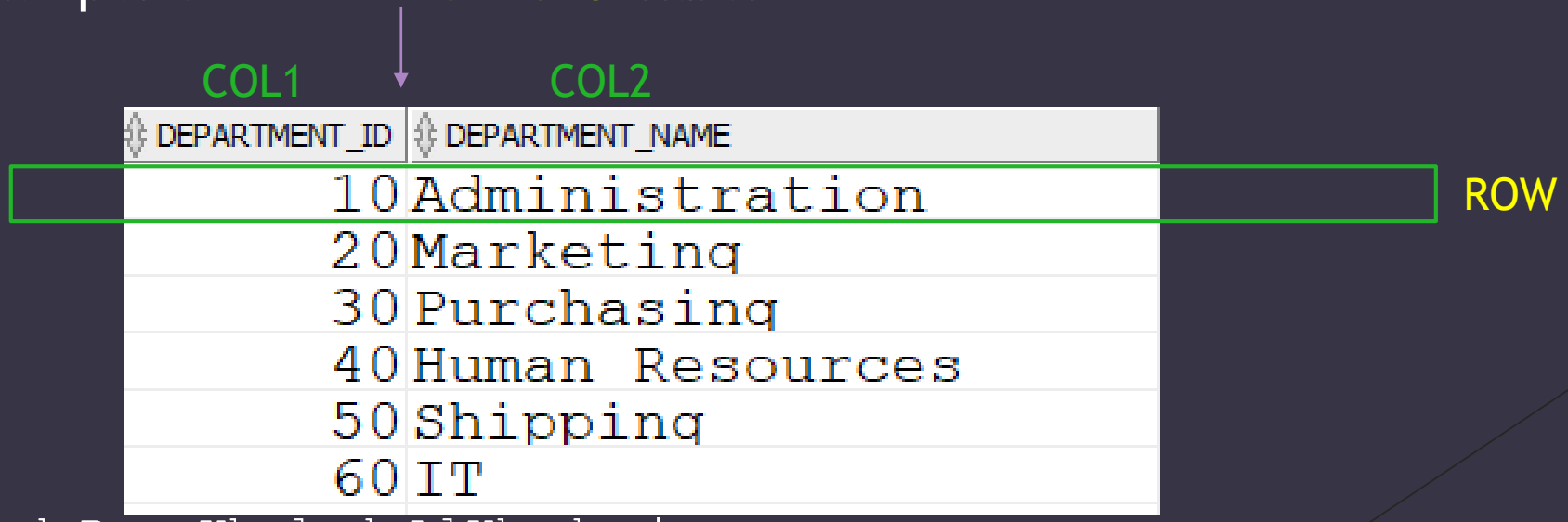
The purpose of Oracle Database is to store , organize, and retrieve data for your applications (***application*** :interface between users and DB)

What is the Table?

It is the basic storage unit of an RDBMS (it is logical unit , not physical)

The table consists of rows and columns

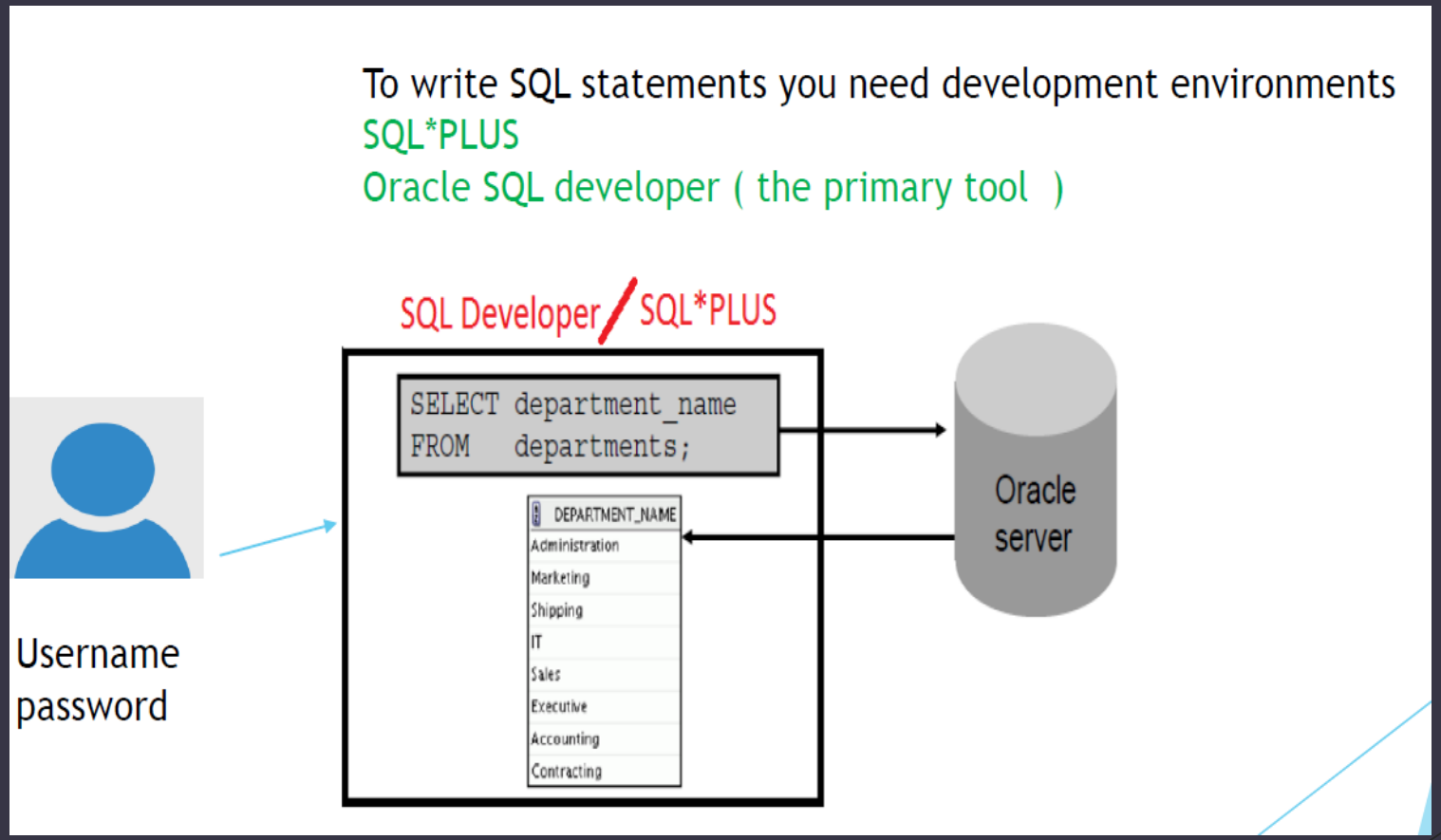
Example : **DEPARTMENTS** table

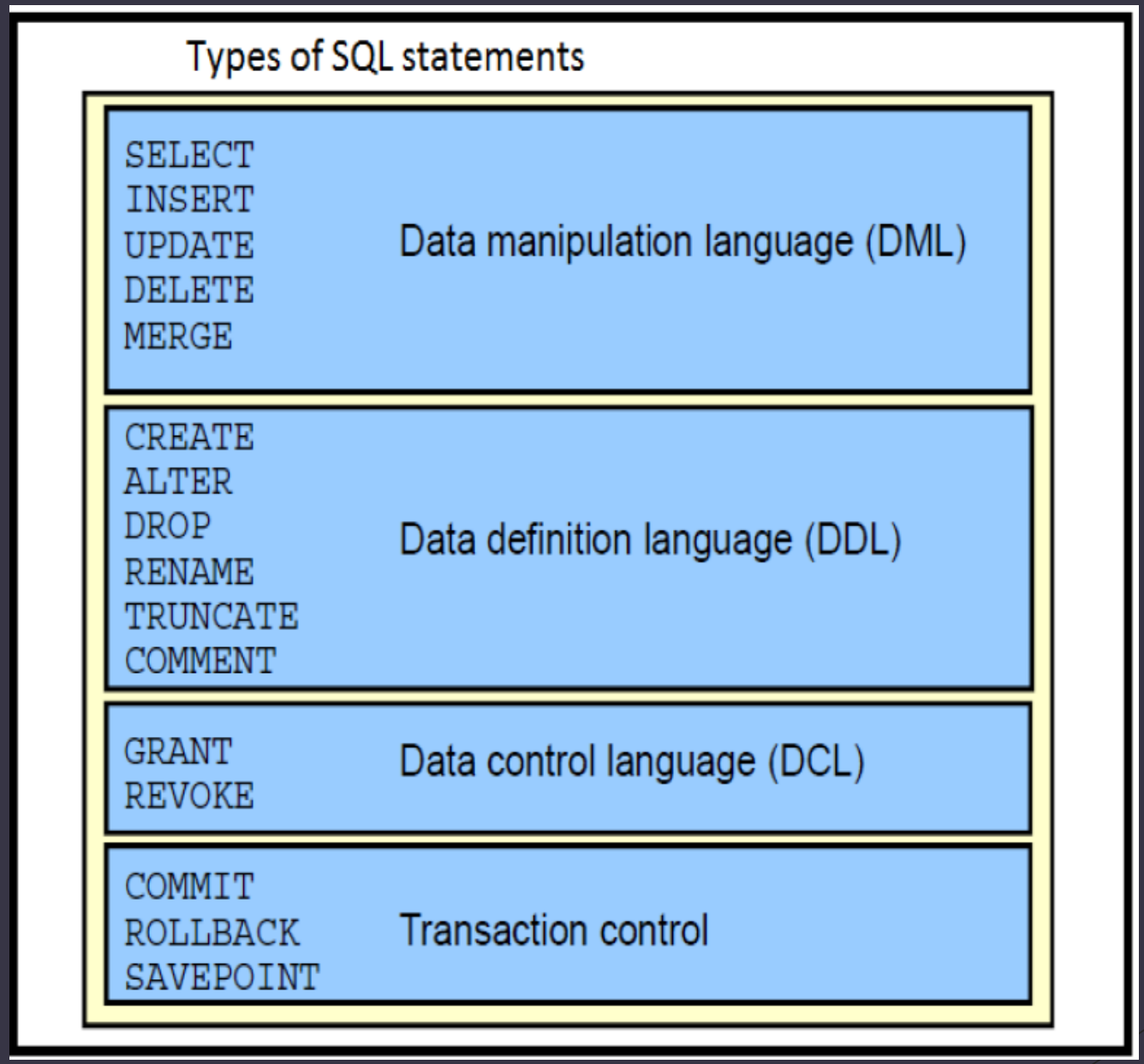


To access Oracle database you need SQL

What is SQL?

SQL is structure query language to access database




Types of SQL statements
SELECT
INSERT
UPDATE
DELETE
MERGE
Data manipulation language (DML)
CREATE
ALTER
DROP
RENAME
TRUNCATE
COMMENT
Data definition language (DDL)
GRANT
REVOKE
Data control language (DCL)
COMMIT
ROLLBACK
SAVEPOINT
Transaction control

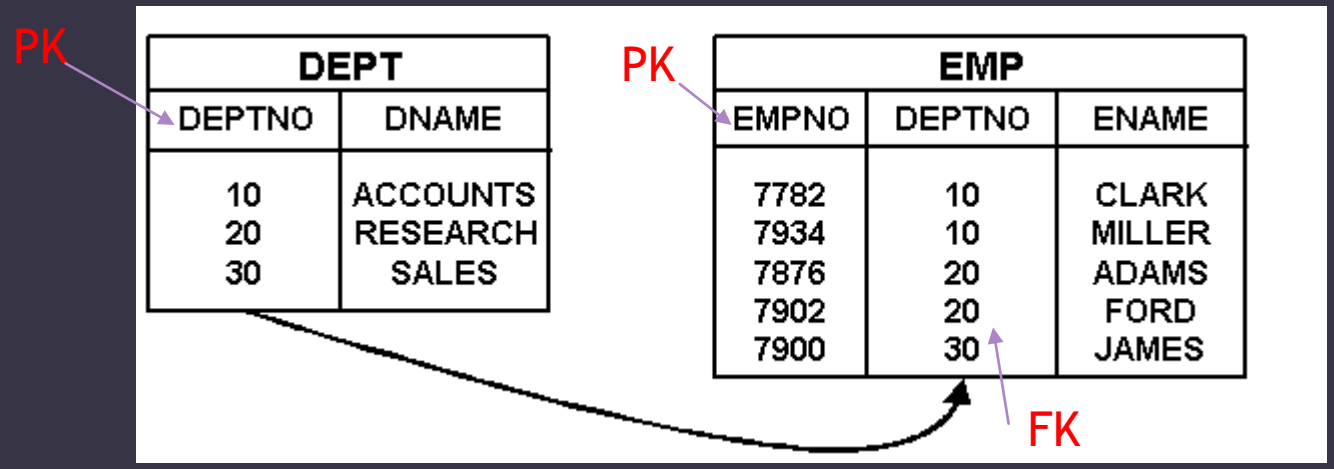
About PL/SQL

Belong to oracle

- PL/SQL is the procedural extension to SQL with design features of programming languages.
- Data manipulation and query statements of SQL are included within procedural units of code.

Oracle is a Relational Database

A relational database stores data in a set of simple relations



What is Normalization?

- Normalization is a database design technique which organizes tables in a manner that reduces redundancy and dependency of data.
- It divides larger tables to smaller tables and links them using relationships.

Problems Without Normalization

- Extra memory space
- Difficult to handle and update the database
- Data Inconsistency

EMP		
EMPNO	DEPTNO	ENAME
7782	10	CLARK
7934	10	MILLER
7876	20	ADAMS
7902	20	FORD
7900	30	JAMES

DNAME
accounts
ACCOUNTS

DEPT	
DEPTNO	DNAME
10	ACCOUNTS
20	RESEARCH
30	SALES

EMP		
EMPNO	DEPTNO	ENAME
7782	10	CLARK
7934	10	MILLER
7876	20	ADAMS
7902	20	FORD
7900	30	JAMES

Note:
In some cases we need DE-normalization for reporting purpose and for better performance

Hosting Oracle 12c / 18c

On-Premises

The Software installed in your own Environments (your own server)

Cloud

Oracle host the Database and all its components

Thank You

Brief History of Oracle Database

- ✓ ***In 1977***, Larry Ellison, Bob Miner, and Ed Oates started the consultancy Software Development Laboratories, which became Relational Software Inc (RSI) .

- ✓ ***In 1983***, RSI became Oracle Systems Corporation and then later Oracle Corporation.

- ✓ ***In 1979***, Oracle V2 :the first commercially available SQL-based RDBMS

- ✓ ***in 1983***, Oracle V3:
the first relational database to run on mainframes, minicomputers, and PCs. The database was written in C, enabling the database to be ported to multiple platforms.

- ✓ *In 1984* , Oracle v4: Multiversion read consistency

- ✓ ***in 1985*** , Oracle v5: supported client/server computing and distributed database systems

- ✓ ***In 1988*** , Oracle v6 : brought enhancements to disk I/O, row locking, scalability, and backup and recovery, introduced the first version of the PL/SQL language.

Brief History of Oracle Database

- ✓ ***In 1992*** , Oracle7: introduced PL/SQL stored procedures and triggers
- ✓ ***In 1997*** , Oracle8 was released the object-relational database, supporting many new data types. Additionally, Oracle8 supported partitioning of large tables.
- ✓ ***In 1999*** ,Oracle8i :provided native support for internet protocols and server-side support for Java.
- ✓ ***In 2001*** ,Oracle9i :introduced Oracle RAC, enabling multiple instances to access a single database Additionally, introduced Oracle XML Database.
- ✓ ***In 2003*** ,Oracle 10g : introduced grid computing ,A computing architecture that coordinates large numbers of servers and storage to act as a single large computer
- ✓ ***In 2007*** , Oracle 11g:Active Data Guard, Secure Files, Exadata and many new features
- ✓ **In 2013** ,Oracle 12c: designed for the Cloud , Multitenant architecture
- ✓ **In 2018** ,Oracle 18c: Cloud , Multitenant architecture , and many new features

https://en.wikipedia.org/wiki/Oracle_Database

Thank You

Oracle DB editions

What we will learn in this lecture?

- ❑ What are the available database editions in 12c?
- ❑ What are the available database editions in 18c?
- ❑ What is the purpose of each edition ?

Oracle database software can be very expensive or very cheap (even free), depending on what you buy/use

Oracle DB 12c editions

- Oracle Database Personal Edition (PE)

supports single-user development, includes all of the components that are included with Enterprise Edition , no Oracle RAC , no Oracle Management Packs

- Oracle Database Standard Edition 2 (SE2) starting from Release 1 (12.1.0.2).

includes all the features necessary to develop workgroup and Web applications. Support RAC, no parallel execution, no Data guard, no management pack, no cloud control , only one pluggable database allowed

Note: before SE2, we have SE and SE1 and both no RAC option

- Oracle Database Enterprise Edition (EE)

Oracle Database Enterprise Edition provides performance, availability, scalability, and security for developing applications such as high-volume online transaction processing (OLTP) applications, query-intensive data warehouses, and demanding Internet applications. Oracle Database Enterprise Edition contains all of the components of Oracle Database

- Oracle Database Express Edition (XE)

Free but limited , use 1 CPU, 1 GB memory

To know more about Oracle DB editions

12c

https://docs.oracle.com/database/121/DBLIC/editions.htm#DBLIC-GUID-B6113390-9586-46D7-9008-DCC9EDA45AB4

18c

https://docs.oracle.com/en/database/oracle/oracle-database/18/dblic/Licensing-Information.html#GUID-B6113390-9586-46D7-9008-DCC9EDA45AB4

Thank You

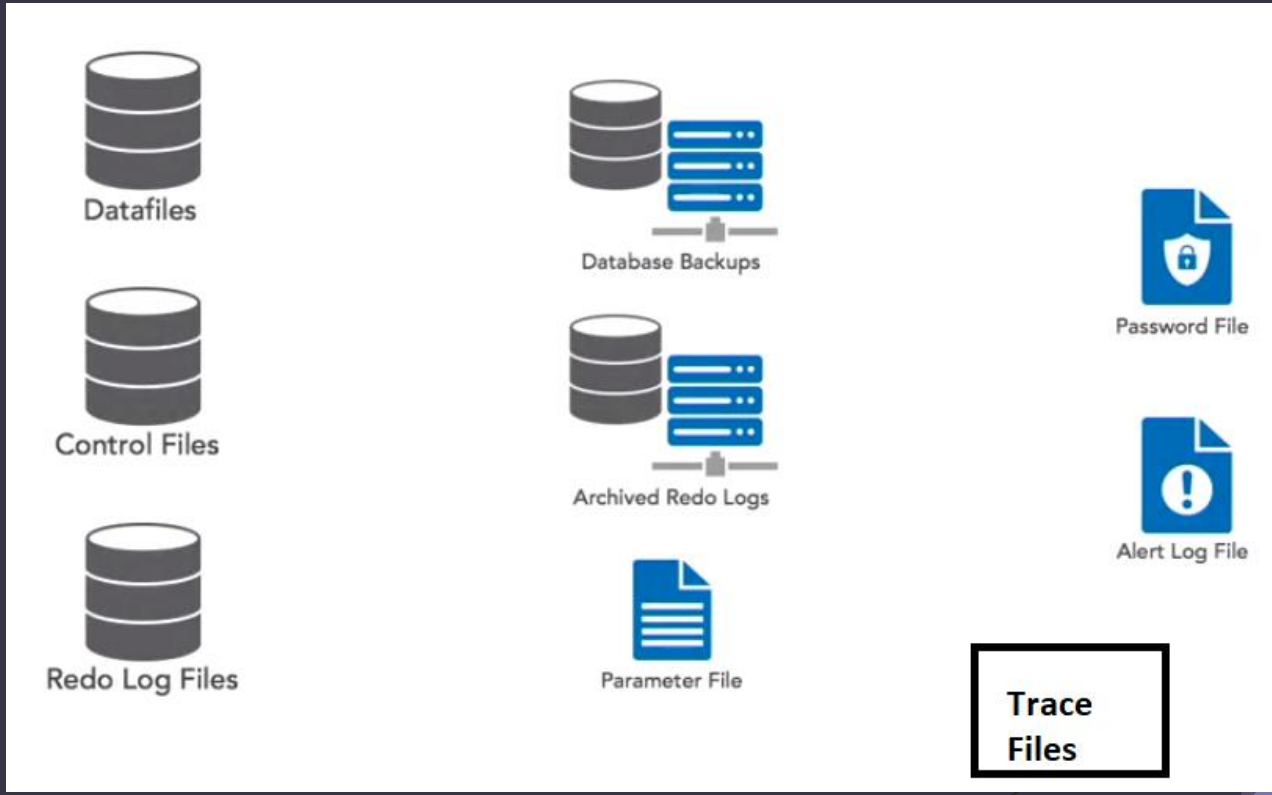
Database VS Database Instance

Oracle DB consists of 2 major components

- The Database storage
- The Oracle Instance

Database: Organized collection of information.
It contains collection of database files stored in disk storage. (physical)

Types of Database files:

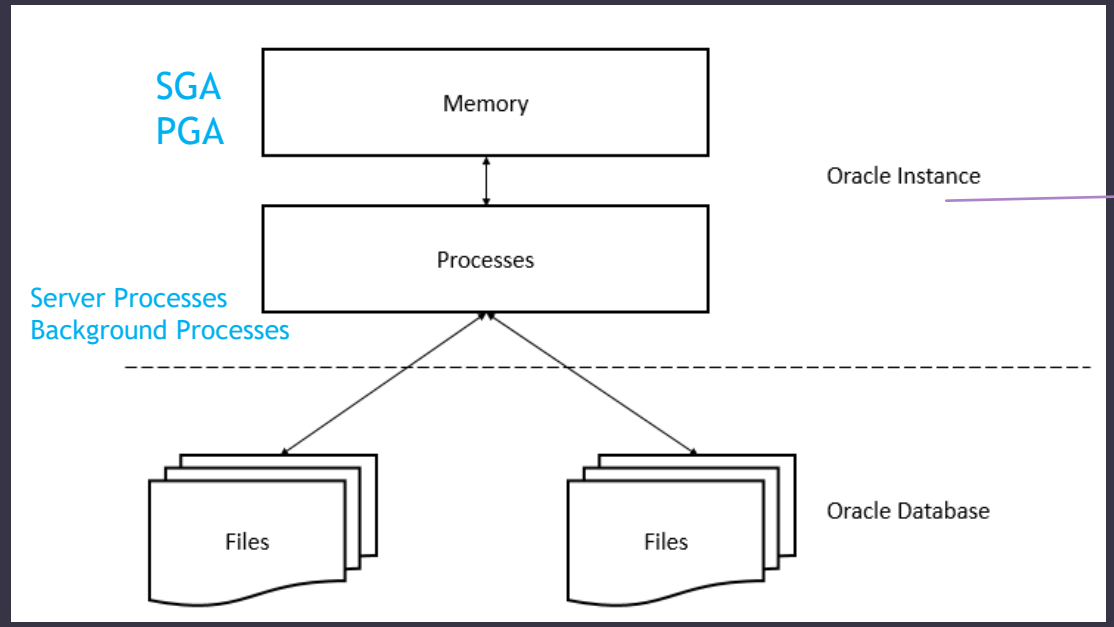


Database VS Database Instance

What is Database Instance?

A database instance is a set of memory structures and processes that manage database files

Note: A database instance exists only in memory



- The Oracle program, or binary, loaded into the server RAM
- created by Oracle every time you start up your database
- reading from memory is a lot faster compared to reading from disk

✓ Every running Oracle database is associated with at least one Oracle database instance.

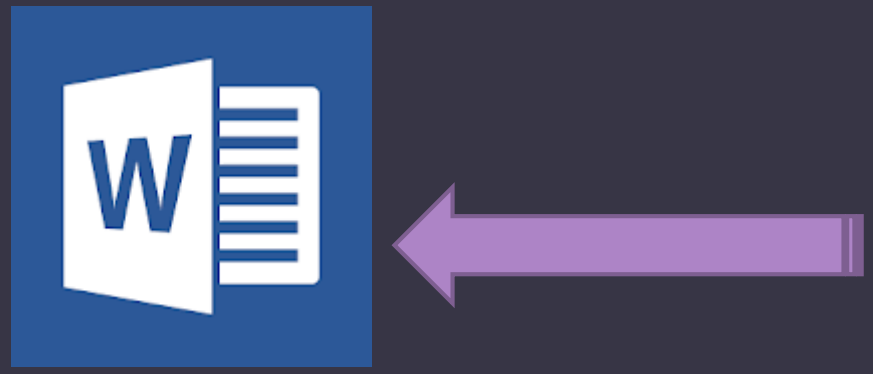
✓ Because an instance exists in memory and a database exists on disk, *an instance can exist without a database and a database can exist without an instance.*

✓ ***Losing instance no issue, losing data files for example = losing the database***

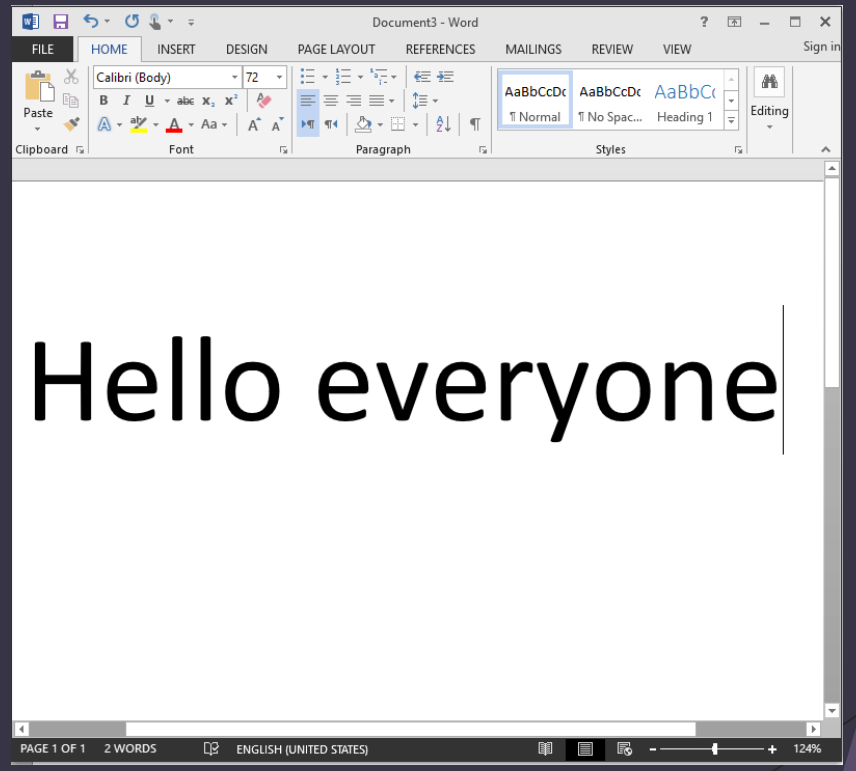
Database VS Database Instance

Another simple way to understand DB and instance :)

Microsoft word and Microsoft document



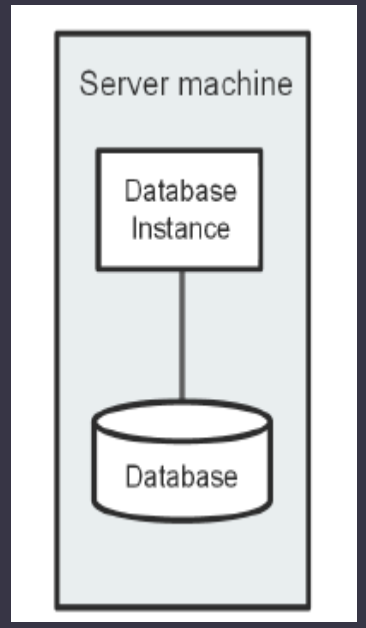
Microsoft word
(imagine it the instance)



Microsoft document (imagine it the DB)

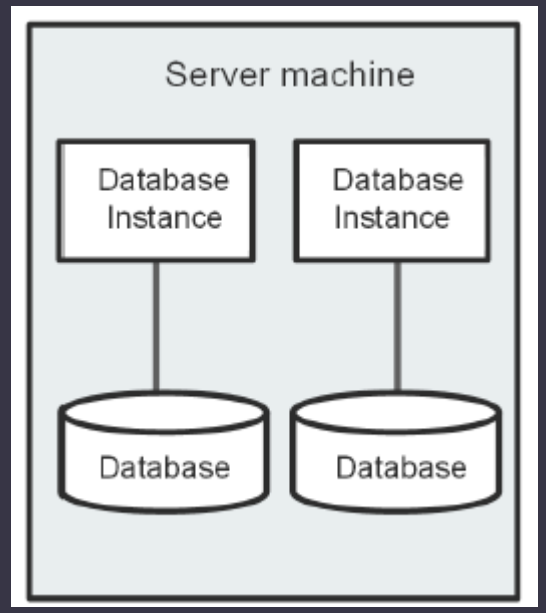
Oracle DB Server architecture

Configuration options



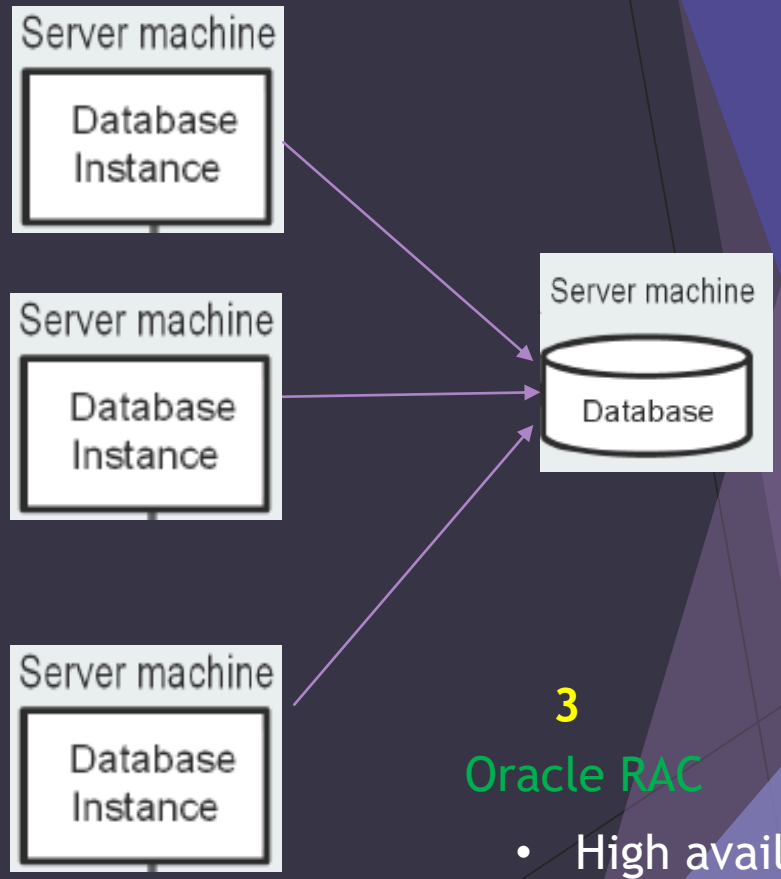
1

Single-instance DB



2

Multi Single-instance DBs
On same server



3

Oracle RAC

- High availability
- Scalability
- High performance

Thank You

Database Instance

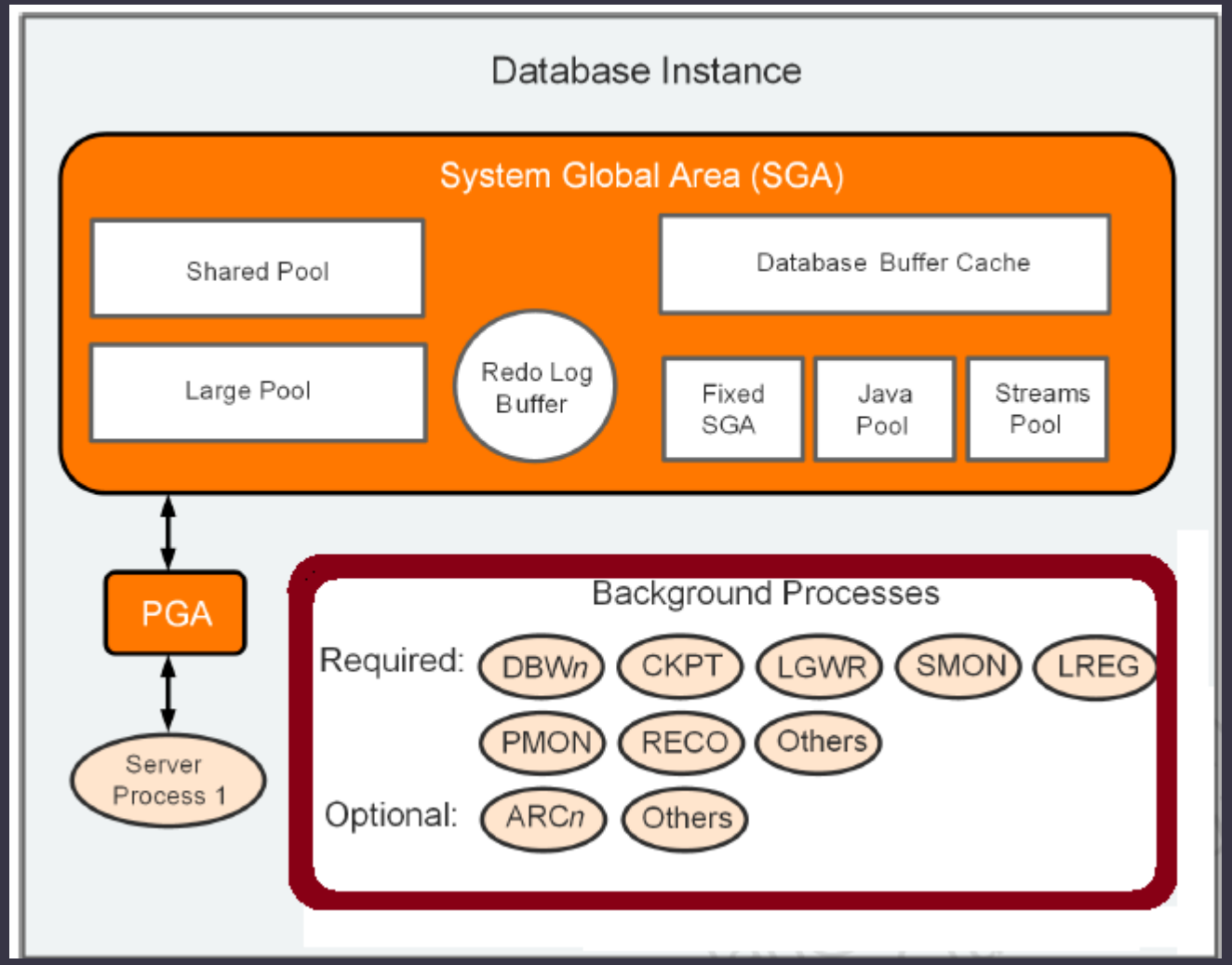
sever processes + PGA

What we will learn in this lecture?

- What is the sever processes?
- Tasks of sever processes?
- What is the PGA?
- Oracle dedicated server process
- *Oracle Shared Server Processes*

Database Instance in-depth

A database instance is a set of memory structures and processes that manage database files



Memory

- ✓ System Global Area (SGA)
- ✓ Program Global Area (PGA)

Processes

- ✓ Background processes
- ✓ Server processes

Server processes + PGA

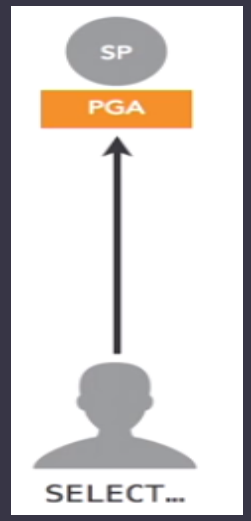
- Oracle starts up server processes to handle the requests of client processes (User sessions) connected to the Oracle database

- Perform the work for the client program

Example: Parsing and running SQL statements , retrieving results to the client program *and this mean reading database data from the database storage and loading that data into the Oracle instance buffer cache.*

- Act on behalf of client sessions

- Each server process has its own cache dedicated for each connecting client.
  This cache is also known as the PGA



So here in this example, I have one user session doing select statement ,so this mean Oracle will create SP and this SP has its own PGA

More users= more dedicated server processes

PGA: non-shared memory region reserved only for the specific user session connected to that specific server process.

it contains data and control information used by the server processes when sorting data, joining large tables together as part of a SQL statement, and so on

Server processes

Oracle dedicated server process

one-to-one relation
between connecting user sessions
and server processes

Oracle Shared Server Processes

client user processes connect to a dispatcher.
The dispatcher can support multiple
client connections concurrently

Shared server architecture eliminates the need
for a dedicated server process for each connection

Your database is always enabled to allow dedicated server processes, but you must specifically configure and enable **shared server** by setting one or more initialization parameters

Thank You

Database Instance

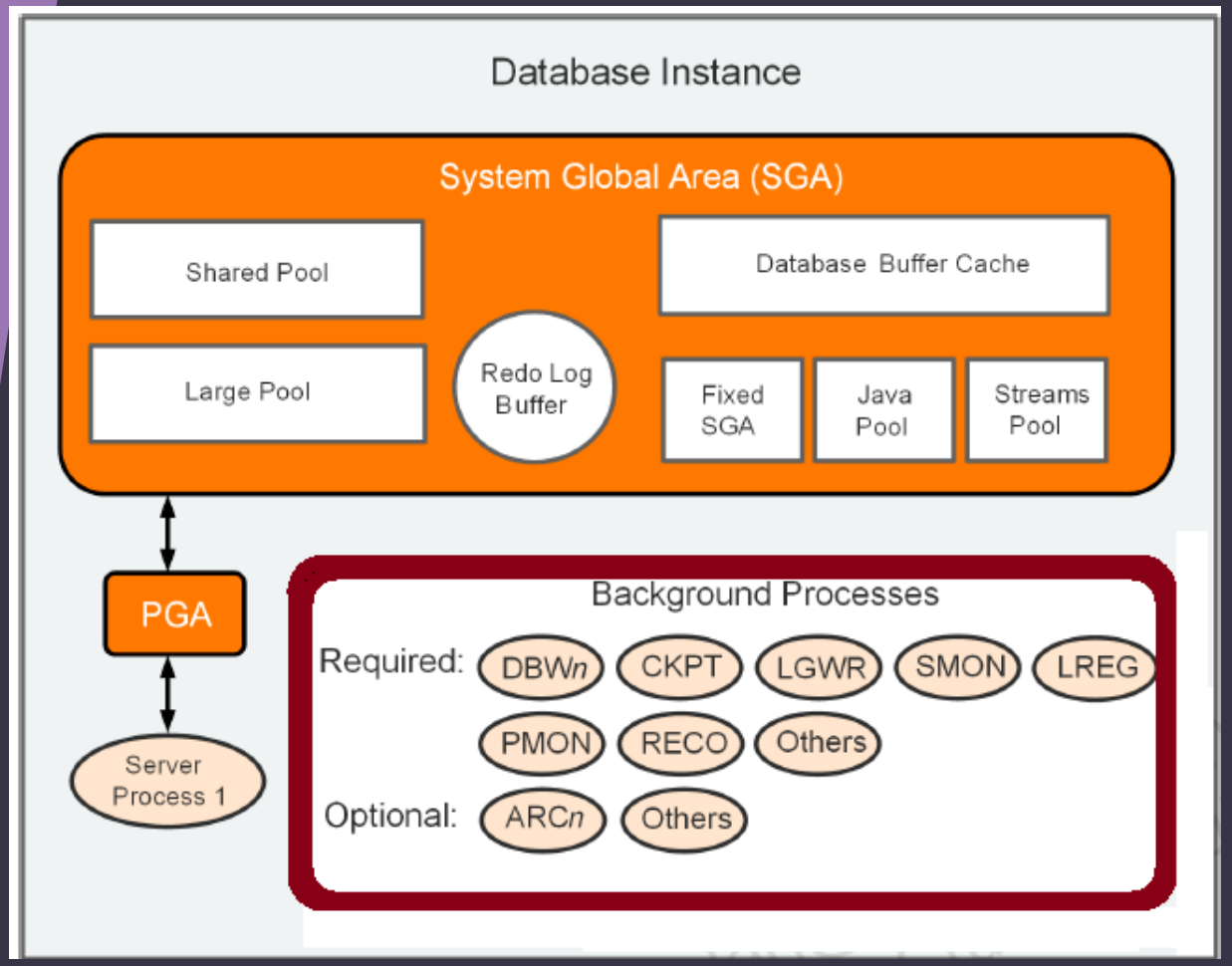
System Global Area (SGA) Part 1

What we will learn in this lecture?

- What is System Global Area (SGA)?
- Main tasks of SGA
- Shared Pool
- Database buffer cache
- Redo Log Buffer

Database Instance

A database instance is a set of memory structures and processes that manage database files

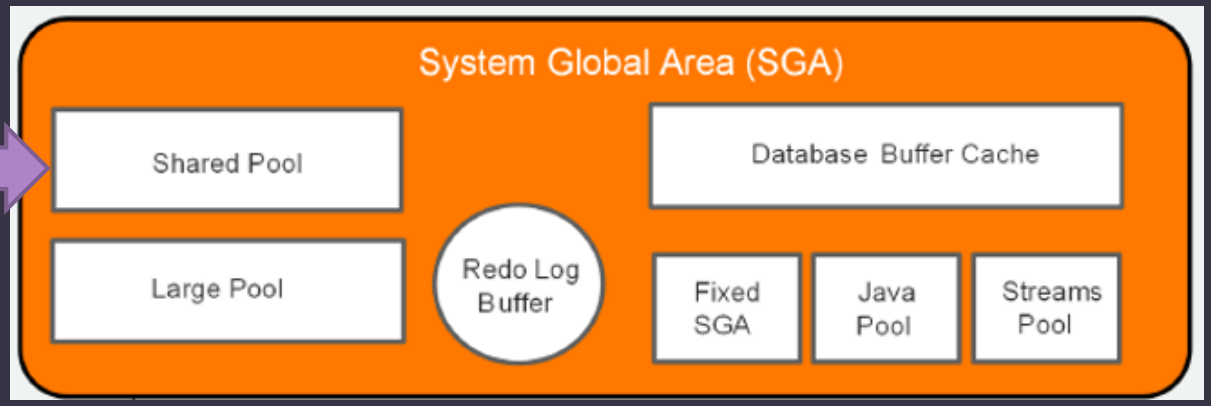


What is System Global Area (SGA)

The SGA is a group of shared memory structures that contain data and control information for one database instance.

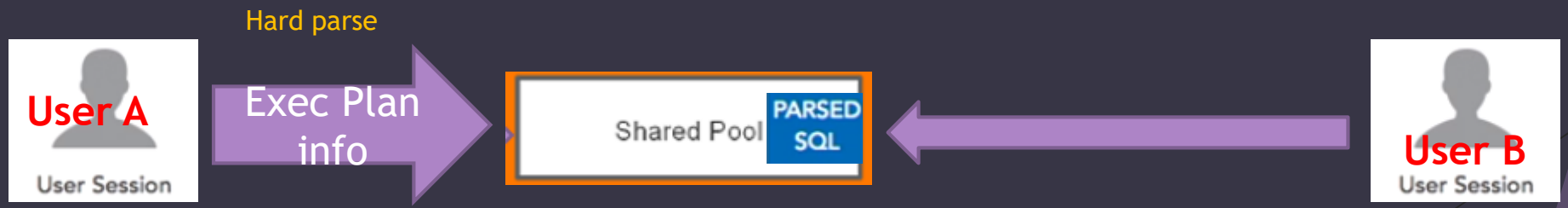
Main tasks of SGA

- ✓ Maintaining internal data structures that many processes access concurrently
- ✓ Caching data blocks read from disk
- ✓ Buffering redo data before writing it to the online redo log files
- ✓ Storing SQL execution plans



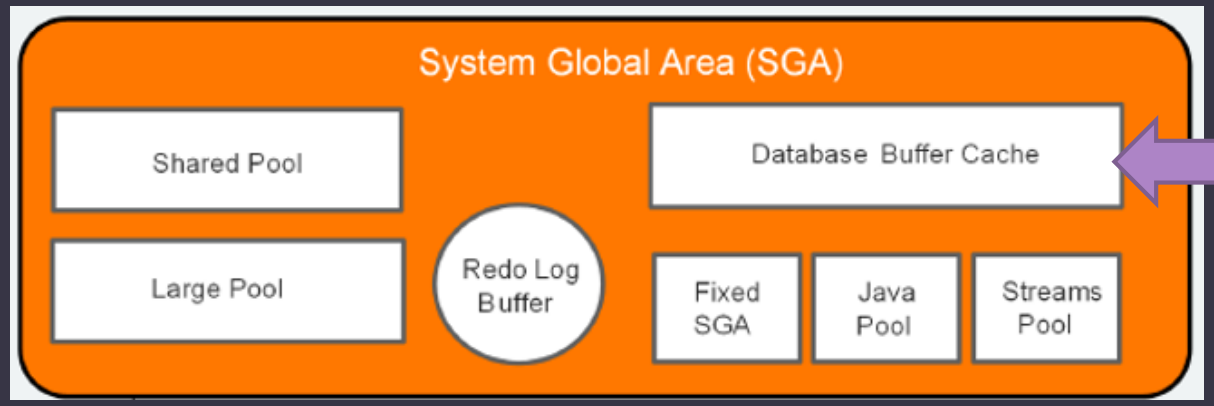
Shared Pool

- The most important component of SGA
- Cache non user Data like Data dictionary (metadata: data about data ex: DBA_tables)
- Shared Pool contains sub components like Data dictionary cache, library cache ,server result cache and many others
- Store the cached information about each SQL statement that is executed, like execution plan



Select * from DEPT;

Select * from DEPT;

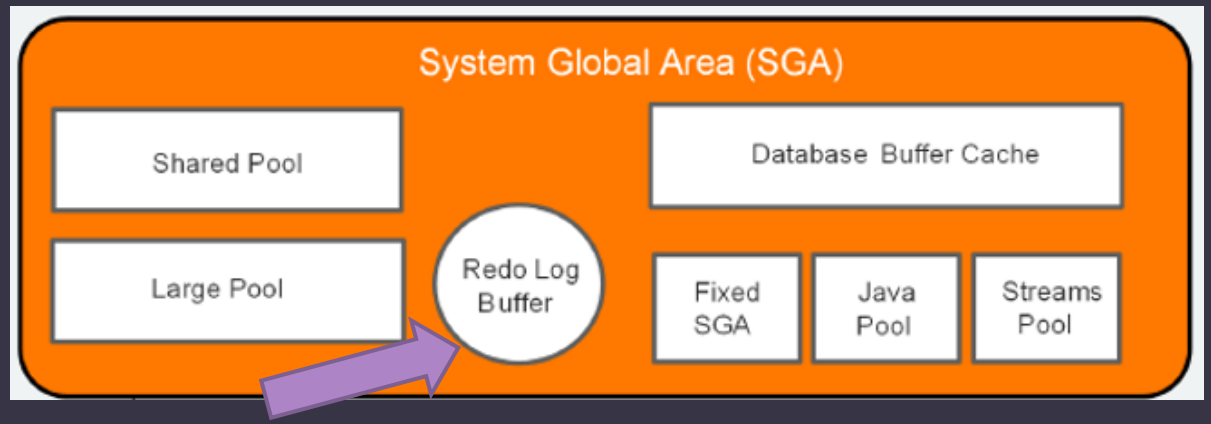


Database buffer cache

- responsible for caching database user data.
- The buffer cache caches frequently accessed database data into memory.

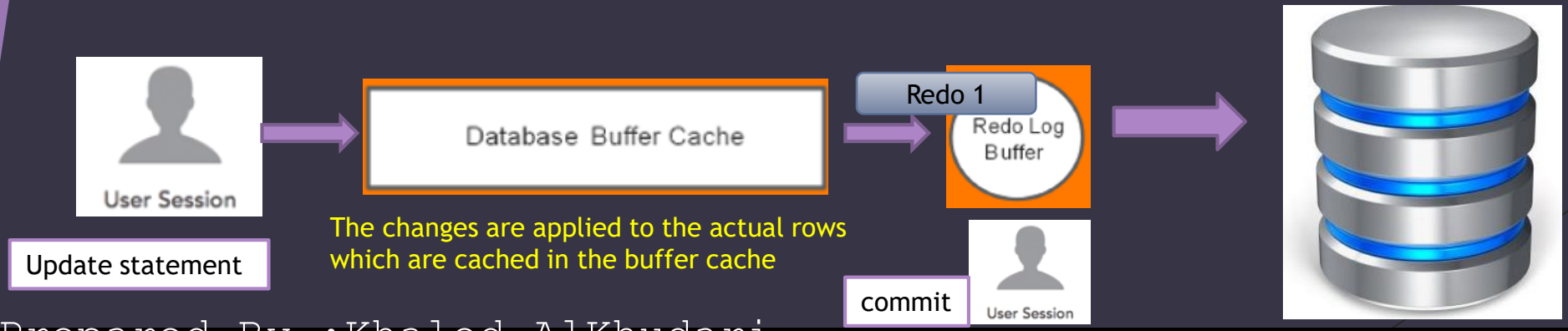
Note: The buffer cache caches blocks of data instead of individual rows (1 block=8 kB by default)

- All users who are concurrently connected to the database share and access a single database buffer cache
- The buffer cache including the keep pool, recycle pool, and others



Redo Log Buffer

- circular buffer that hold information about changes made to the database
- designed to store redo entries (small records that reflect any changes made to the database as part of transactions or database structure changes)
  Note: Redo entries are used for database recovery when and if needed.
- the Redo Log entries in the RedoLog buffer are also written on a periodic basis to a set of files in our Oracle database storage known as Redo logs files



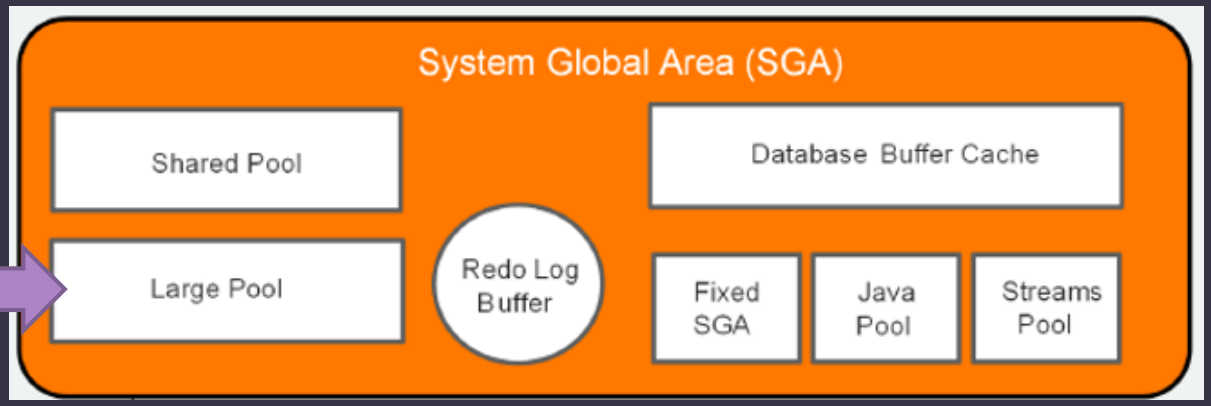
Thank You

Database Instance

System Global Area (SGA) Part 2

What we will learn in this lecture?

- Large Pool
- Java Pool
- Fixed SGA
- Streams Pool
- Sizing SGA and PGA

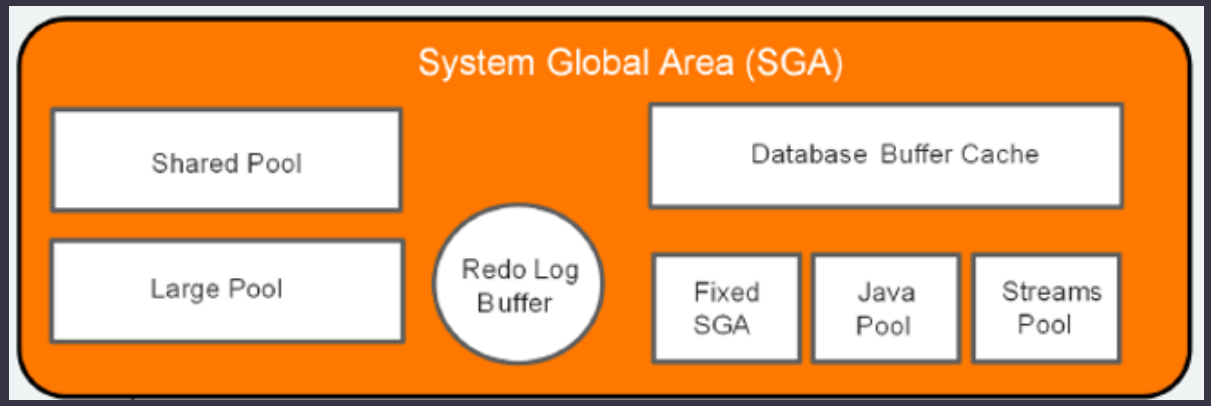


Large Pool

- contains memory used by special oracle features like:
  - Shared server processes
  - Parallel queries

```
SELECT /*+ PARALLEL(emp,4) */ * FROM emp;
```

  - Database backup and recovery operations
  - I/O server processes



Java Pool

- Parsing of Java code and scripts

Streams Pool

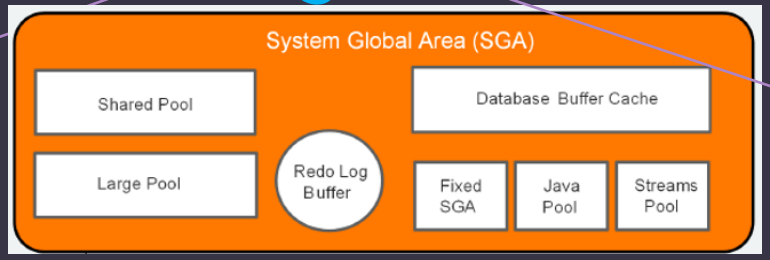
- Provides memory for oracle streams processes

Fixed SGA

- contains general information about the state of the database and the instance

Sizing SGA and PGA

Sizing SGA



1. Using Automatic Shared Memory Management **ASMM**

SGA_TARGET:
actual memory in use by the current SGA

SGA_MAX_SIZE
the largest amount of memory that will be available for the SGA in the instance

Oracle Database automatically distributes this memory among the various SGA components to ensure the most effective memory utilization.

ALTER SYSTEM SET SGA_TARGET=value [SCOPE={SPFILE|MEMORY|BOTH}]

2. Using Manual Shared Memory Management

you must manually configure several SGA component sizes

A. Set the MEMORY_TARGET initialization parameter to 0.

B. Set the SGA_TARGET initialization parameter to 0.

C. manually configure SGA component

Sizing SGA and PGA

Sizing PGA

1. Using Automatic PGA Memory Management

PGA_AGGREGATE_TARGET:
total amount of PGA memory allocated across all database server processes and background processes

Oracle strongly recommends that you leave automatic PGA memory management enabled.

2. Using Manual PGA Memory Management

you must manually configure several PGA component sizes

Not recommended

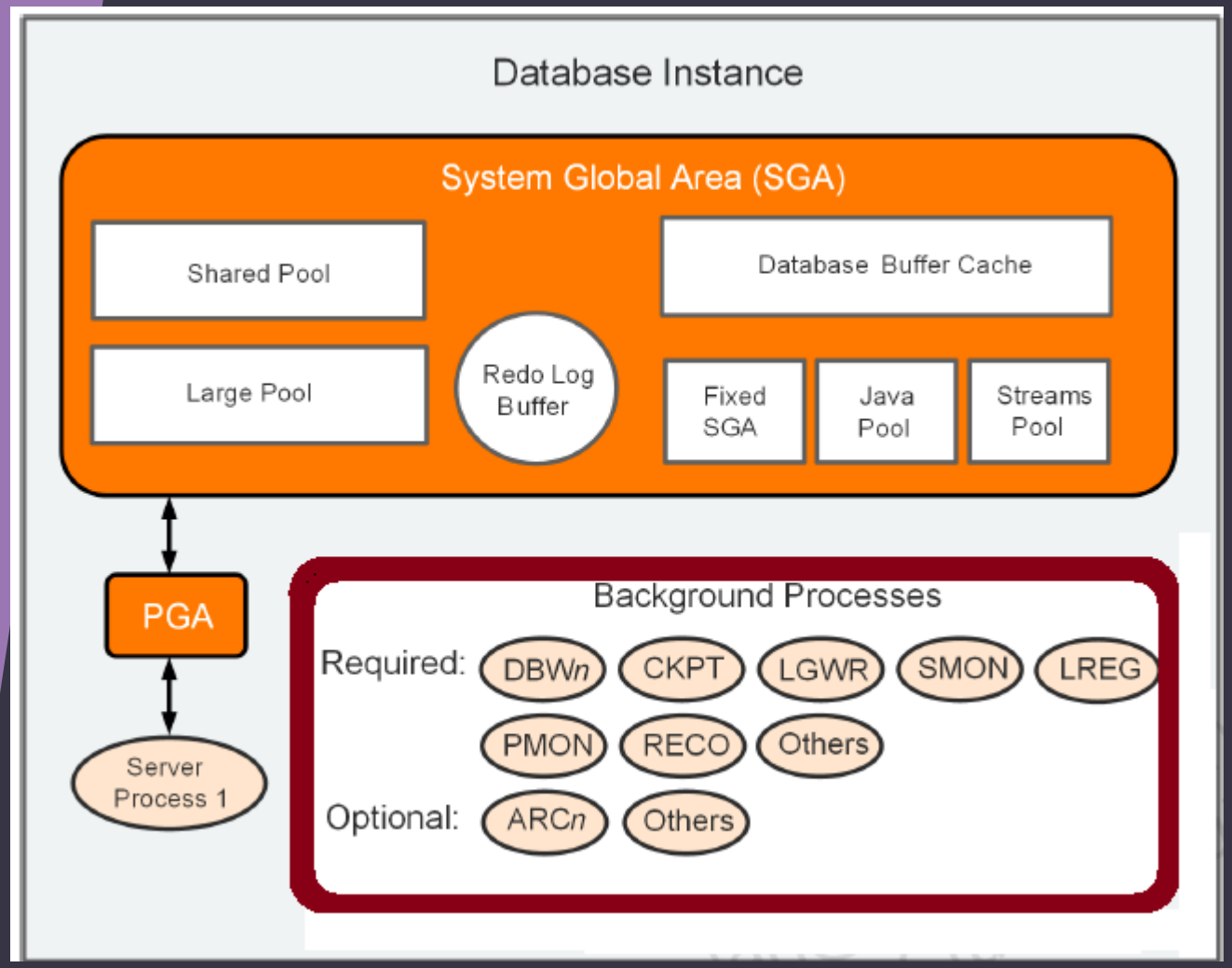
Thank You

Database Instance

Background Processes

What we will learn in this lecture?

- What are the Background processes?
- The Main purpose of each Background process



Background Processes:
bunch of dedicated server-side processes running in the background

TASKS:

- writing database blocks to disk
- writing redo entries to disk
- making sure all of the database files on disk are synchronized
- perform maintenance tasks

- Database Writer processes (DBWn)

responsible for writing contents of the database buffers to data files on disk

- Log writer (LGWR)

responsible for writing redo records from the redo log buffering memory into a physical disk

- checkpoint process (CKPT)

This process handles database checkpoints.
An Oracle checkpoint is a database event which synchronizes modified data blocks in memory from the buffer cache with the data files on disk

- System Monitor process (SMON)

performs recovery during the startup sequence of the Oracle Instance if required.
responsible for cleaning up any unused temporary segments.

- Process Monitor (PMON)

performs process recovery when a user process or a session fails.
responsible for cleaning up any changes made to blocks in the database buffer cache, and releasing resources that were previously used by a failed user session.

- Recover Process (RECO)

used as part of distributed database transactions.

Distributed transactions are transactions that involve multiple databases, and should either commit a rollback on both databases at once.

- Listener registration process (LREG)

  It is responsible for registering the Oracle instance with the Oracle network listener.
  The listener accepting remote incoming user connections

- Archiver process (ARCn)

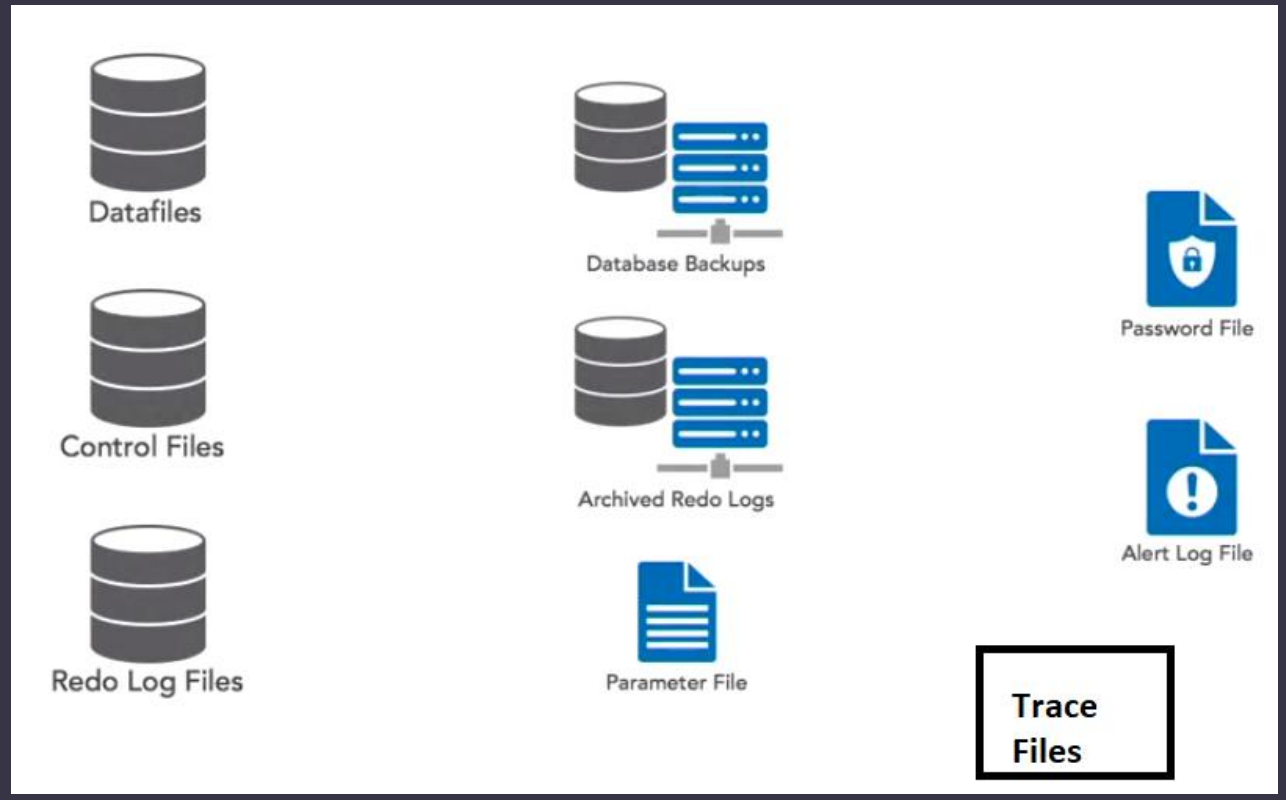
It is responsible to copy the Oracle redo log files to a remote storage device after a redo log switch has occurred

Note: Copying the database relogs to another storage system is very important from a backup and recovery perspective

Thank You

Database Files

Database: Organized collection of information.
It contains collection of database files stored in disk storage. (physical)



Datafiles

contains the actual users data, applications data, metadata.
(Tables, Rows, indexes ,procedures, views…)
Note: If you lose Datafiles, you lose your database.
The extension for datafiles is *.dbf*

Control files

Stores metadata about the datafiles and online redo log files (like names ,locations and statuses) and this info is required by the database instance to open the database.
Note: If you lose control files, you lose your database.
The extension for Control files is *.ctl*

Redo log files

stores changes to the database as they occur and are used for data recovery.
Note: If you lose Redo log files, you lose your database.
The extension for redo log file is *.log*

Database backups files

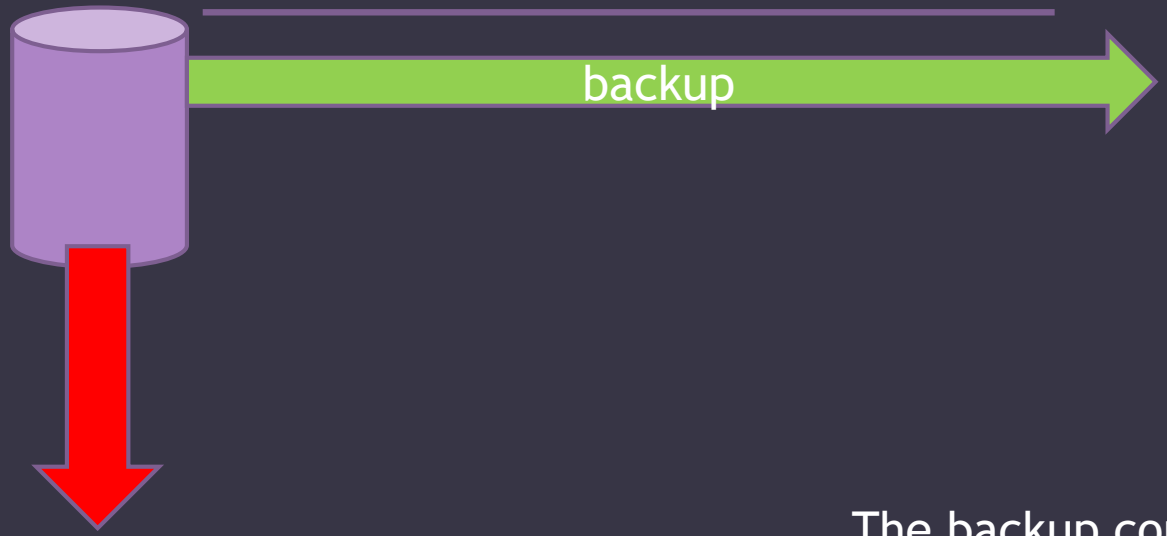
include any backups of your database that you have taken and placed somewhere safe
Note: it should include the datafiles, control files, redo log files

Archived redo log files (groups of redo log files)

Contains ongoing history of the data changes .
Using these files + backups files you can recover your database

8:00 am

The backup contains data as 8:00 AM



DB crashed at 10:00 AM

The backup contains data as 8:00 AM

Parameter file (spfile, pfile)

This file defines how the database instance is configured when it starts up.
Example: the PGA size PGA_AGGREGATE_TARGET
Note: spfile is binary file, you can not edit directly, it should by oracle commands.
If you lose the spfile no issue, you can recreate it again

Password file

stores **passwords** for users with administrative privileges (sys user) in order to connect remotely.
Note: DBA password cannot be stored in the database, because Oracle cannot access the database before the instance is started , Therefore, the authentication of the DBA must happen outside of the database

Alert Log File

is a chronological log of messages and errors written out by an Oracle Database.
so this is your go-to file in case you're trying to troubleshoot a problem with your database.
Example: You can see when the database was started and stopped.

Trace File

Each server and background process writes to a trace file.

When a process detects an internal error, it writes information about the error to its trace file.

Thank You

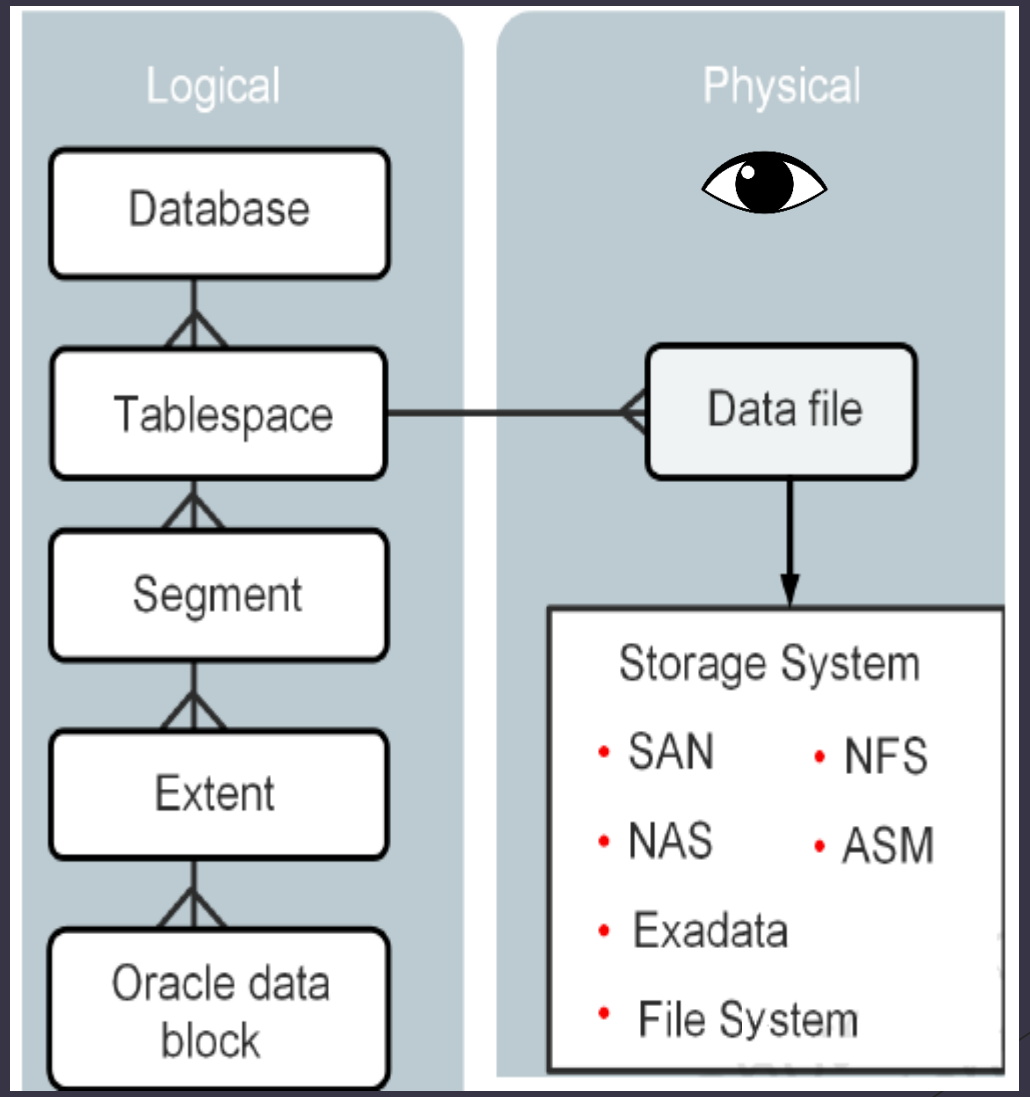
Logical Storage Structure

Tablespaces are logical storage groups
that can be used
to store logical database constructs,
such as tables and indexes
Logically it stores the database files

A Segment is a set of Extents,
one or more Extents,
allocated for certain logical structures
inside the database (ex: table, index)

An Extent is a set of contiguous
Oracle Data Blocks
it is much more efficient,
when allocating space

Oracle data stored in DB blocks
1 Block= 8 K by default
A single Oracle Data Block
contains one or more rows

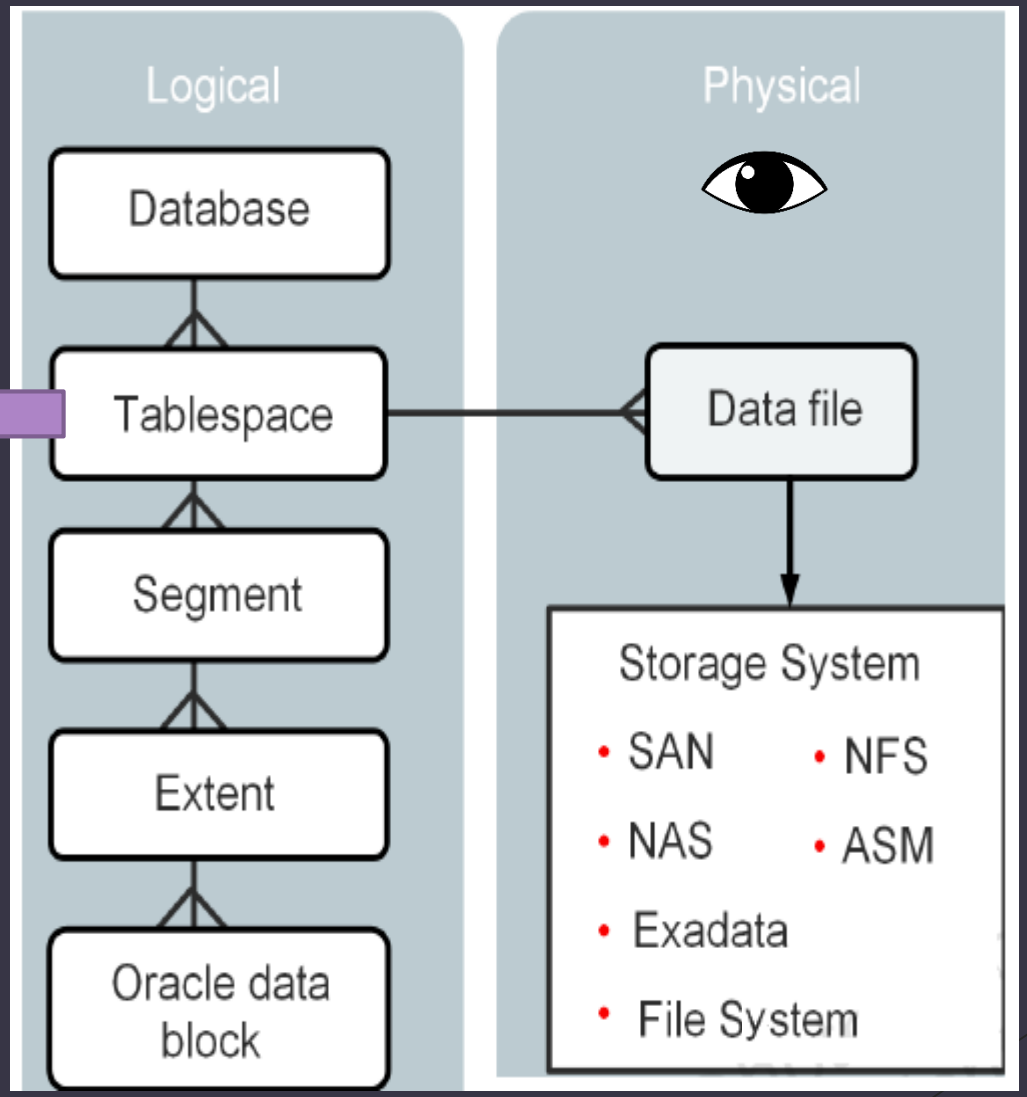


SAN: Storage area network
NAS: network attached storage
NFS: network file system
ASM: automatic storage management

Thank You

Default tablespaces

- SYSTEM
- SYSAUX
- TEMP
- UNDO
- USERS



SYSTEM tablespace

Used for core functionality.
Stores the data dictionary (belong to sys schema).
Oracle create system tablespace automatically when the database is created.
you cannot rename or drop the SYSTEM tablespace.

SYSAUX tablespace

The SYSAUX tablespace is an auxiliary tablespace to the SYSTEM tablespace.
It reduces the load on the SYSTEM tablespace.
Oracle create it automatically when the database is created
you cannot rename or drop the SYSAUX tablespace.

TEMP tablespace

are used to manage space for database sort and joining operations and for storing global temporary tables.

Other SQL operations that might require disk sorting are: CREATE INDEX, ANALYZE, SELECT DISTINCT, ORDER BY, GROUP BY, UNION, INTERSECT, MINUS,…

UNDO tablespace

is used to roll back, or undo, changes to the database.

- Roll back transactions when a ROLLBACK statement is issued
- Recover the database
- Provide read consistency

USERS tablespace

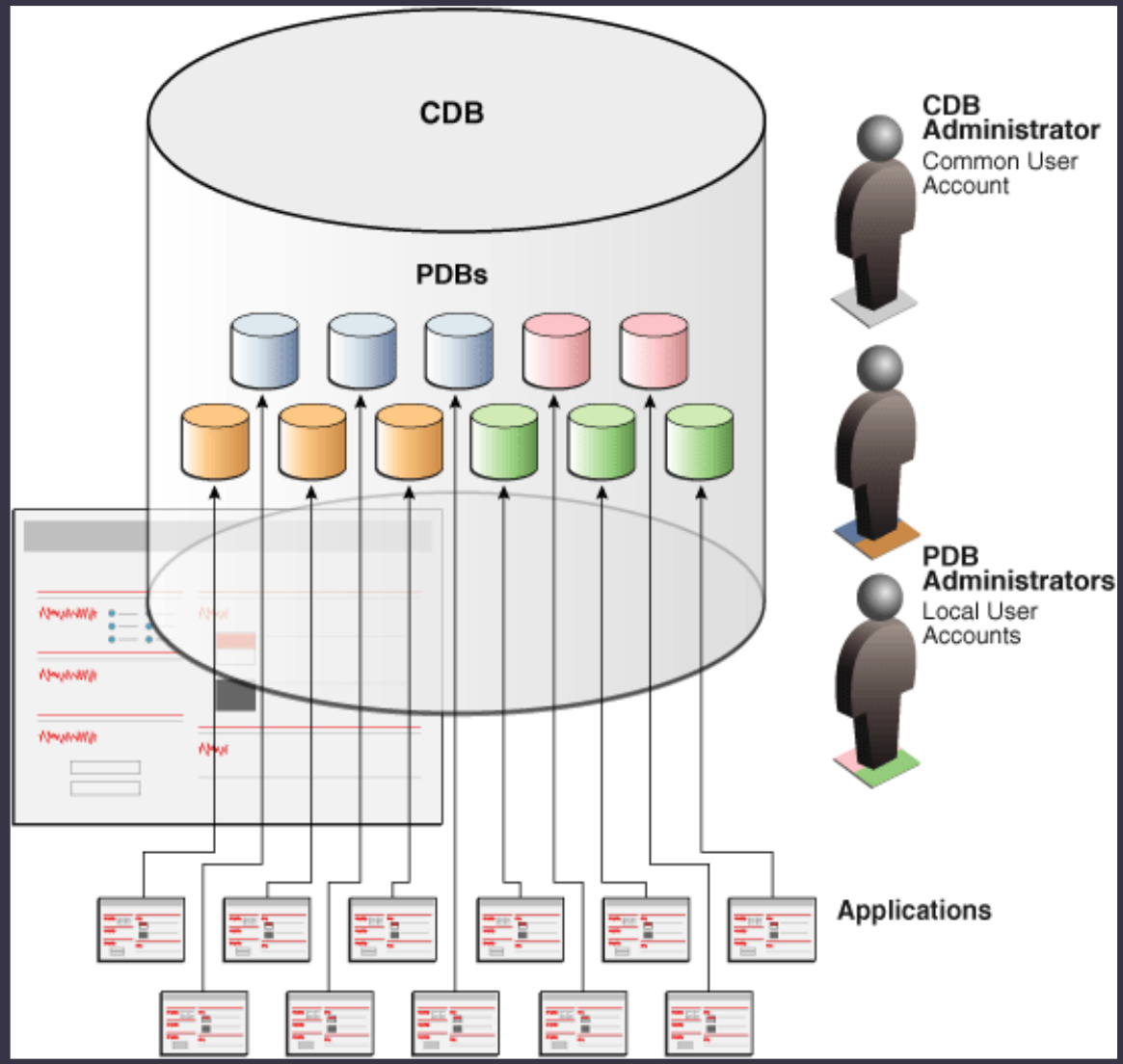
Stores users objects and data

every database should have a tablespace for permanent user data that is assigned to users. Otherwise, user objects will be created in the SYSTEM tablespace, which is not good practice.
In the preconfigured database, USERS is designated as the default tablespace for all new users.

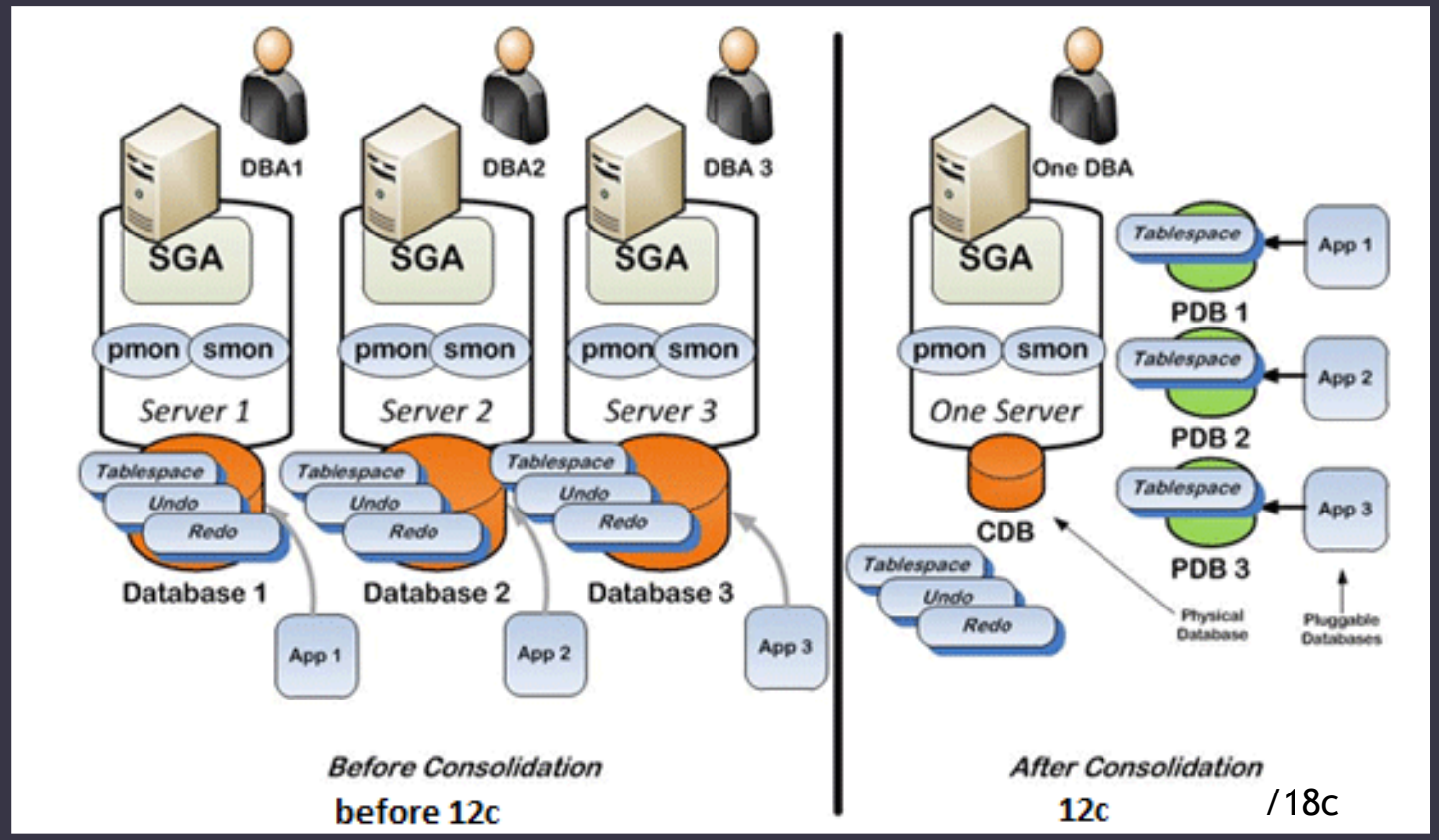
Note: all these tablespaces exits in the container database and also the pluggable databases .

Thank You

Multitenant Database 12c /18c



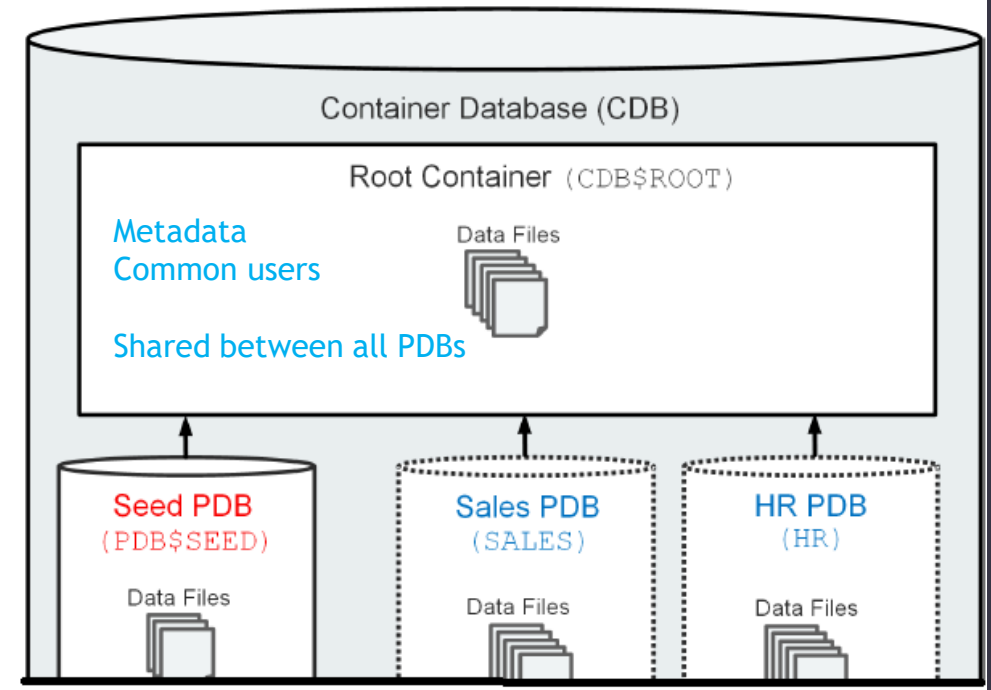
Multitenant Database 12c /18c



- ✓ Reduce cost
- ✓ Saving resources
- ✓ Easy maintenance
- ✓ Easy backup
- ✓ Easy cloning
- ✓ Separation of rules

(PDB Admin vs CDB Admin)

Multitenant Database 12c /18c



Every CDB has the following containers:

1. Exactly one CDB root container called CDB$ROOT
2. Seed PDB called PDB$SEED (it is a template)
3. Zero or more user-created PDBs

Note: starting from 12c R2 , we have something called application container, but it is out of scope of this course.
Application Container is optional.
Application container seems to be a mini CDB, within CDB root.

Thank You

DBA Tasks and tools

Common Oracle DBA Tasks

- Installing Oracle software
- Creating Oracle databases
- Performing upgrades of the database and software to new release levels
- Starting and shutting down the database instance
- Managing the storage structures of the database
- Managing users and security
- Managing database objects, such as tables, indexes, and views
- Backing up the database and performing recovery operations when necessary
- Monitoring the state of the database
- Monitoring and tuning database performance
- reporting critical errors to Oracle Support Services

DBA Tasks and tools

Tools for Administering the Database

❖ Oracle Universal Installer

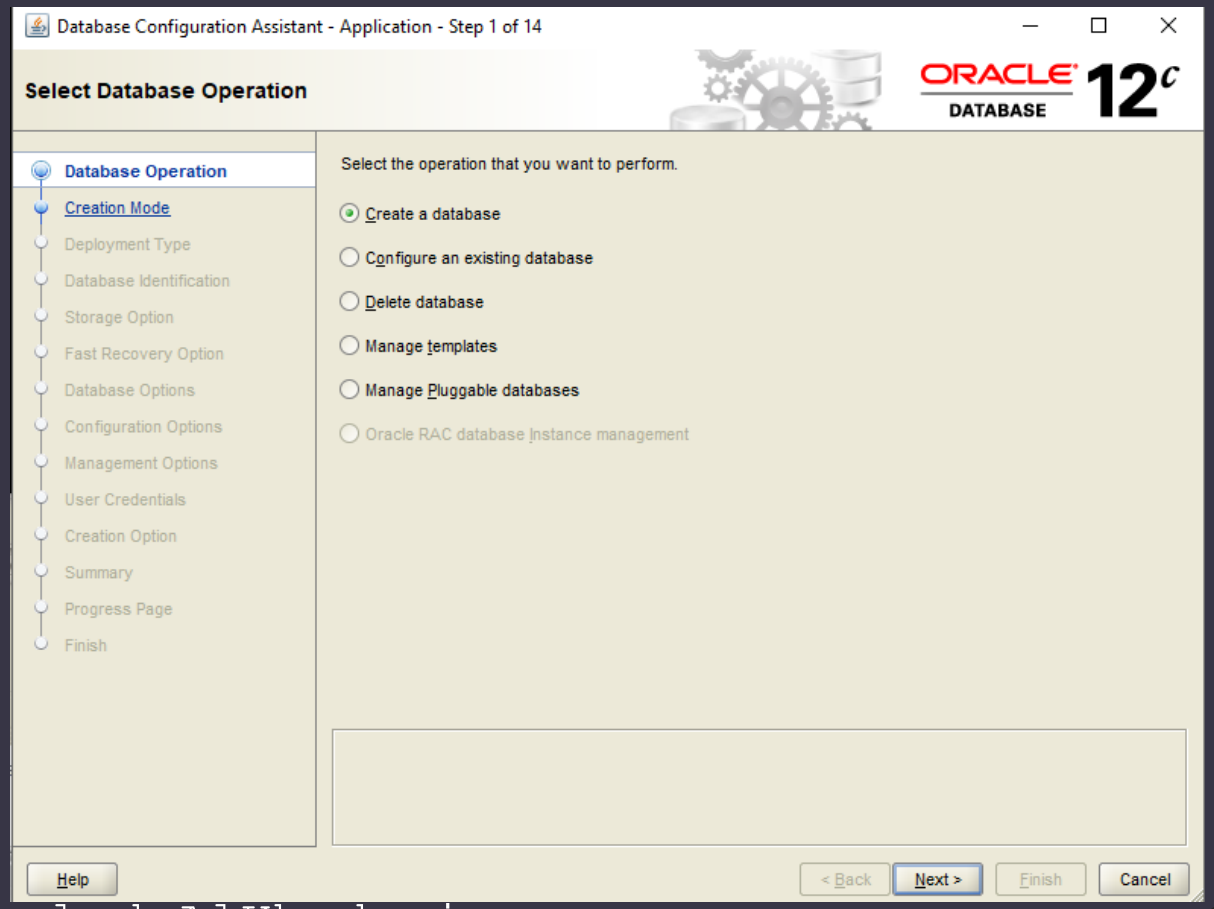
is a utility that installs your Oracle software and options. It can automatically start Oracle Database Configuration Assistant to install a database.

DBA Tasks and tools

Tools for Administering the Database

❖ Oracle Database Configuration Assistant

(DBCA) is a utility that creates a database from templates that are supplied by Oracle

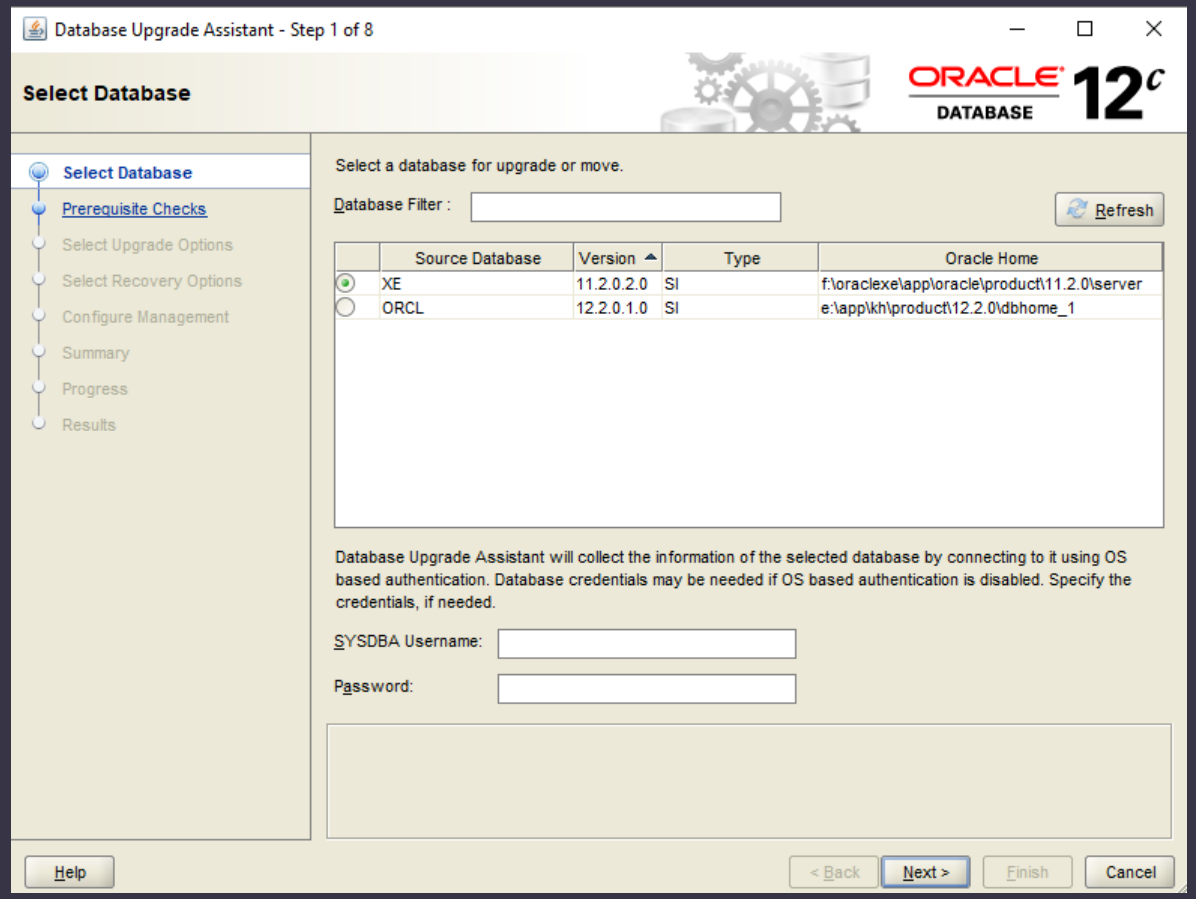


DBA Tasks and tools

Tools for Administering the Database

❖ Database Upgrade Assistant

(DBUA) is a tool that guides you through the upgrade of your existing database to a new Oracle Database release



DBA Tasks and tools

Tools for Administering the Database

- **Net Configuration Assistant**

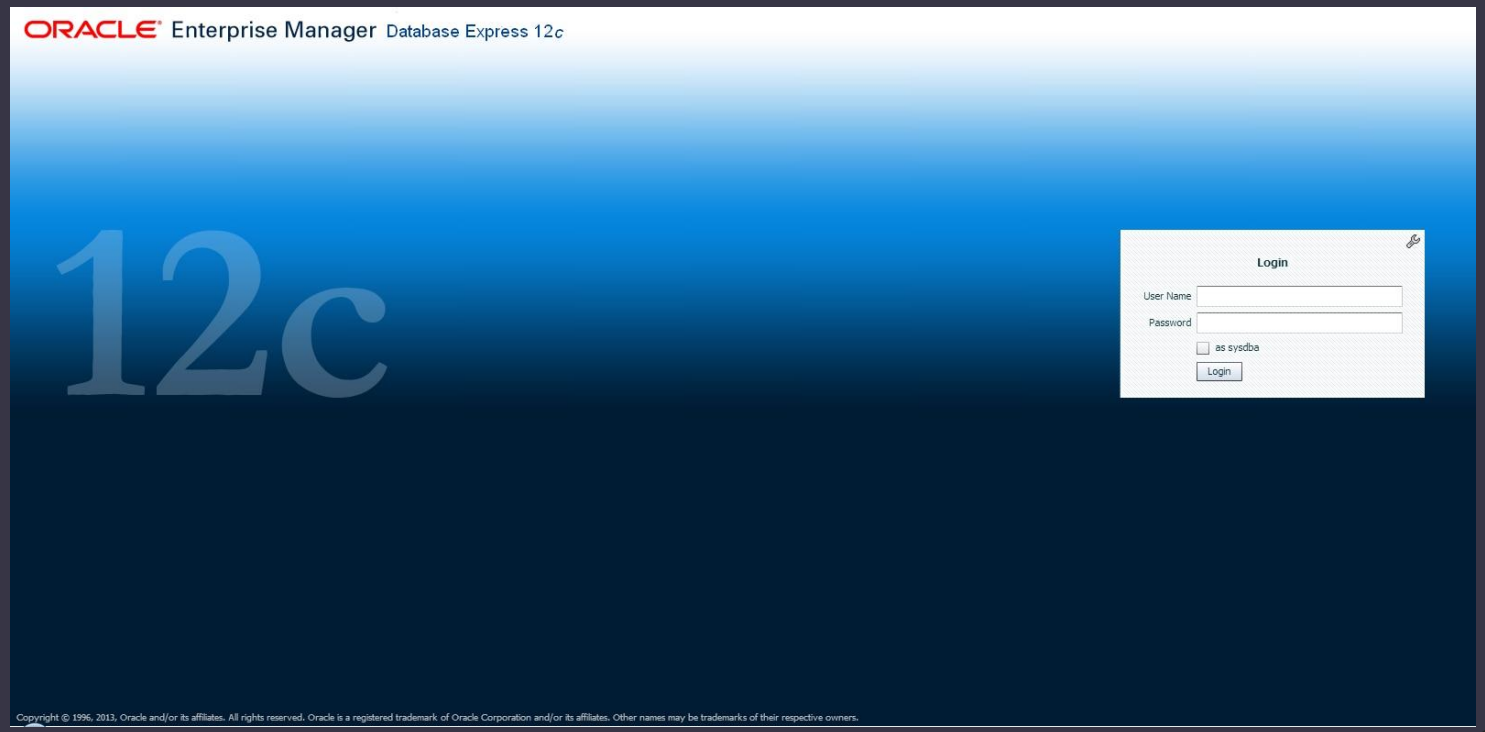
is a utility that enables you to configure listeners and naming methods, which are critical components of the Oracle Database network.

DBA Tasks and tools

Tools for Administering the Database

- **Oracle Enterprise Manager Database Express**

The primary product for managing your database, a Web-based interface
EM Express used to manage your database in very simple ways like simple wizard

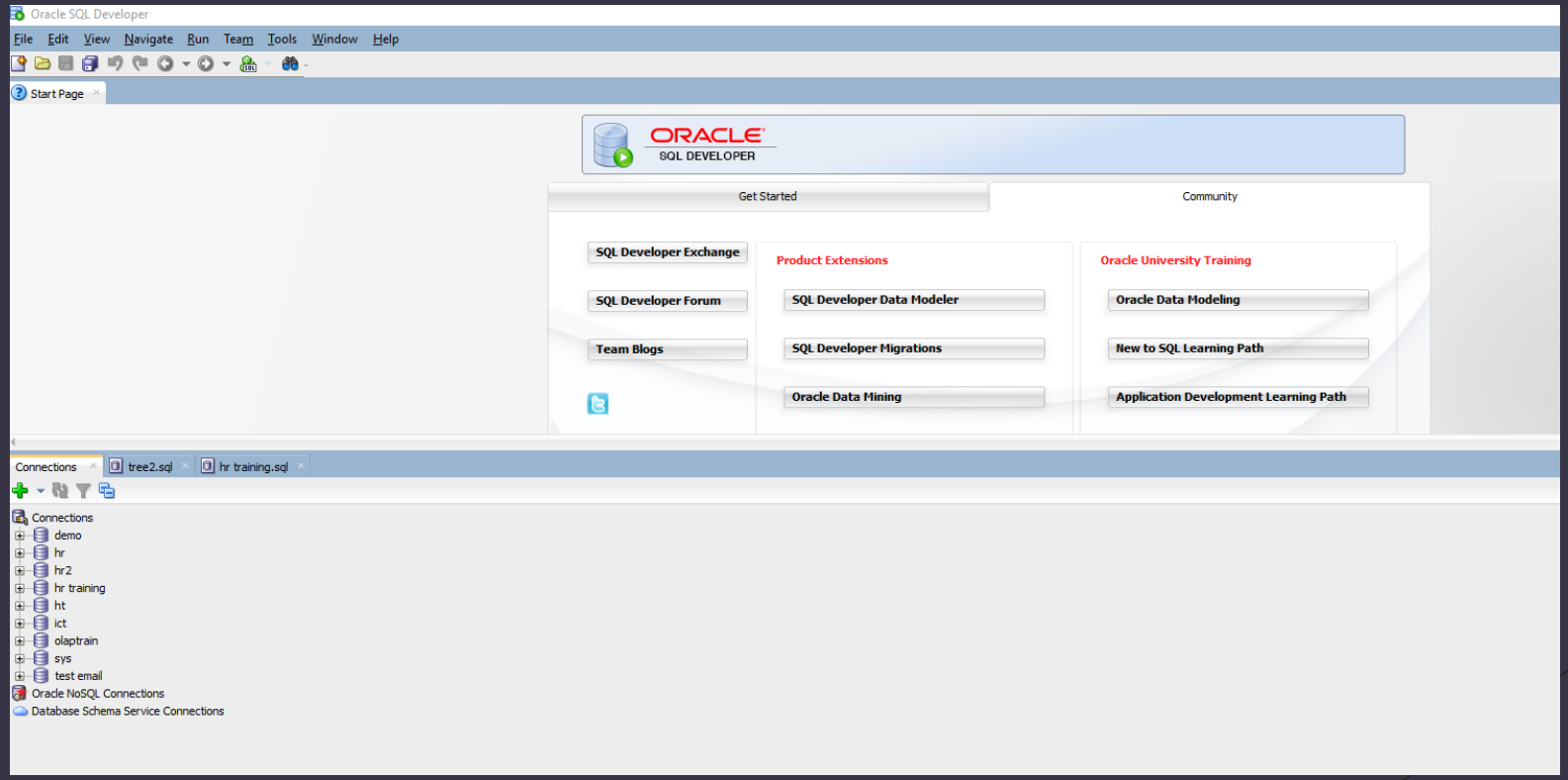


DBA Tasks and tools

Tools for Administering the Database

- **Oracle SQL Developer**

SQL Developer provides another GUI for accessing your Oracle database. SQL Developer supports development in both the SQL and PL/SQL languages



Thank You

Installation Methods and OS

Installation Methods

Desktop Class :This installation class is most appropriate for laptop or desktop computers. It includes a starter database and requires minimal configuration.

Server Class :This installation class is for servers, such as you would find in a data center, or used to support enterprise-level applications.
Choose this installation class if you need access to advanced configuration options.

Note: the operating system in sever or desktop could be (windows, Linux, Unix,…)

In our course :
1- we will install oracle VirtualBox
2- we will install oracle Linux operating system on virtual machine
3- we will install oracle Database 12 or 18 as **Server Class**

Why Linux?

- Free and Open Source (not all Linux free)
- Stability and Reliability
- Security
- Flexibility
- Hardware Support

In Conclusion
Linux has today become a strategic, efficient and reliable platform for business systems at many small, medium to big companies.
A larger percentage of servers powering the Internet run on a Linux-based operating system.

What is Linux distribution?

is an operating system made from **Linux**

- Red hat
- CentOS
- Fedora
- Oracle Linux (the common used for running oracle DB)
- **Ubuntu**
- **And many others**

Thank You