Lead Training

2nd Batch 2025

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Table of contents

2

Oracle Database Editions

Oracle Database Standard Edition 2

Oracle Database Standard Edition 2 delivers unprecedented ease of use, power, and performance for workgroup, department-level, and Web applications.
Note: Oracle Database Standard Edition 2 is available starting with Oracle Database 12c Release 1 (12.1.0.2). For 12.1.0.1, Oracle Database Standard Edition One and Oracle Database Standard Edition are available.

Oracle Database Enterprise Edition

Oracle Database Enterprise Edition provides the performance, availability, scalability, and security required for mission-critical 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 Editions

Oracle Database Express Edition

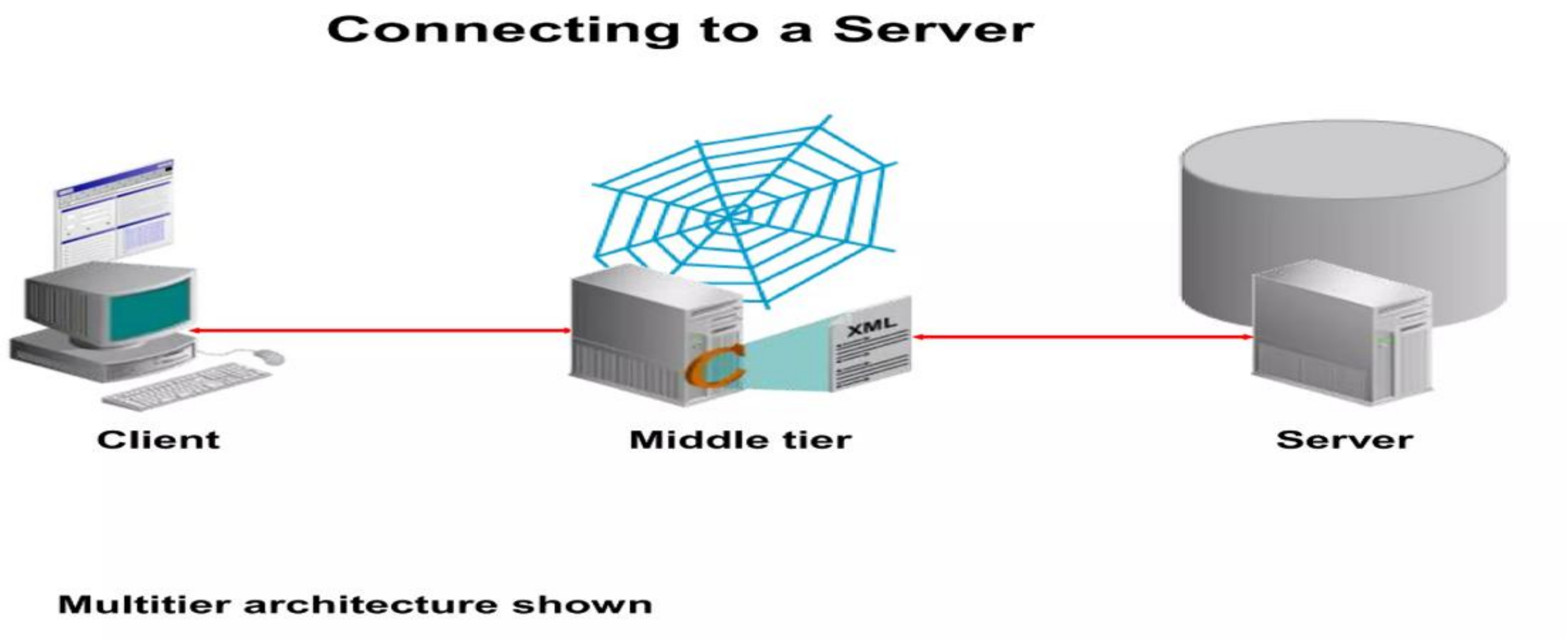
Oracle Database Express Edition (Oracle Database XE) is an entry-level edition of Oracle Database that is quick to download, simple to install and manage, and is free to develop, deploy, and distribute. Oracle Database XE makes it easy to upgrade to the other editions of Oracle without costly and complex migrations. Oracle Database XE can be installed on any size machine with any number of CPUs, stores up to 11 GB of user data, using up to 1 GB of memory, and using only one CPU on the host machine. Support is provided by an online forum. The current version of Oracle Database XE is Oracle Database 11*g* Release 2.

Oracle Database Personal Edition

Oracle Database Personal Edition supports single-user development and deployment environments that require full compatibility with Oracle Database Standard Edition One, Oracle Database Standard Edition, and Oracle Database Enterprise Edition. Personal Edition includes all of the components that are included with Enterprise Edition, as well as all of the options that are available with Enterprise Edition, with the exception of the Oracle Real Application Clusters option, which cannot be used with Personal Edition. Personal Edition is available on Windows and Linux platforms only. The Management Packs are not included in Personal Edition.

Oracle database architecture overview

Oracle Database follows a multi-tiered architecture that provides a highly scalable and flexible platform for managing and processing data. The architecture of Oracle Database can be broadly categorized into the following components.



Oracle database architecture overview

Client Tier:

- Client Applications: These are the end-user applications that interact with the Oracle Database. Examples include web applications, desktop applications, or command-line tools.
- Oracle Net Services: Handles communication between the client applications and the database server. It includes protocols such as TCP/IP and Oracle's SQL*Net.

Middle Tier:

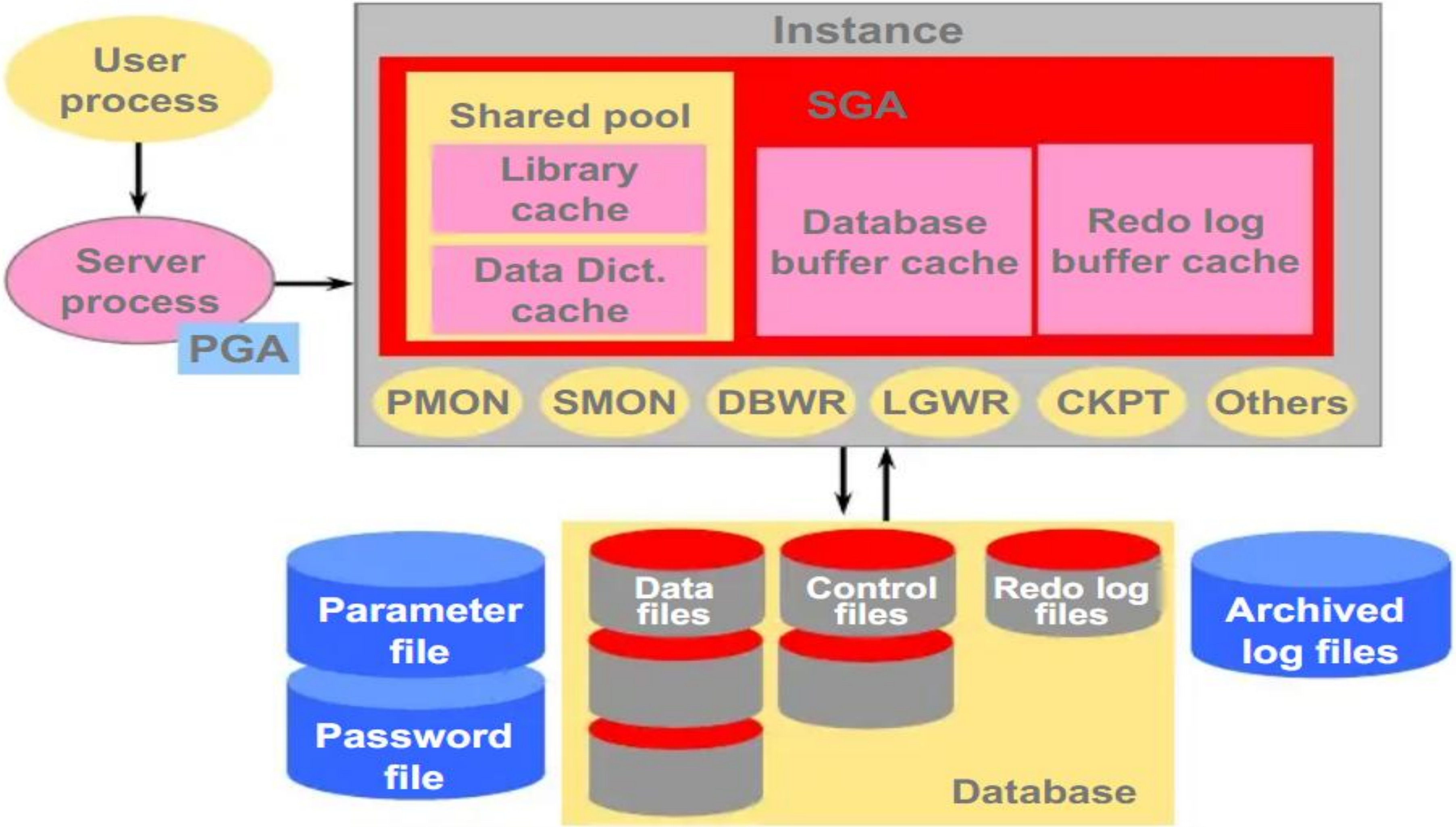
- Application Server: In some architectures, there is an intermediate application server layer that hosts middleware components, which mediate communication between client applications and the database. Oracle provides products like Oracle WebLogic Server for this purpose.

Oracle database architecture overview

Database Tier:

- Oracle Database Instance: The database instance is a set of memory structures and background processes that manage database operations. It includes components such as the System Global Area (SGA) and the background processes (e.g., processes for managing cache, processes for managing transactions).
- Data Files: Physical files on disk that store the actual data and metadata of the database. These include data files, control files, and redo log files.
- Tablespaces: Logical storage containers within the database that organize and group related data files.

Oracle database architecture



Database instance and Memory structure

An Oracle instance refers to the combination of memory structures and background processes that collectively manage and provide access to an Oracle Database. When a user connects to an Oracle Database, they are interacting with a specific instance. Each running Oracle Database is associated with one and only one instance.

The key components of Oracle database instance.

System Global Area (SGA):

- The SGA is a shared memory region that is allocated when an Oracle instance starts. It contains data and control information that is shared among all the connected user sessions and background processes.
- Key components of the SGA include the Database Buffer Cache, Shared Pool, Redo Log Buffer, and other structures.

Program Global Area (PGA):

- The PGA is a memory region that is allocated for each individual user session or background process. It contains data and control information specific to that session or process.
- Each user connecting to the database has their own PGA.

SGA and PGA in oracle instance

The SGA is divided into several components, each serving a specific purpose. Some of the key components include:

Buffer Cache (Database Buffer Cache):
This component stores copies of data blocks read from data files. It helps in reducing physical I/O by caching frequently accessed data in memory.

Buffer States:
A buffer in the Database Buffer Cache can be in one of several states, including:
Free: The buffer is not currently being used.
Pinned: The buffer is in use by a process.
Dirty: The buffer has been modified and needs to be written back to the data file.
Touch: The buffer has been accessed but not modified.

Shared Pool:
It contains the library cache, which stores parsed SQL statements and execution plans, and the data dictionary cache, which stores information about the database's structure.

SGA and PGA in oracle instance

The SGA is divided into several components, each serving a specific purpose. Some of the key components include:

Java Pool:
The Java Pool, part of the SGA, is used for managing Java execution within the database.

Large Pool:
This is an optional area used for large memory allocations, such as backup and restore operations.

Redo Log Buffer:
It holds information about changes made to the database, which is necessary for recovery in the event of a system failure.

SGA and PGA in oracle instance

Background Processes and process structure

These are dedicated processes that run in the background and perform various tasks to manage and maintain the database. Important background processes include:

Process Monitor Process (PMON)

The process monitor (PMON) monitors the other background processes and performs process recovery when a server or dispatcher process terminates abnormally. PMON is responsible for cleaning up the database buffer cache and freeing resources that the client process was using. For example, PMON resets the status of the active transaction table, releases locks that are no longer required, and removes the process ID from the list of active processes.
PMON also registers information about the instance and dispatcher processes with the Oracle Net listener . When an instance starts, PMON polls the listener to determine whether it is running. If the listener is running, then PMON passes it relevant parameters. If it is not running, then PMON periodically attempts to contact it.

Background Process

System Monitor Process (SMON):

The system monitor process (SMON) is in charge of a variety of system-level cleanup duties. The duties assigned to SMON include:

Performing instance recovery, if necessary, at instance startup. In an Oracle RAC database, the SMON process of one database instance can perform instance recovery for a failed instance.

Recovering terminated transactions that were skipped during instance recovery because of file-read or tablespace offline errors. SMON recovers the transactions when the tablespace or file is brought back online.

Cleaning up unused temporary segments. For example, Oracle Database allocates extents when creating an index. If the operation fails, then SMON cleans up the temporary space.

Coalescing contiguous free extents within dictionary-managed tablespaces.

SMON checks regularly to see whether it is needed. Other processes can call SMON if they detect a need for it.

Background Process

Database Writer Process (DBW*n*)
The database writer process (DBWn) writes the contents of database buffers to data files. DBWn processes write modified buffers in the database buffer cache to disk.

Although one database writer process (DBW0) is adequate for most systems, you can configure additional processes—DBW1 through DBW9 and DBWa through DBWj—to improve write performance if your system modifies data heavily. These additional DBWn processes are not useful on uniprocessor systems.

The DBWn process writes dirty buffers to disk under the following conditions:

- When a server process cannot find a clean reusable buffer after scanning a threshold number of buffers, it signals DBWn to write. DBWn writes dirty buffers to disk asynchronously if possible while performing other processing.

- DBWn periodically writes buffers to advance the checkpoint, which is the position in the redo thread from which instance recovery begins. The log position of the checkpoint is determined by the oldest dirty buffer in the buffer cache.

In many cases the blocks that DBWn writes are scattered throughout the disk. Thus, the writes tend to be slower than the sequential writes performed by LGWR. DBWn performs multiblock writes when possible, to improve efficiency. The number of blocks written in a multiblock write varies by operating system.

Background Process

Log Writer Process (LGWR)

The **log writer process (LGWR)** manages the redo log buffer. LGWR writes one contiguous portion of the buffer to the online redo log.
By separating the tasks of modifying database buffers, performing scattered writes of dirty buffers to disk, and performing fast sequential writes of redo to disk, the database improves performance.

In the following circumstances, LGWR writes all redo entries that have been copied into the buffer since the last time it wrote:

- A user commits a transaction.
- An online redo log switch occurs.
- Three seconds have passed since LGWR last wrote.
- The redo log buffer is one-third full or contains 1 MB of buffered data.
- DBW*n* must write modified buffers to disk.

Before DBW*n* can write a dirty buffer, redo records associated with changes to the buffer must be written to disk (the write-ahead protocol).
If DBW*n* finds that some redo records have not been written, it signals LGWR to write the records to disk and waits for LGWR to complete before writing the data buffers to disk.

Background Process

LGWR and Commits:

Oracle Database uses a **fast commit** mechanism to improve performance for committed transactions. When a user issues a COMMIT statement, the transaction is assigned a system change number (SCN). LGWR puts a commit record in the redo log buffer and writes it to disk immediately, along with the commit SCN and transaction's redo entries.

The redo log buffer is circular. When LGWR writes redo entries from the redo log buffer to an online redo log file, server processes can copy new entries over the entries in the redo log buffer that have been written to disk.

LGWR normally writes fast enough to ensure that space is always available in the buffer for new entries, even when access to the online redo log is heavy.

The atomic write of the redo entry containing the transaction's commit record is the single event that determines the transaction has committed.

Oracle Database returns a success code to the committing transaction although the data buffers have not yet been written to disk.

The corresponding changes to data blocks are deferred until it is efficient for DBW*n* to write them to the data files.

Background Process

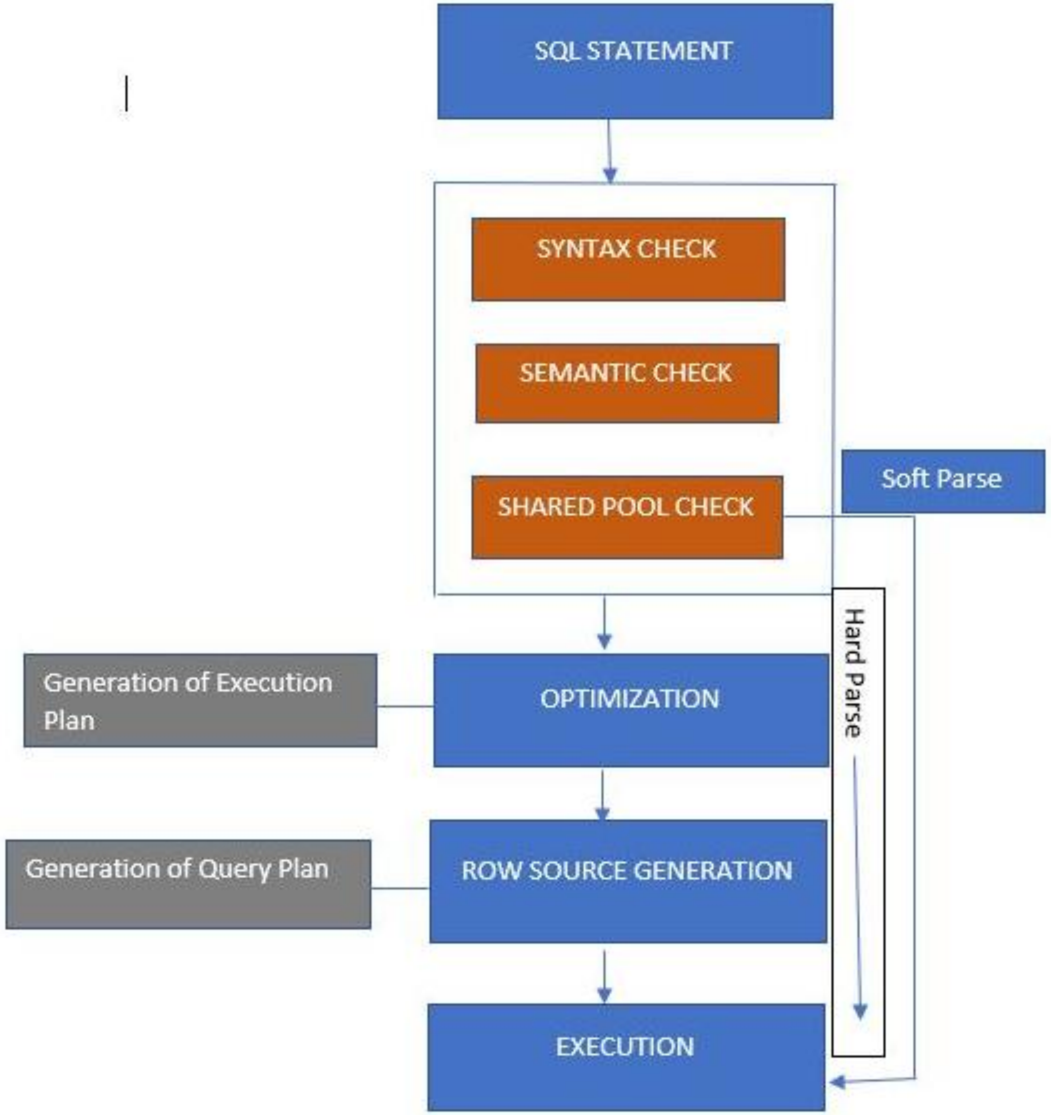
Checkpoint Process (CKPT)

The checkpoint process (CKPT) updates the control file and data file headers with checkpoint information and signals DBW*n* to write blocks to disk. Checkpoint information includes the checkpoint position, SCN, location in online redo log to begin recovery, and so on. CKPT does not write data blocks to data files or redo blocks to online redo log files.

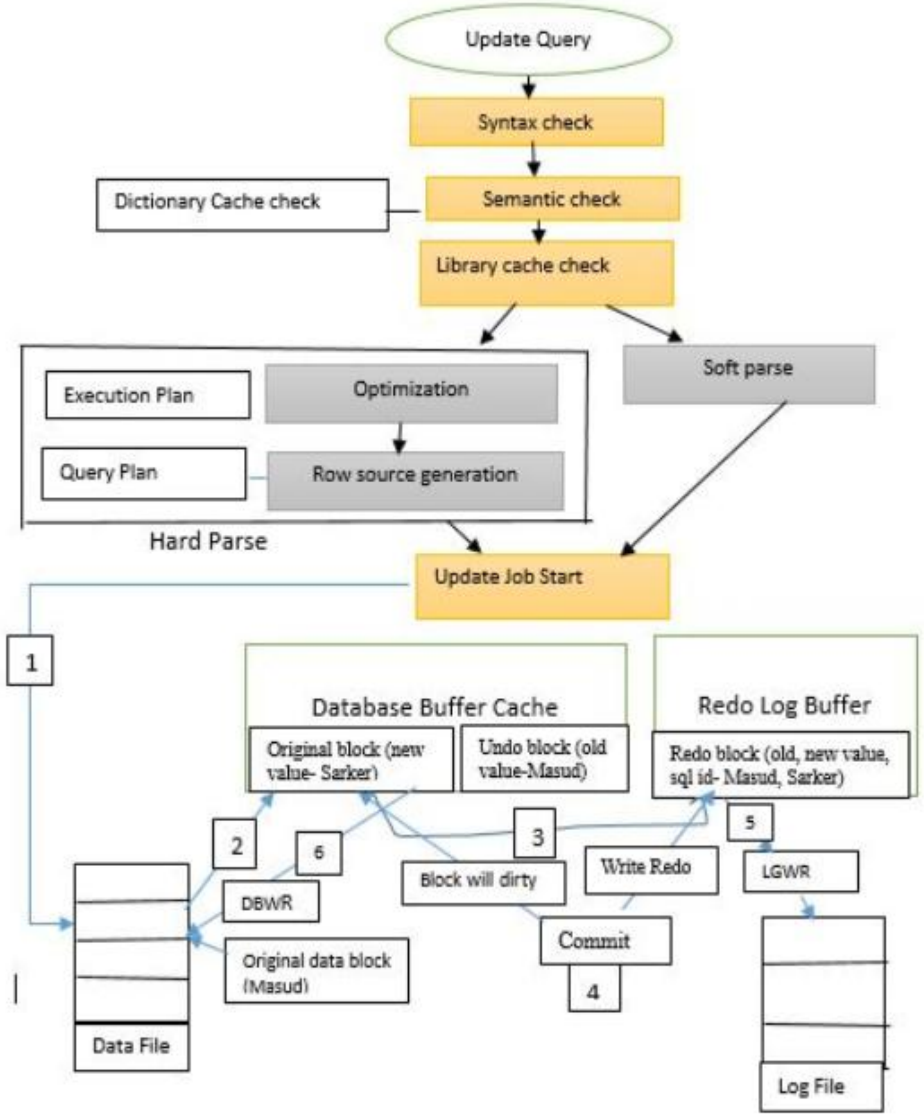
Archiver Processes (ARC*n*)

The **archiver processes (ARCn)** copy online redo log files to offline storage after a redo log switch occurs. These processes can also collect transaction redo data and transmit it to standby database destinations. ARC*n* processes exist *only* when the database is in ARCHIVELOG mode and automatic archiving is enabled.

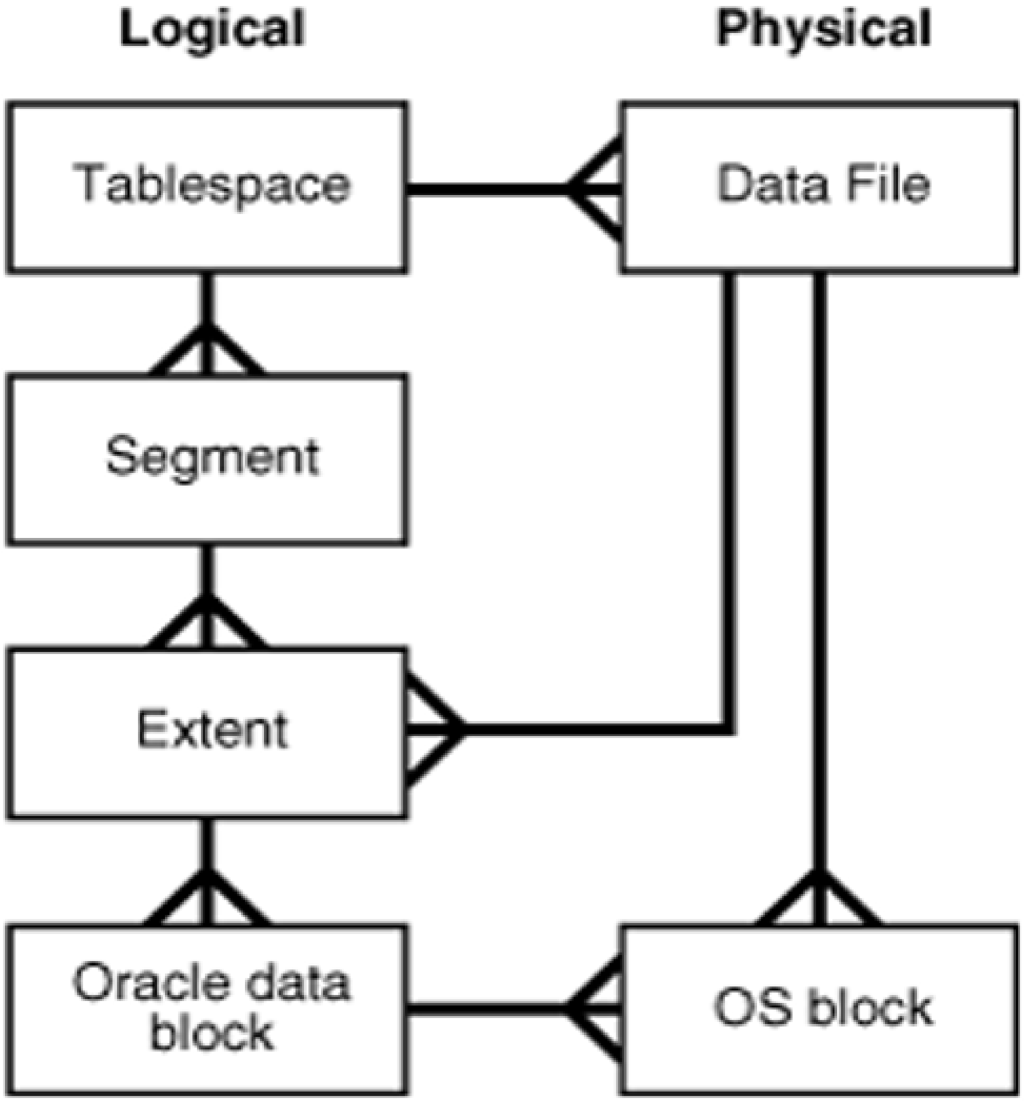
How select statement works?



How update statement works?

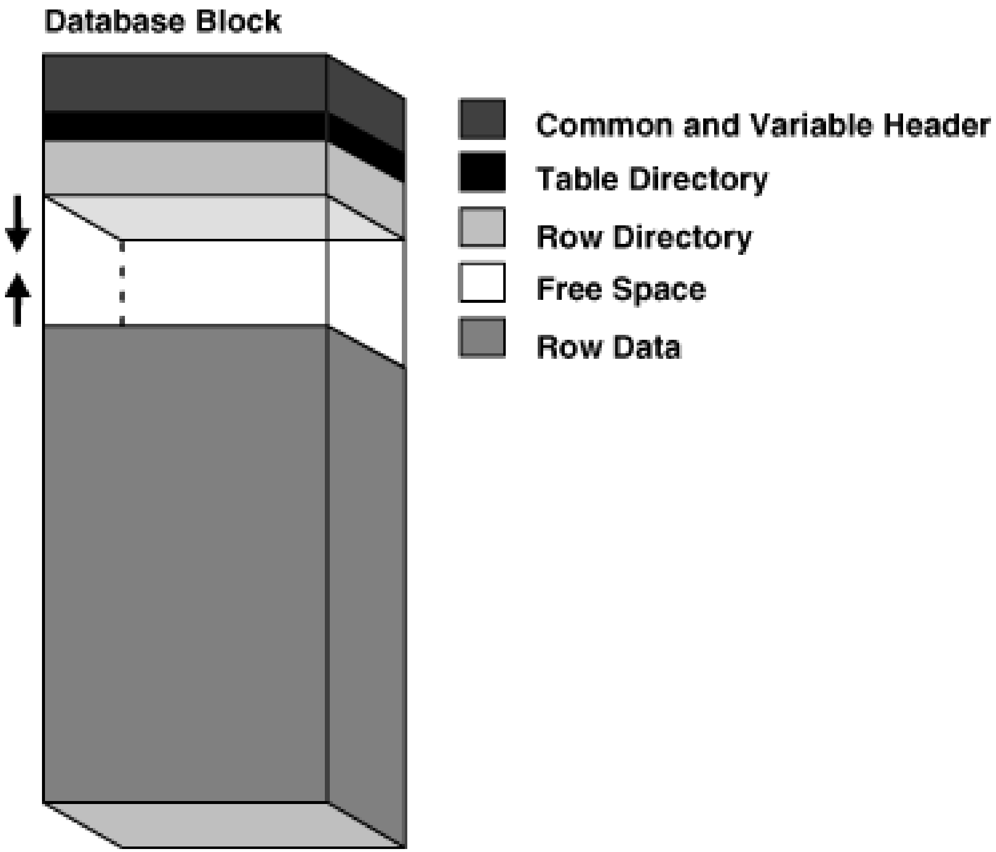


BEST



Logical
Physical
Tablespace
Data File
Segment
Extent
Oracle data block
OS block

Data block structure



Data blocks :

- It is the smallest logical unit of data storage in Oracle Database.
- One logical data block corresponds to a specific number of bytes of physical disk space, for example, 2 KB.
- Data blocks are the smallest units of storage that Oracle Database can use or allocate.

BEST

Extent
It is a set of logically contiguous data blocks allocated for storing a specific type of information
In the preceding graphic, the 24 KB extent has 12 data blocks, while the 72 KB extent has 36 data blocks.

Segment
It is a set of extents allocated for a specific database object, such as a table.
For example, the data for the employees table is stored in its own data segment, whereas each index for employees is stored in its own index segment. Every database object that consumes storage consists of a single segment.

Tablespace
It is a database storage unit that contains one or more segments.
Each segment belongs to one and only one tablespace. Thus, all extents for a segment are stored in the same tablespace. Within a tablespace, a segment can include extents from multiple data files, as shown in the preceding graphic. For example, one extent for a segment may be stored in users01.dbf, while another is stored in users02.dbf. A single extent can never span data files.

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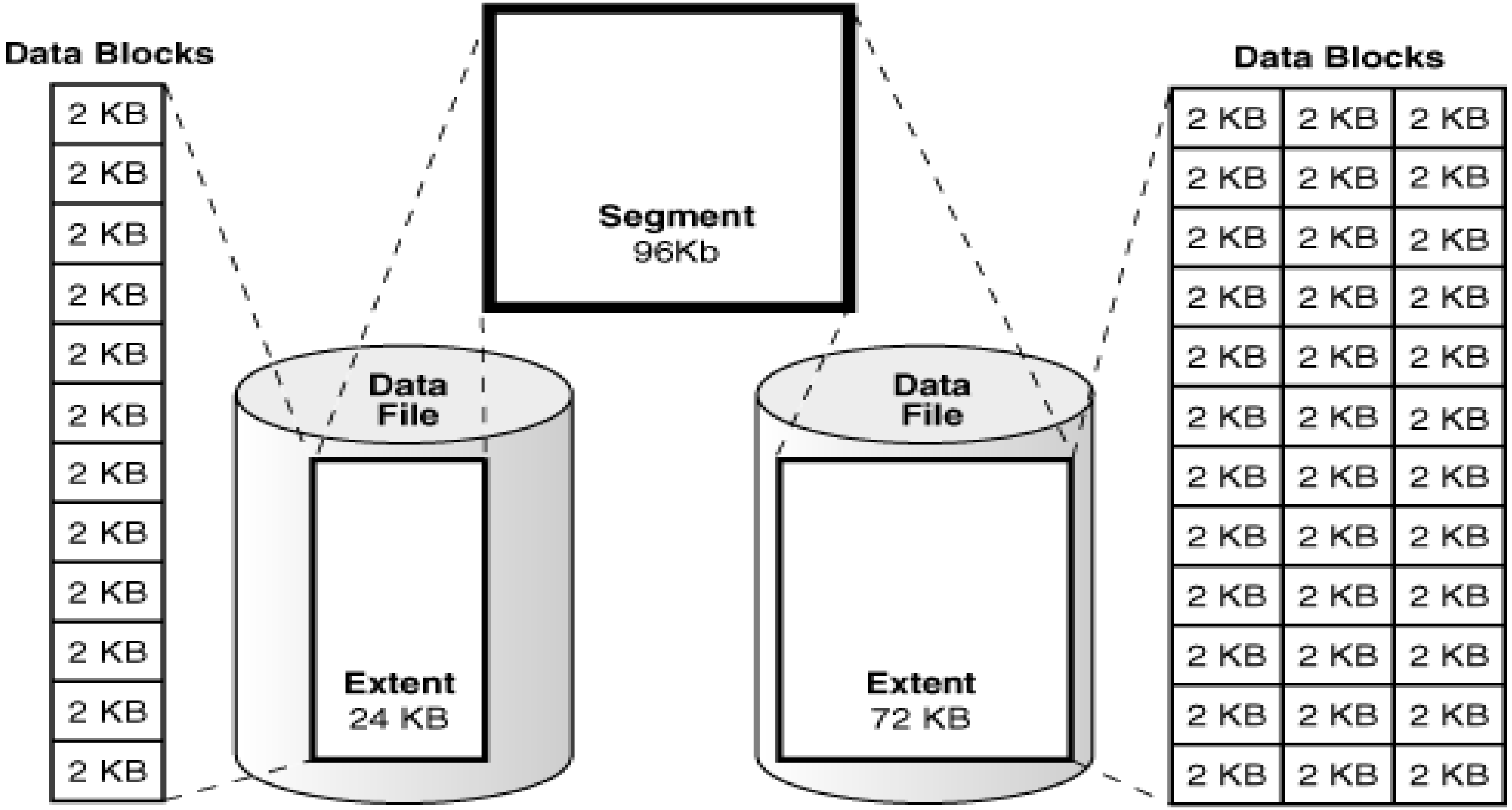

Data Blocks
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
2 KB
Segment
96Kb
Data File
Extent
24 KB
Data File
Extent
72 KB
Data Blocks
2 KB 2 KB 2 KB
2 KB 2 KB 2 KB
2 KB 2 KB 2 KB
2 KB 2 KB 2 KB
2 KB 2 KB 2 KB
2 KB 2 KB 2 KB
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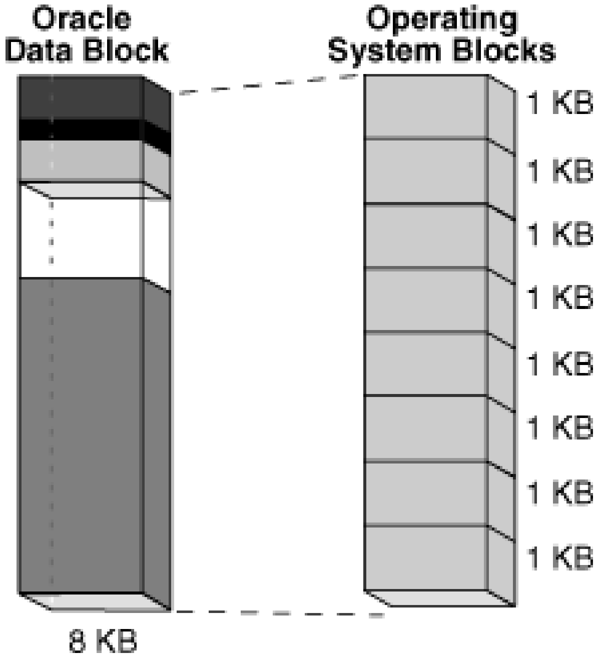
Physical storage structure



Operating System Blocks

- At the physical level, database data is stored in disk files made up of operating system blocks.
- An operating system block is the minimum unit of data that the operating system can read or write. In contrast, an Oracle block is a logical storage structure whose size and structure are not known to the operating system.
- The below shows that operating system blocks may differ in size from data blocks. The database requests data in multiples of data blocks, not operating system blocks.

Physical storage structure

Data files and temp files

A data file is a physical file in persistent storage that was created by Oracle Database and contains data structures such as tables and indexes.
A temp file is a data file that belongs to a temporary tablespace. The database writes data to these files in an Oracle proprietary format that cannot be read by other programs.

Control files

A control file is a root file that tracks the physical components of the CDB. PDBs do not have their own separate control files.

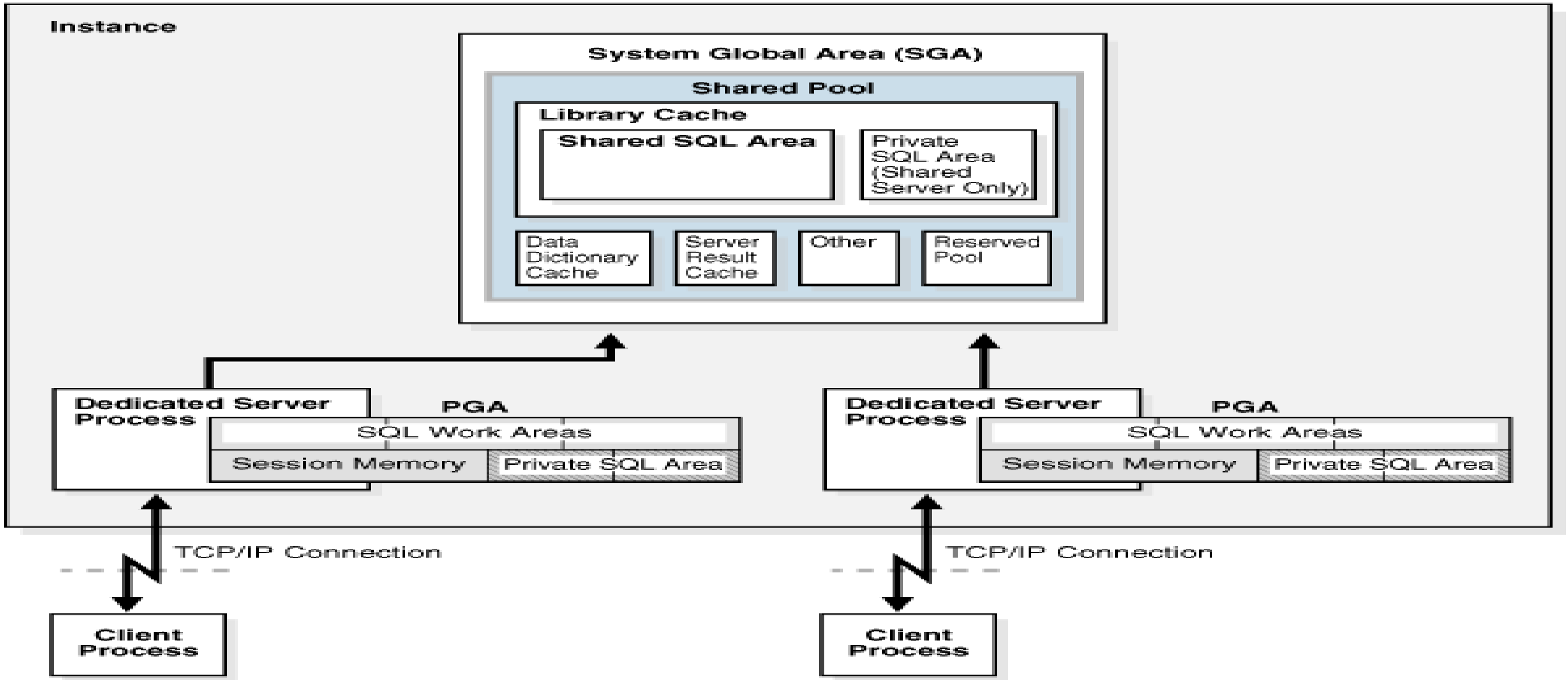
Online redo log files

The online redo log is a set of files containing records of changes made to data within the database.

Getting Started with the Oracle Server

Oracle server - Dedicated Server Architecture

In a **dedicated server** architecture, the server process created on behalf of each client process is called a dedicated server process (or *shadow process*).
A dedicated server process is separate from the client process and acts only on its behalf.



Oracle server - Dedicated Server Architecture

A one-to-one ratio exists between the client processes and server processes. Even when the user is not actively making a database request, the dedicated server process remains—although it is inactive and can be paged out on some operating systems.

The image shows user and server processes running on networked computers. However, the dedicated server architecture is also used if the same computer runs both the client application and the database code but the host operating system could not maintain the separation of the two programs if they were run in a single process. Linux is an example of such an operating system.

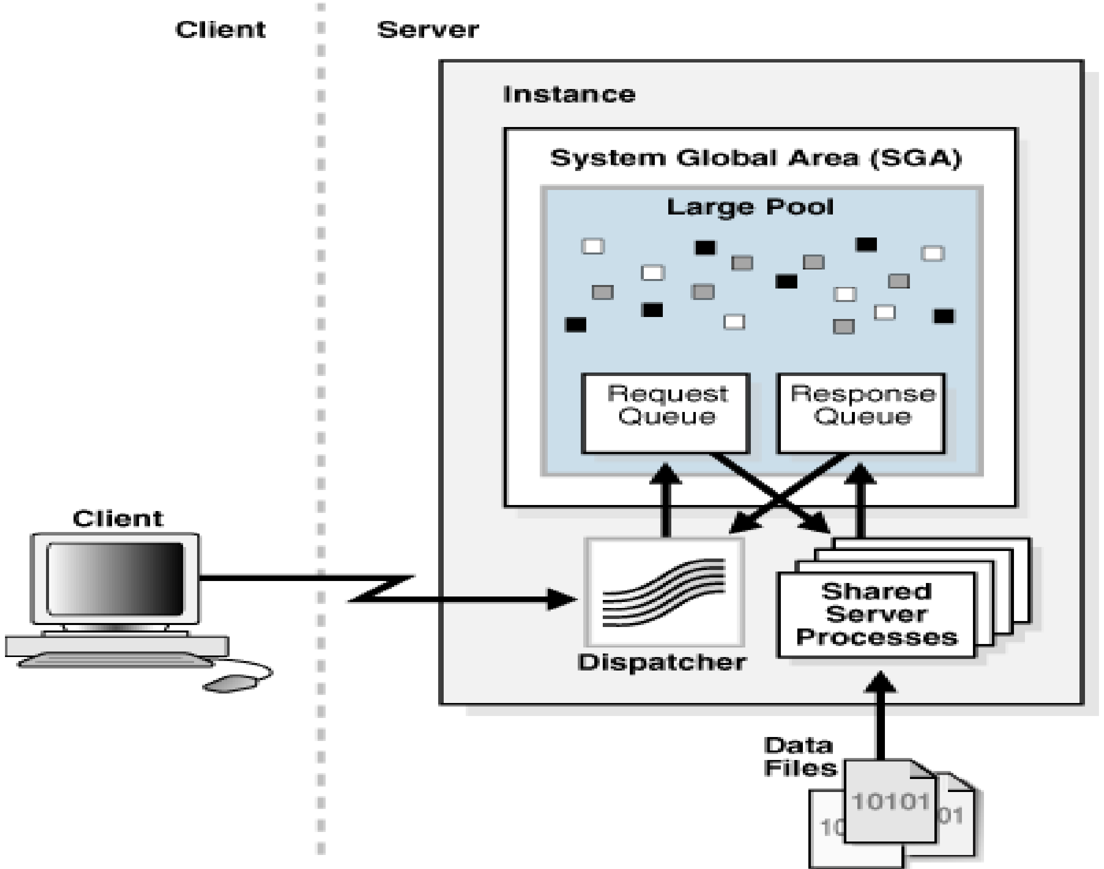
In the dedicated server architecture, the user and server processes communicate using different mechanisms:

- If the client process and the dedicated server process run on the same computer, then the program interface uses the host operating system's interprocess communication mechanism to perform its job.

- If the client process and the dedicated server process run on different computers, then the program interface provides the communication mechanisms (such as the network software and Oracle Net Services) between the programs.

Oracle server - Shared Server Architecture

In a **shared server** architecture, a dispatcher directs multiple incoming network session requests to a pool of shared server processes
The shared pool eliminates the need for a dedicated server process for each connection. An idle shared server process from the pool picks up a request from a common queue.



Oracle server - Shared Server Architecture

The potential benefits of shared server are as follows:

- Reduces the number of processes on the operating system.
- A small number of shared servers can perform the same amount of processing as many dedicated servers.
- Reduces instance PGA memory
- Every dedicated or shared server has a PGA. Fewer server processes means fewer PGAs and less process management.
- Increases application scalability and the number of clients that can simultaneously connect to the database
- May be faster than dedicated server when the rate of client connections and disconnections is high

Oracle server - Shared Server Architecture

Dispatcher Request and Response Queues

A request from a user is a single API call that is part of the user's SQL statement. When a user makes a call, the following actions occur.

- The dispatcher places the request on the request queue, where it is picked up by the next available shared server process.
- The request queue is in the SGA and is common to all dispatcher processes of an instance.
- The shared server processes check the common request queue for new requests, picking up new requests on a first-in-first-out basis.
- One shared server process picks up one request in the queue and makes all necessary calls to the database to complete this request.
- A different server process can handle each database call. Therefore, requests to parse a query, fetch the first row, fetch the next row, and close the result set may each be processed by a different shared server.
- When the server process completes the request, it places the response on the calling dispatcher's response queue. Each dispatcher has its own response queue.
- The dispatcher returns the completed request to the appropriate client process.

Operating system that supports oracle databases

▽ Operating Systems (13 Items)	
Fujitsu BS2000	5 Versions (V9.0, V8.0, V7.0, V11.0, V10.0)
Fujitsu BS2000/OSD (SQ series)	4 Versions (V9.0, V8.0, V11.0, V10.0)
HP OpenVMS Itanium	1 Version (8.4)
HP-UX Itanium	1 Version (11.31)
HP-UX PA-RISC (64-bit)	1 Version (11.31)
IBM AIX on POWER Systems (64-bit)	4 Versions (7.2, 7.1, 6.1, 5.3)
Linux on IBM Z	6 Versions (SLES 11, SLES 10, Red Hat Enterprise Linux 7, Red Hat Enterprise Linux 6, Red Hat Enterprise Linux 5, Red Hat Enterprise Linux 4)
Linux x86	11 Versions (SLES 11, SLES 10, Red Hat Enterprise Linux 6, Red Hat Enterprise Linux 5, Red Hat Enterprise Linux 4, Oracle Linux 6, Oracle Linux 5, Oracle Linux 4, Asianux 4, Asianux 3) and 1 other
Linux x86-64	18 Versions (SLES 12, SLES 11, SLES 10, Red Hat Enterprise Linux 8, Red Hat Enterprise Linux 7, Red Hat Enterprise Linux 6, Red Hat Enterprise Linux 5, Red Hat Enterprise Linux 4, Oracle Linux 8, Oracle Linux 7) and 8 others
Microsoft Windows (32-bit)	8 Versions (XP, Vista, 8.1, 8, 7, 2008, 2003 R2, 2003)
Microsoft Windows x64 (64-bit)	11 Versions (XP, Vista, 8.1, 8, 7, 2012 R2, 2012, 2008 R2, 2008, 2003 R2) and 1 other
Oracle Solaris on SPARC (64-bit)	2 Versions (11, 10)
Oracle Solaris on x86-64 (64-bit)	2 Versions (11, 10)

Database Administration tools

- Putty
- SQL Developer
- Toad
- WinSCP
- OEM – Oracle Enterprise Manager

Database Administrator Users

- SYS - The account used to perform database administration tasks.
- SYSTEM - Another account used to perform database administration tasks.
- SYSDBA - Highest privileges used by a DBA.
- SYSASM - Administrator ASM instance an ASM disks
- SYSBACKUP - It is used to perform BACKUP and RECOVERY Tasks
- APEX_050100 - This account administers APEX Schema and metadata.
- AUDSYS - The account where the unified audit trail resides.
- DBSNMP - The account used by the Management Agent component of Oracle Enterprise Manager to monitor and manage the database.