Oracle Instance Architecture

Oracle Architecture

- Oracle Database Instance
- Memory Architecture
- Process Architecture
- Application and Networking Architecture

INTRODUCTION TO THE ORACLE DATABASE INSTANCE

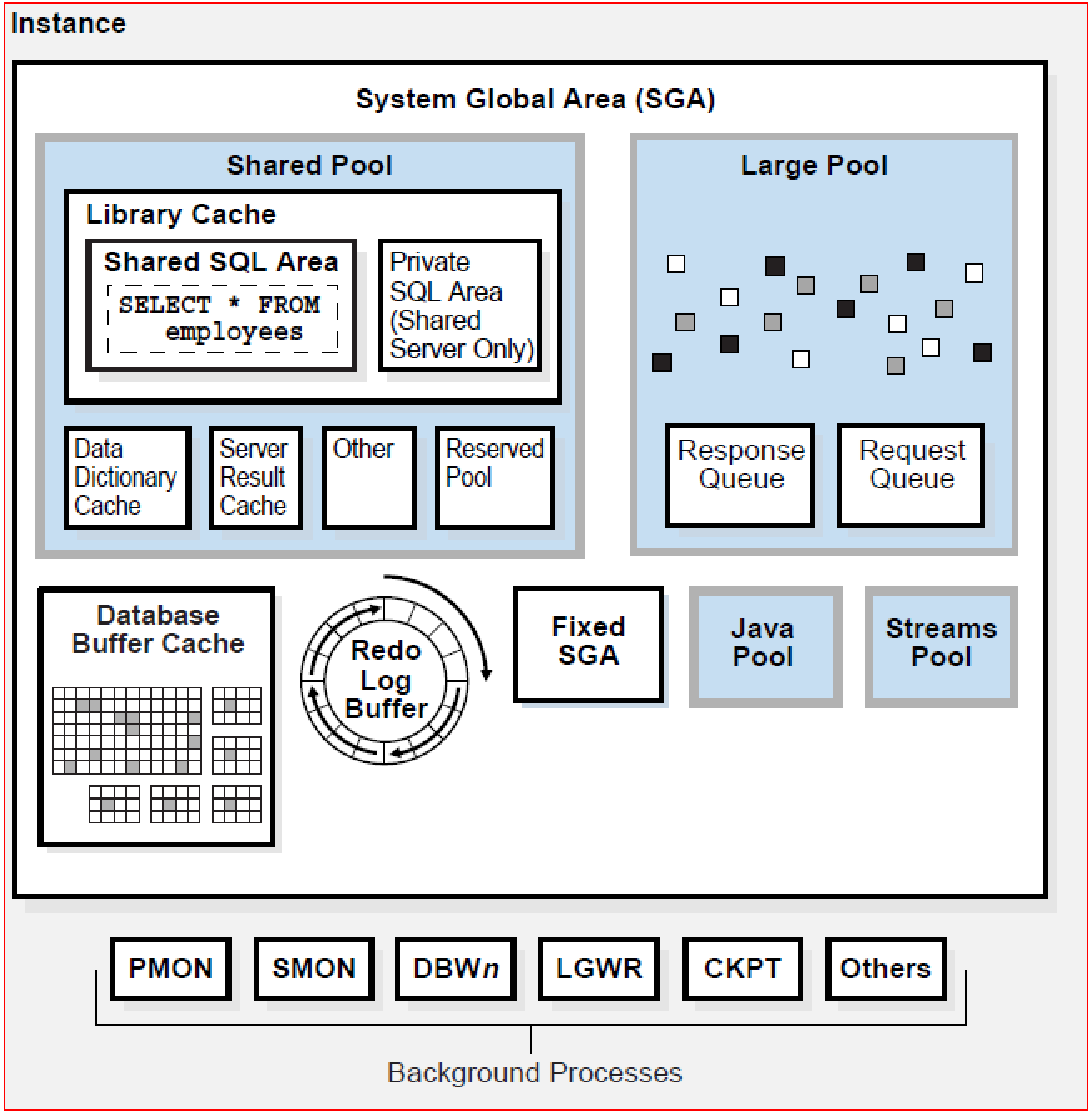
- A database instance is a set of memory structures that manage database files
- A database is a set of physical files on disk
- The instance manages its associated data and serves the users of the database
- Every running Oracle database is associated with at least one Oracle database instance
- Instance can exist without Database
- Database Can exist without instance

DATABASE INSTANCE STRUCTURE

- What happens When an instance is started,
  - Oracle Database allocates a memory area called the **system global area (SGA)**
  - **Starts one or more background processes. The SGA serves various purposes, including the following:**

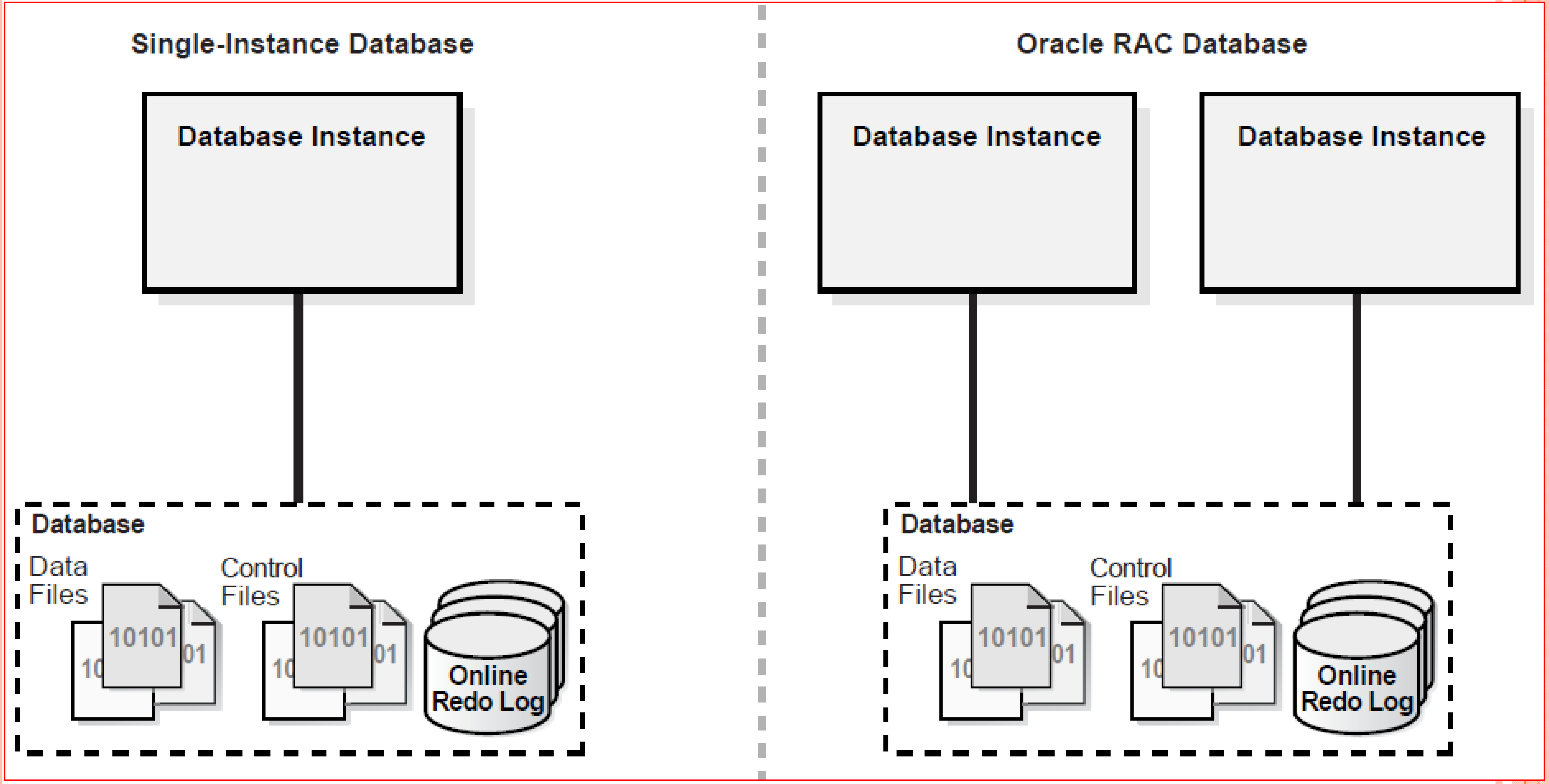
DATABASE INSTANCE STRUCTURE

- What does SGA does
  - Maintaining internal data structures that are accessed by many processes and threads concurrently
  - Caching data blocks read from disk
  - Buffering redo data before writing it to the online redo log files
  - Storing SQL execution plans


Instance
System Global Area (SGA)
Shared Pool
Library Cache
Shared SQL Area
SELECT * FROM employees
Private SQL Area (Shared Server Only)
Data Dictionary Cache
Server Result Cache
Other
Reserved Pool
Large Pool
Response Queue
Request Queue
Database Buffer Cache
Redo Log Buffer
Fixed SGA
Java Pool
Streams Pool
PMON
SMON
DBWn
LGWR
CKPT
Others
Background Processes

DATABASE INSTANCE CONFIGURATIONS

- You can run Oracle Database in either of the following mutually exclusive configurations:
  - Single-instance configuration
    - A one-to-one relationship exists between the database and an instance
  - Oracle Real Application Clusters (Oracle RAC) configuration
    - one-to-many relationship exists between the database and instances


Single-Instance Database
Oracle RAC Database
Database Instance
Database Instance
Database Instance
Database
Data Files
Control Files
Online Redo Log
Database
Data Files
Control Files
Online Redo Log
10101
01
10

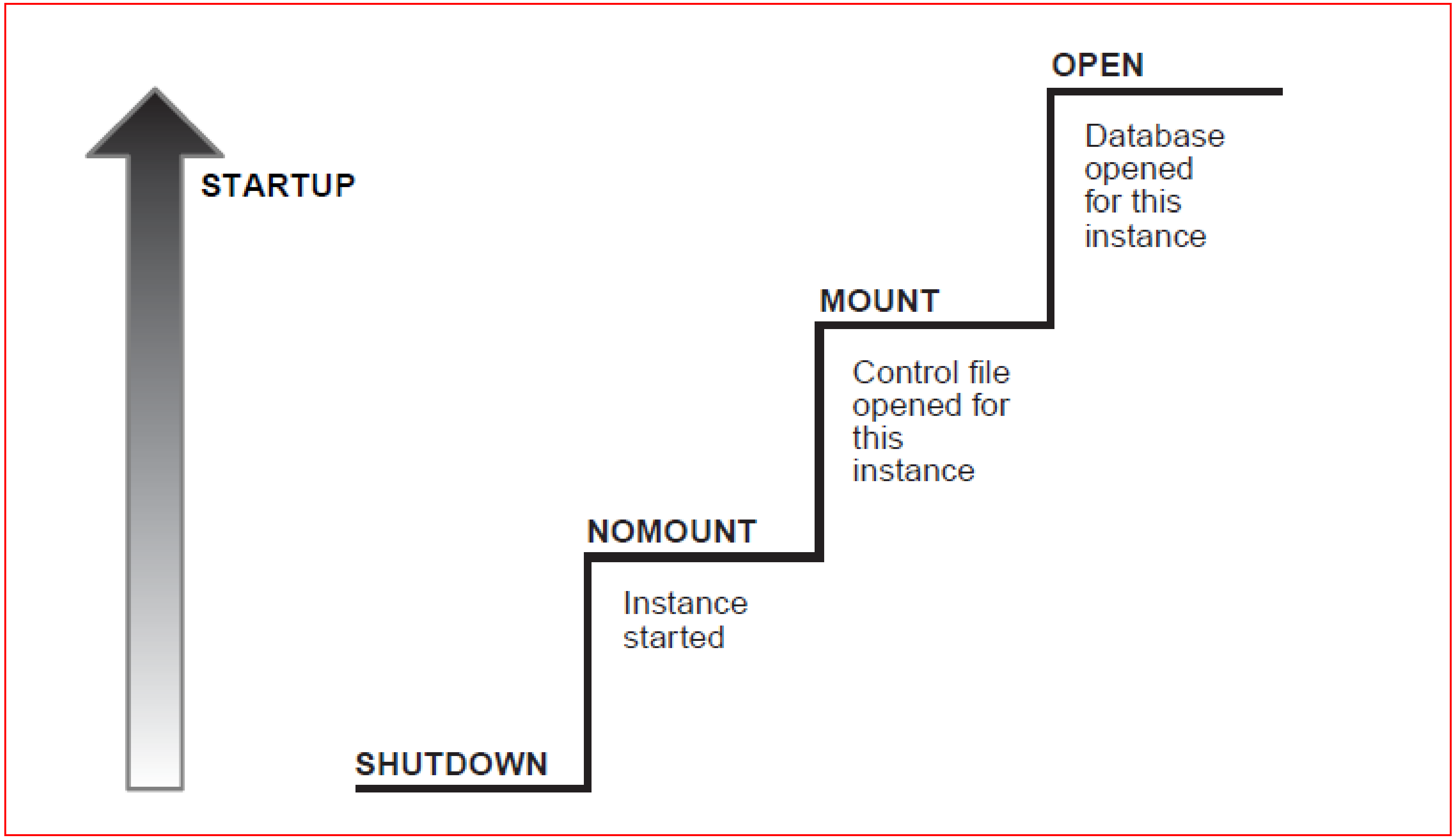
DATABASE INSTANCE CONFIGURATIONS

- Whether in a single-instance or Oracle RAC configuration, a database instance is associated with only one database at a time.
- You can start a database instance and mount (associate the instance with) one database, but not mount two databases simultaneously with the same instance
- Multiple instances can run concurrently on the same computer/ Server, each accessing its own database

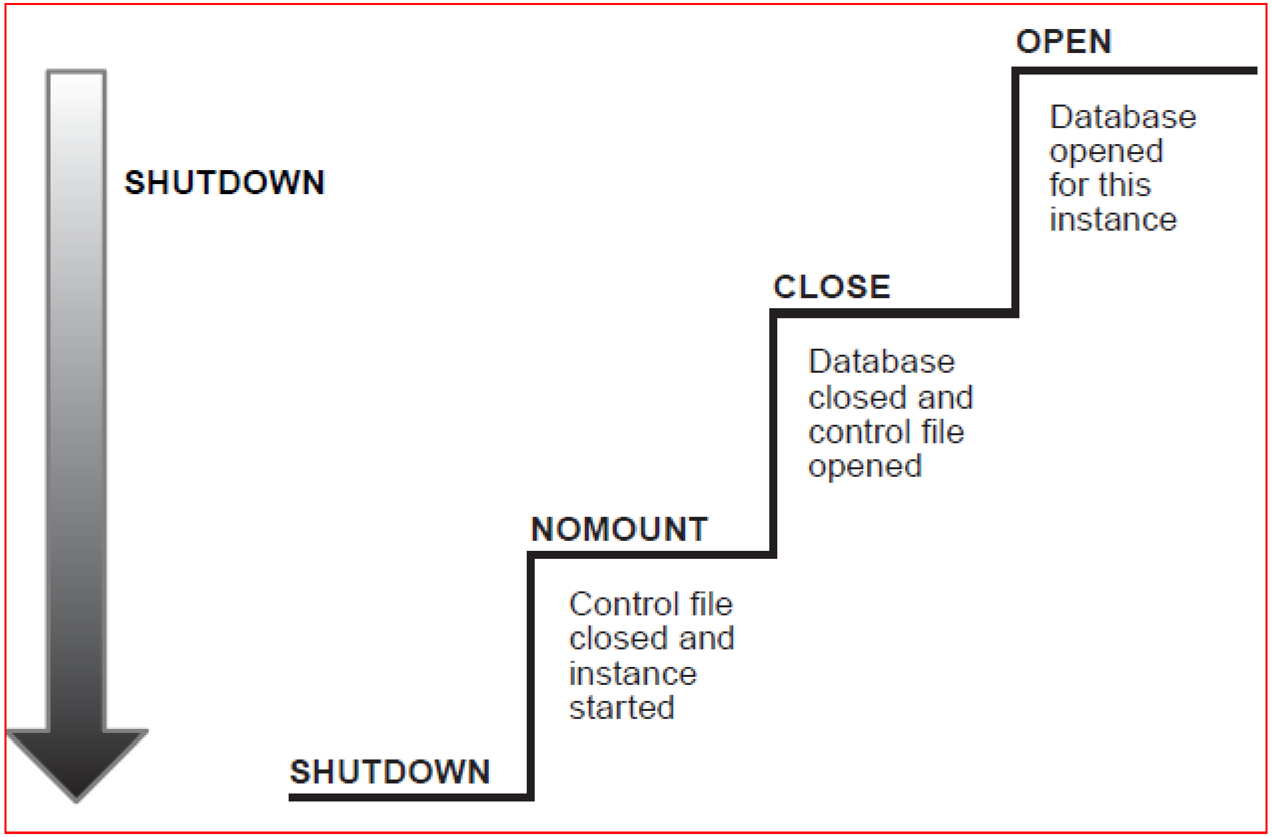
DATABASE INSTANCE CONFIGURATIONS

- **Duration of an Instance**
  - An instance begins when it is created with the STARTUP command and ends when it is terminated
  - During this period, an instance can associate itself with one and only one database

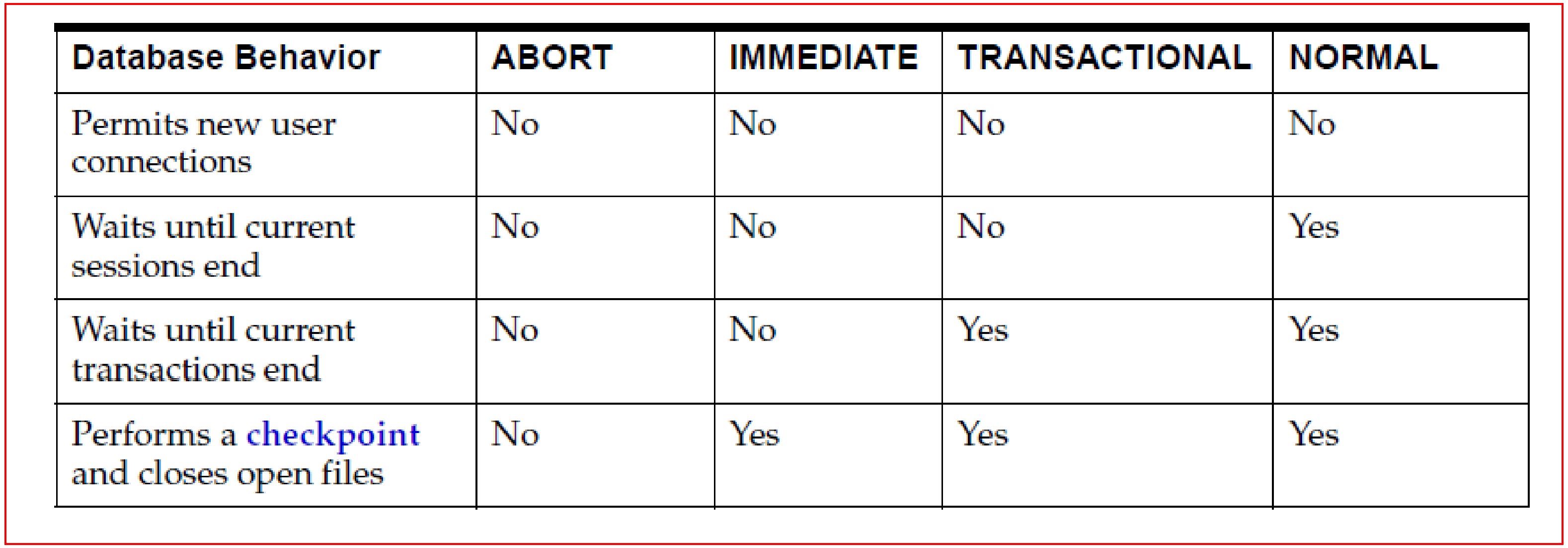
INSTANCE AND DATABASE STARTUP


STARTUP
OPEN
Database opened for this instance
MOUNT
Control file opened for this instance
NOMOUNT
Instance started
SHUTDOWN

DATABASE AND INSTANCE SHUTDOWN


OPEN
Database opened for this instance
CLOSE
Database closed and control file opened
NOMOUNT
Control file closed and instance started
SHUTDOWN
SHUTDOWN

SHUTDOWN MODES



Database Behavior	ABORT	IMMEDIATE	TRANSACTIONAL	NORMAL
Permits new user connections	No	No	No	No
Waits until current sessions end	No	No	No	Yes
Waits until current transactions end	No	No	Yes	Yes
Performs a checkpoint and closes open files	No	Yes	Yes	Yes

CHECKPOINTS

- A **checkpoint is a crucial mechanism in consistent database shutdowns, instance recovery, and Oracle Database operation**

- **Purpose of Checkpoints**
  - Reduce the time required for recovery in case of an instance or media failure
  - Ensure that dirty buffers in the buffer cache are written to disk regularly
  - Ensure that all committed data is written to disk during a consistent shutdown

INSTANCE RECOVERY

- **Instance recovery is the process of applying records in the online redo log to data files to reconstruct changes made after the most recent checkpoint**

- Instance recovery occurs automatically when an administrator attempts to open a database that was previously shut down inconsistently.

- Instance recovery ensures that the database is in a consistent state after an instance failure.

When Oracle Database Performs Instance Recovery

- Whether instance recovery is required depends on the state of the redo threads.

- A redo thread is marked open in the control file when a database instance opens in read/write mode, and is marked closed when the instance is shut down consistently.

- The database opens for the first time after the failure of a single-instance database or all instances of an Oracle RAC database
- Some but not all instances of an Oracle RAC database fail

PARAMETER FILES

- To start a database instance, Oracle Database must read either a **server parameter file, which is recommended, or a text initialization parameter file, which is a legacy implementation.**

- These files contain a list of configuration parameters

PARAMETER FILES

- **Server Parameter Files**
  - A server parameter file is a repository for initialization parameters that is managed by Oracle Database**.**
- Characteristics of Server Parameter file.
  - Only one server parameter file exists for a database
  - The server parameter file is written to and read only by Oracle Database
  - The server parameter file is binary file

PARAMETER FILES

- **Text Initialization Parameter Files**
  - A **text initialization parameter file is a text file that contains a list of initialization parameters.**

- Characteristics of Text Initialization Parameter file.
  - Reside on the same host
  - A text initialization parameter file is text-based, not binary
  - Oracle Database can read but not write to the text initialization parameter file

TRACE FILES

- A **trace file is an administrative file that contain diagnostic data used to investigate problems**

ORACLE DATABASE MEMORY STRUCTURES

- When an instance is started, Oracle Database allocates a memory area and starts **background processes.**
- The memory area stores information such as the following
  - Program code
  - Information about each connected **session**
  - Information needed during program execution
  - Information such as **lock data that is shared and communicated among processes**
  - Cached data, such as **data blocks and redo records, that also exists on disk**

Basic Memory Structures

- System global area (SGA)
  - The SGA is a group of shared memory structures, known as **SGA components, that contain data and control information for one Oracle Database instance**
- Program global area (PGA)
  - A PGA is a nonshared memory region that contains data and control information exclusively for use by an Oracle process
- User Global Area (UGA)
  - The UGA is memory associated with a user session.
- Software code areas
  - Software code areas are portions of memory used to store code that is being run or can be run.

DATABASE MEMORY MANAGEMENT

- Memory management involves maintaining optimal sizes for the Oracle instance memory structures as demands on the database change
  - Automatic memory management
  - Automatic shared memory management
    - Partially automated
  - Manual memory management
    - Instead of setting the total memory size individually set SGA and PGA memmory.

USER GLOBAL AREA

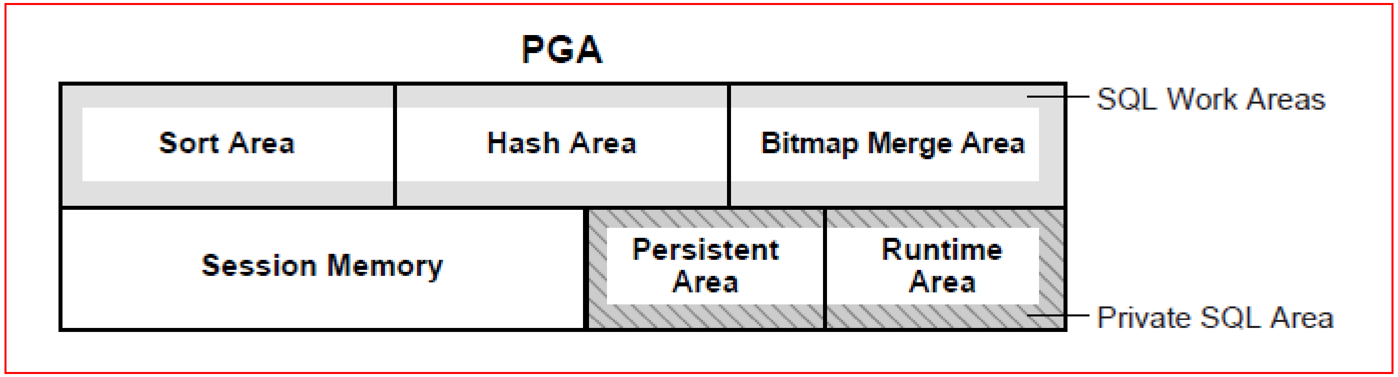
- The UGA is **session memory**
  - Memory allocated for session variables
  - logon information
  - P/L SQL Package State.

Program Global Area

- The PGA is memory specific to an operating process or thread that is not shared by other processes or threads on the system

- PGA is process-specific, it is never allocated in the SGA.

CONTENTS OF THE PGA



Contents of the PGA

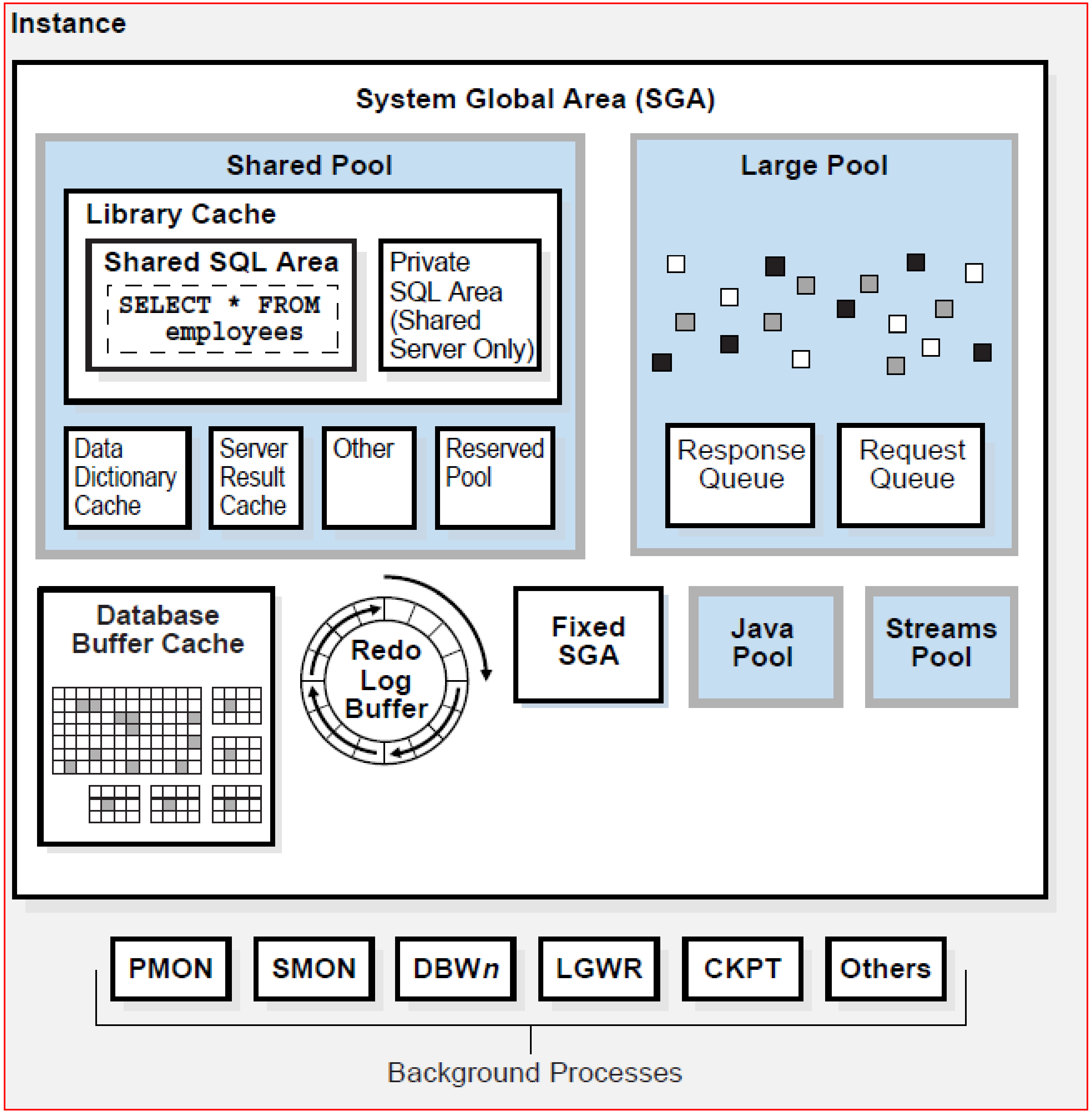
- **Private SQL Area**
  - The run-time area
    - This area contains query execution state information
  - The persistent area
    - This area contains **variable values**
    - A variable value is supplied to a SQL statement at run time when the statement is executed
- **SQL Work Areas**
  - A **work area is a private allocation of PGA memory used for memory-intensive operations.**

System Global Area

- The SGA is a read/write memory area that, along with the Oracle background processes, make up a database instance

- All server processes that execute on behalf of users can read information in the instance SGA

- Each database instance has its own SGA.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Database Buffer Cache
Redo Log Buffer
Fixed SGA
Java Pool
Streams Pool
PMON
SMON
DBWn
LGWR
CKPT
Others
Background Processes

SGA COMPONENTS

- The most important SGA components are the following
  - Database Buffer Cache
  - Redo Log Buffer
  - Shared Pool
  - Large Pool
  - Java Pool
  - Fixed SGA

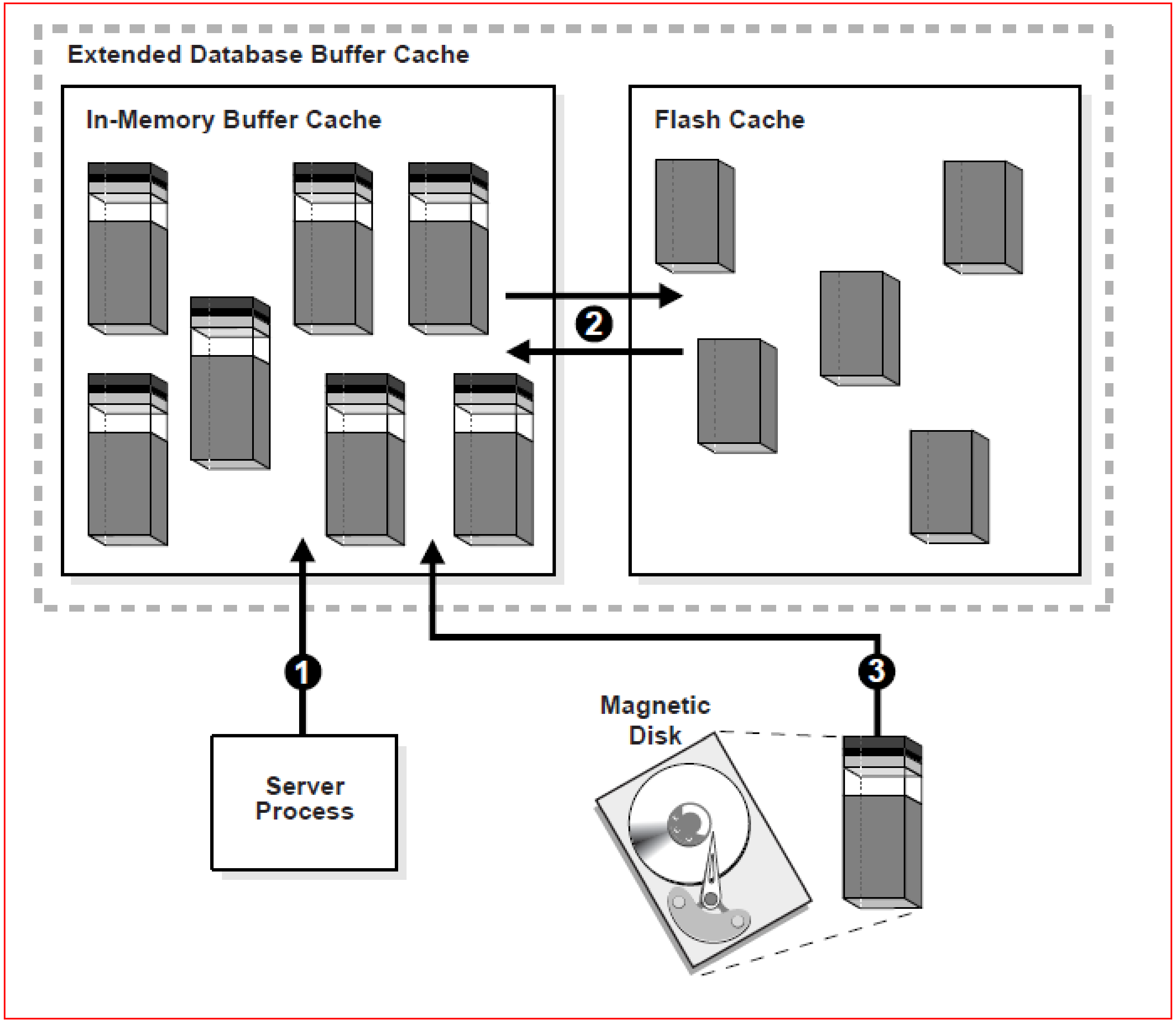
DATABASE BUFFER CACHE

- The database buffer cache, also called the buffer cache, is the memory area that stores copies of data blocks read from data files.

- Why Buffer Cache
  - Optimize physical I/O
  - Keep frequently accessed blocks in the buffer cache and write infrequently accessed blocks to disk

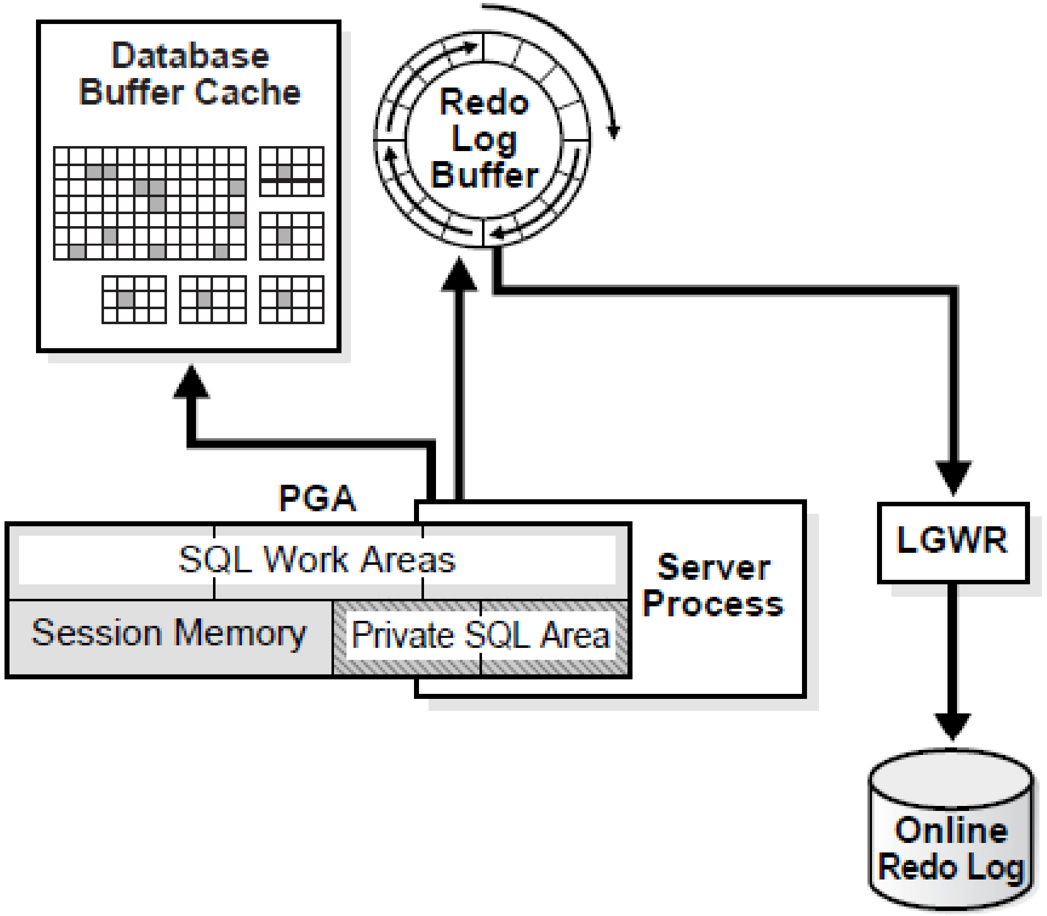
BUFFER STATES

- The database uses internal algorithms to manage buffers in the cache
- A buffer can be in any of the following mutually exclusive states:
  - Unused
    - The buffer is available for use because it has never been used or is currently unused
  - Clean
    - This buffer was used earlier and now contains a read-consistent version of a block as of a point in time.
  - Dirty
    - The buffer contain modified data that has not yet been written to disk


Extended Database Buffer Cache
In-Memory Buffer Cache
Flash Cache
2
1
3
Magnetic Disk
Server Process

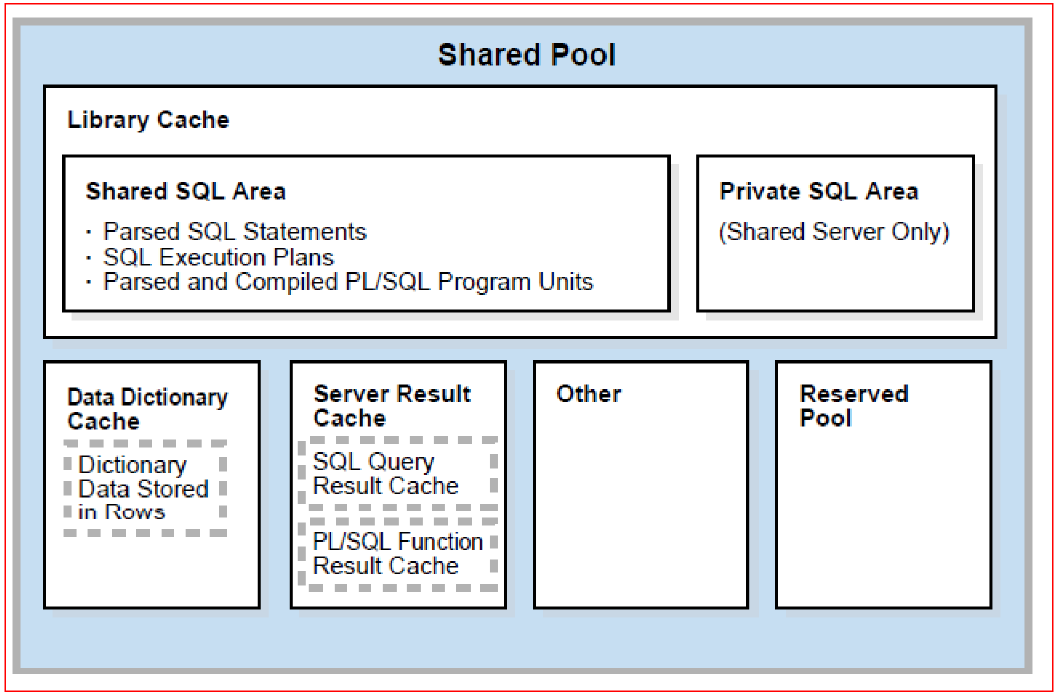
REDO LOG BUFFER

- The redo log buffer is a circular buffer in the SGA that stores redo entries describing changes made to the database.
- Redo entries contain the information necessary to reconstruct, or redo, changes made to the database by DML or DDL operations.
- Database recovery applies redo entries to data files to reconstruct lost changes.


Database Buffer Cache
Redo Log Buffer
PGA
SQL Work Areas
Session Memory
Private SQL Area
Server Process
LGWR
Online Redo Log

SHARED POOL

- The **shared pool caches various types of program data**
  - **Parsed SQL/PLSQL**
  - **System Parameters**
  - **Data dictionary Information.**



Shared Pool

Library Cache

Shared SQL Area

- Parsed SQL Statements
- SQL Execution Plans
- Parsed and Compiled PL/SQL Program Units

Private SQL Area

(Shared Server Only)

Data Dictionary Cache

Dictionary Data Stored in Rows

Server Result Cache

SQL Query Result Cache

PL/SQL Function Result Cache

Other

Reserved Pool

LARGE POOL

- The **large pool is an optional memory area intended for memory allocations that are larger than is appropriate for the shared pool**
  - UGA for the shared server where transactions interact with multiple databases
  - Message buffers used in the parallel execution of statements
  - Buffers for Recovery Manager (RMAN)

JAVA POOL

- The Java pool is an area of memory that stores all session-specific Java code and data within the Java Virtual Machine (JVM).

FIXED SGA

- The **fixed SGA is an internal housekeeping area**
  - General information about the state of the database and the instance, which the background processes need to access
  - Information communicated between processes, such as information about **locks**

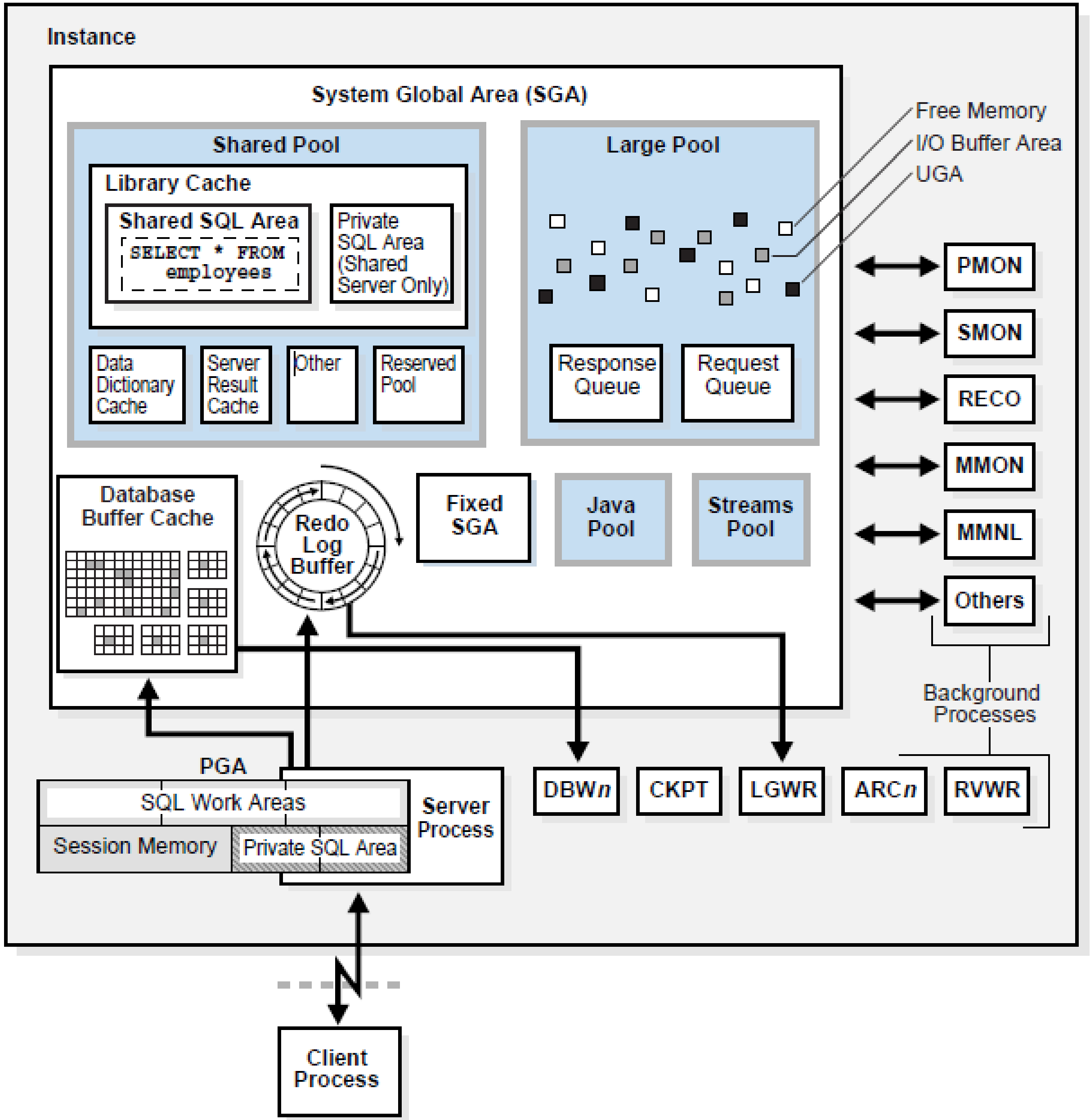
Process Architecture

INTRODUCTION TO PROCESSES

- A **process is a mechanism in an operating system that can run a series of steps**
- All connected Oracle Database users must run the following modules to access a database **instance**
  - Application or Oracle Database utility
  - Oracle database code
- A process normally runs in its own private memory area

TYPES OF PROCESSES

- **Client processes**
  - run the application
  - Oracle tool code
- **Oracle processes**
  - Run the Oracle database code
  - **Background processes**
    - start with the database instance
    - perform maintenance tasks (instance recovery**,** cleaning up processes , writing redo buffers to disk ….)
  - **Slave processes**
    - perform additional tasks for a background or server process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Redo Log Buffer
Fixed SGA
Java Pool
Streams Pool
PMON
SMON
RECO
MMON
MMNL
Others
Background Processes
PGA
SQL Work Areas
Session Memory
Private SQL Area
Server Process
DBWn
CKPT
LGWR
ARCn
RVWR
Client Process

CLIENT PROCESSES

- When a user runs an application such as a Pro*C program or SQL*Plus, the operating system creates a client process (sometimes called a user process) to run the user application.

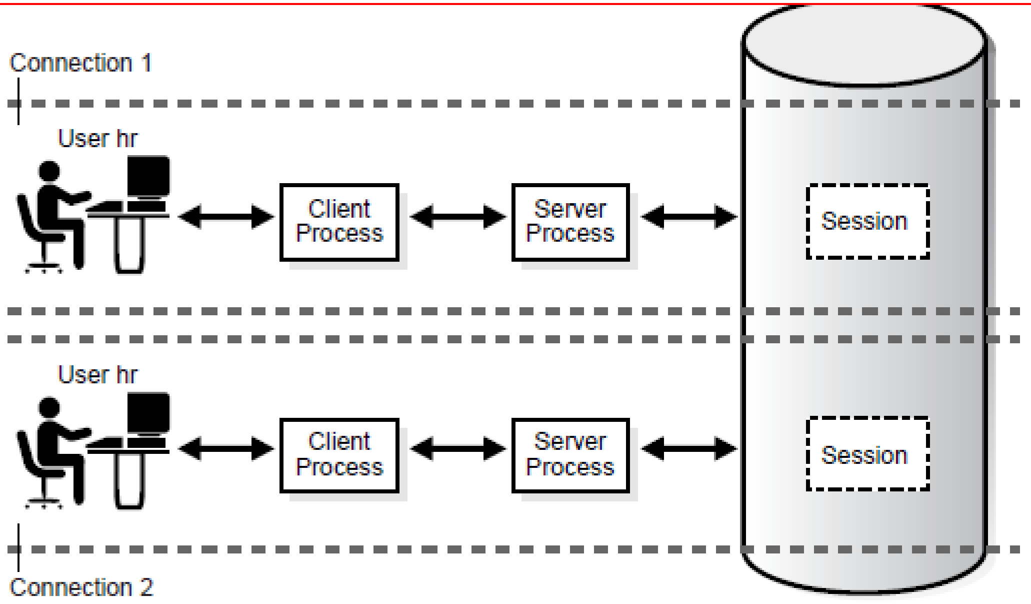
- The client application has Oracle Database libraries linked into it that provide the APIs required to communicate with the database.

Connections and Sessions

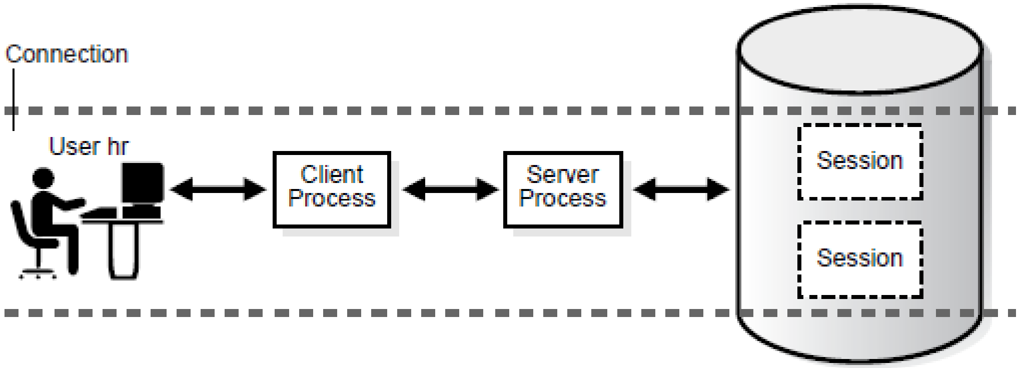
- Connection
  - A connection is a physical communication pathway between a client process and a database instance
  - A communication pathway is established using available interprocess communication mechanisms or network software

CONNECTIONS AND SESSIONS

- Session
  - A session is a logical entity in the database instance memory that represents the state of a current user login to a database
  - A single connection can have 0, 1, or more sessions established on it
  - The sessions are independent: a commit in one session does not affect transactions in other sessions



Two Sessions in One Connection



SERVER PROCESSES

- Oracle Database creates server processes to handle the requests of client processes connected to the instance

- A client process always communicates with a database through a separate server process.

Dedicated Server Processes

- In dedicated server connections, the client connection is associated with one and only one server process
- Each client process communicates directly with its server process
- This server process is dedicated to its client process for the duration of the session.

Shared Server Processes

- In shared server connections, client applications connect over a network to a dispatcher process, not a server process
- The dispatcher process receives requests from connected clients and puts them into a request queue in the large pool
- The first available shared server process takes the request from the queue and processes it.
- shared server place the result into the dispatcher response queue

Background Processes

- Mandatory Background Processes
- Optional Background Processes
- Slave Processes

MANDATORY BACKGROUND PROCESSES

- The mandatory background processes are present in all typical database configurations
  - Process Monitor Process (PMON)
  - System Monitor Process (SMON)
  - Database Writer Process (DBWn)
  - Log Writer Process (LGWR)
  - Checkpoint Process (CKPT)
  - Manageability Monitor Processes (MMON and MMNL)
  - Recoverer Process (RECO)