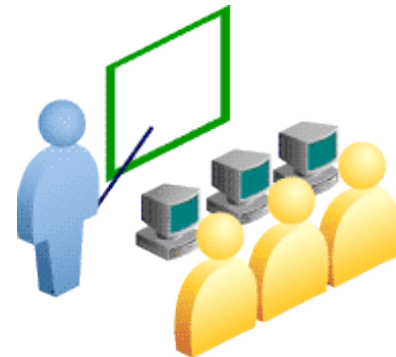# Exploring the Oracle Database Architecture

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Objectives

After completing this lesson, you should be able to:

- List the major architectural components of Oracle Database

- Explain the memory structures

- Describe the background processes

- Correlate the logical and physical storage structures
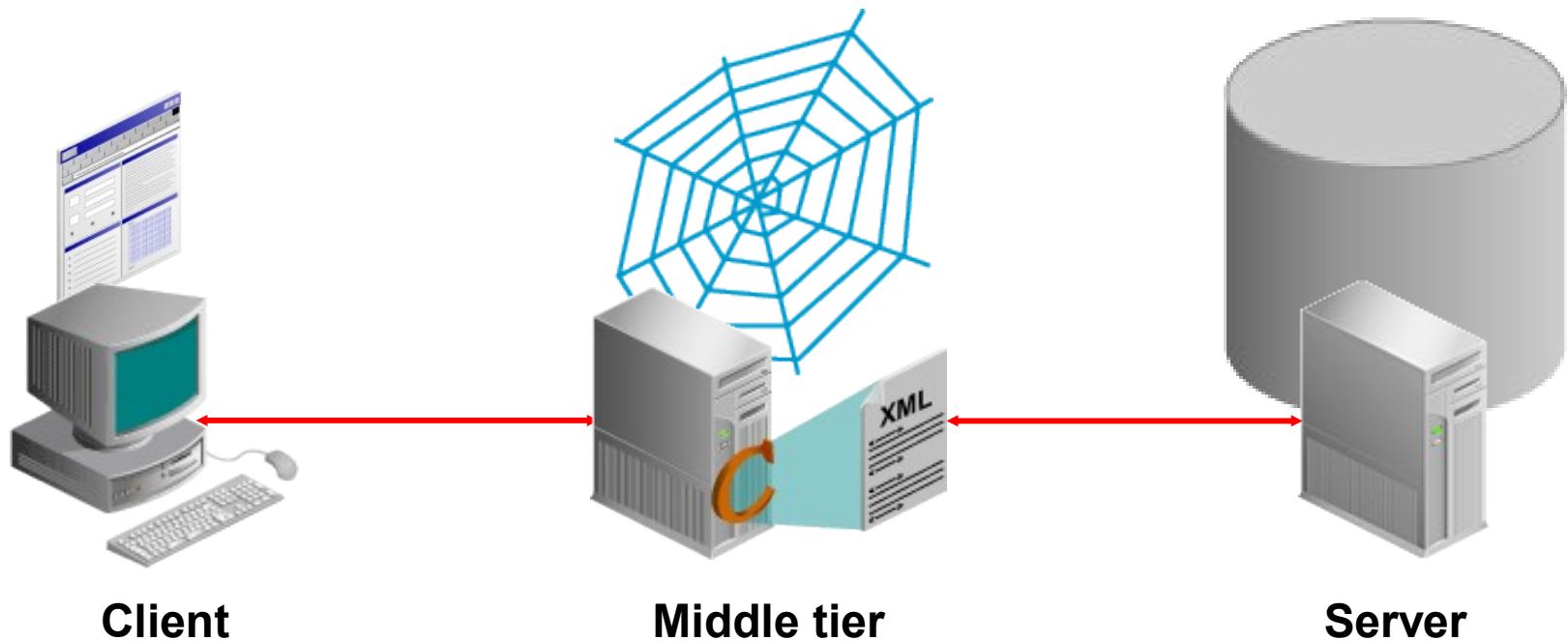
- Describe ASM storage components

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Oracle Database

The Oracle relational database management system (RDBMS) provides an open, comprehensive, integrated approach to information management
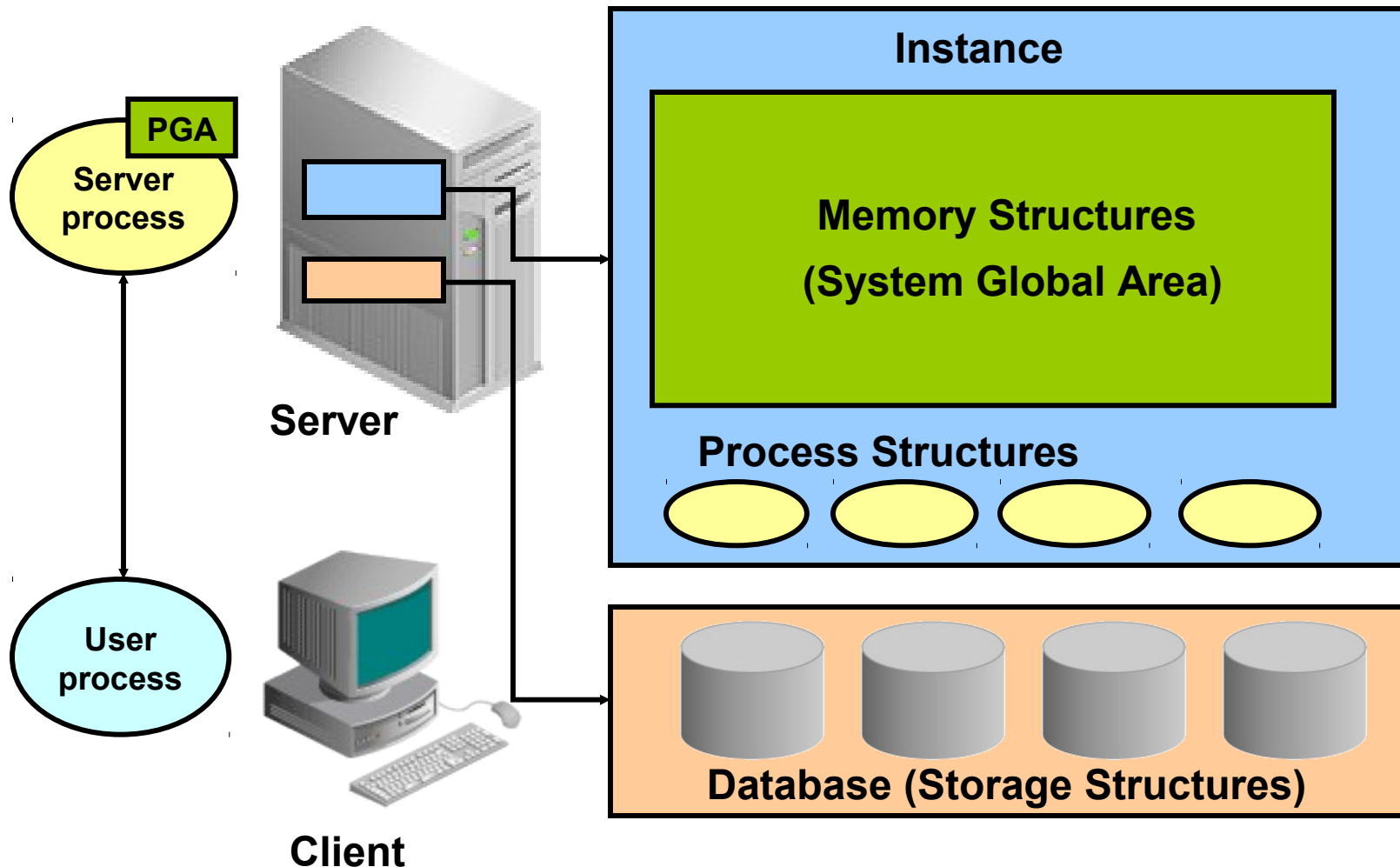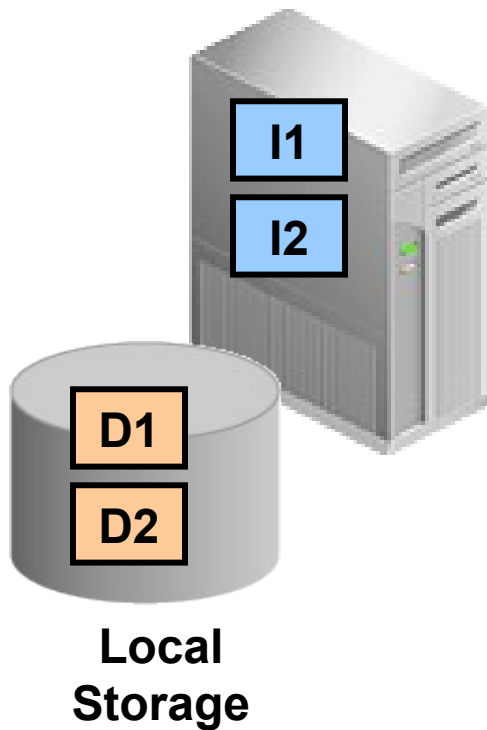
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Connecting to a Server

Client   **Middle tier**   **Server**

Multitier architecture shown

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Oracle Database Server Architecture: Overview

PGA

Server process

User process

Server

Client

Instance

Memory Structures

(System Global Area)

Process Structures

Database (Storage Structures)

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Instance: Database Configurations

Nonclustered System

Clustered System

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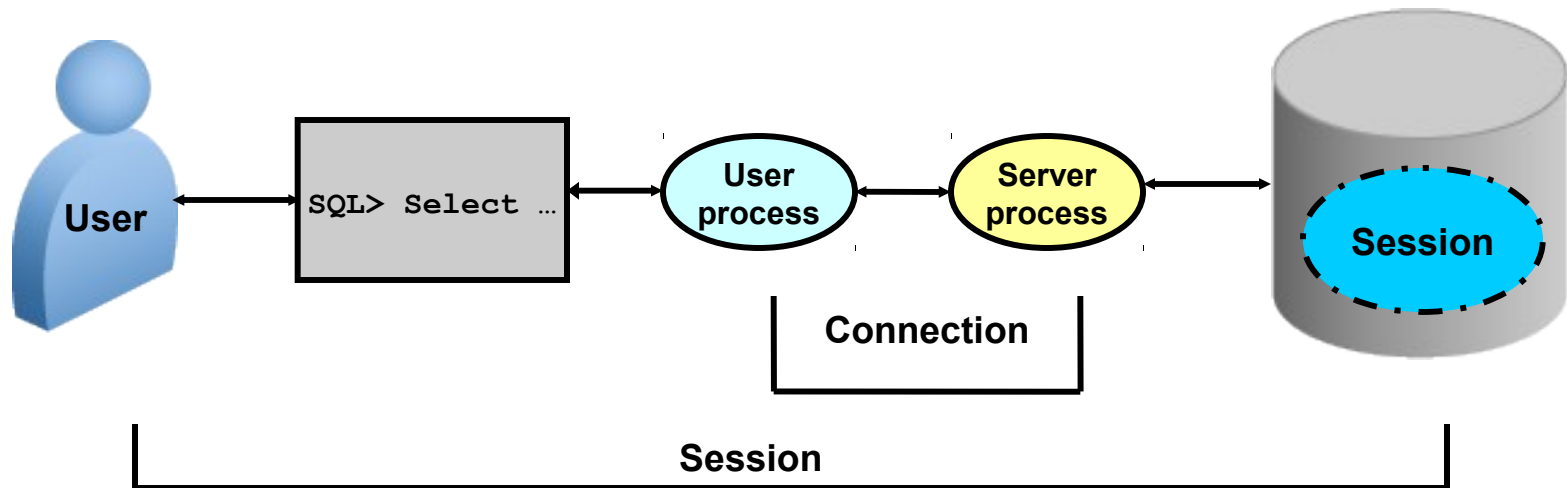
I1
I2

I1

I2
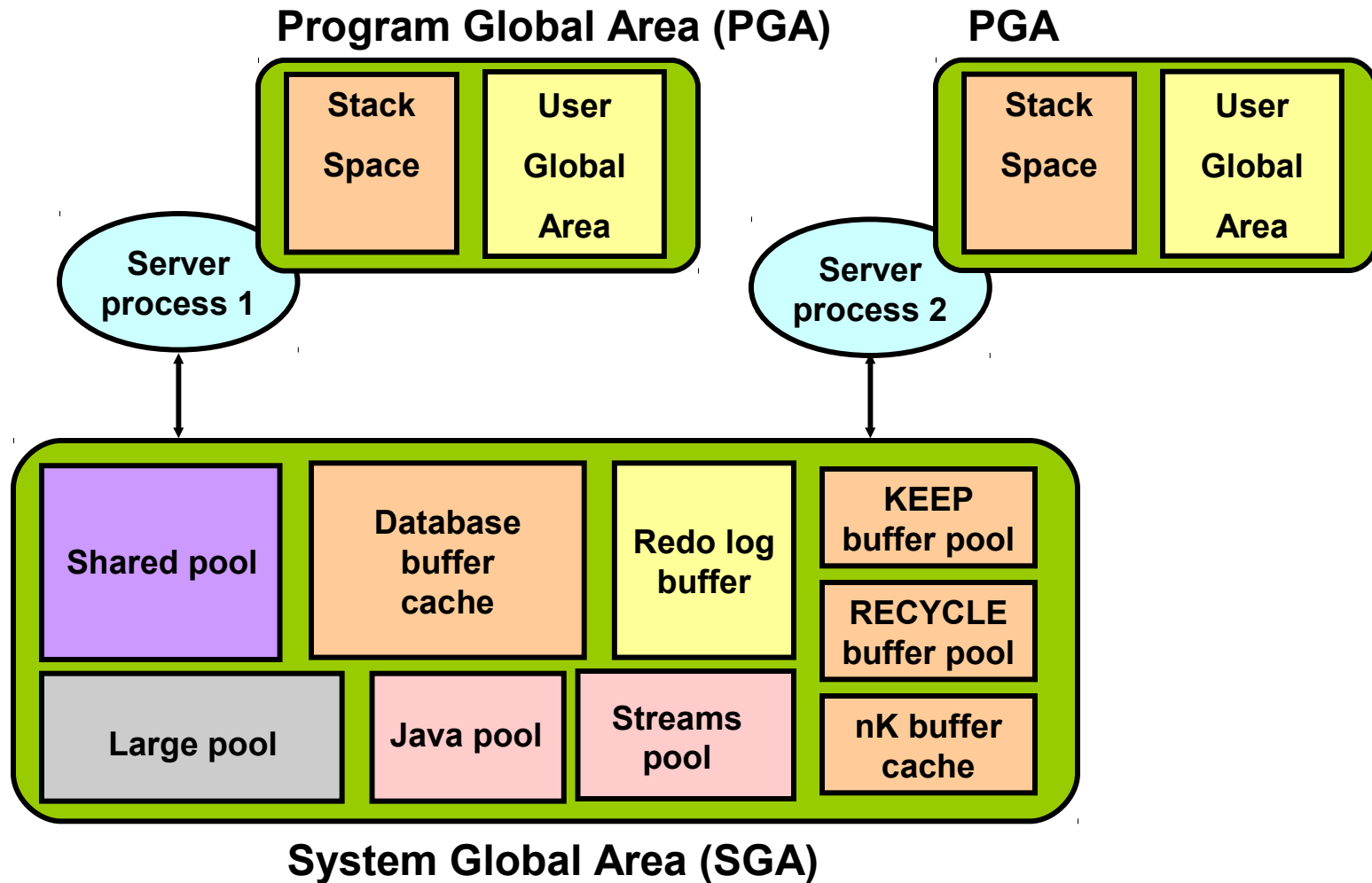
I3

D1
D2

Local Storage

D

Shared Storage
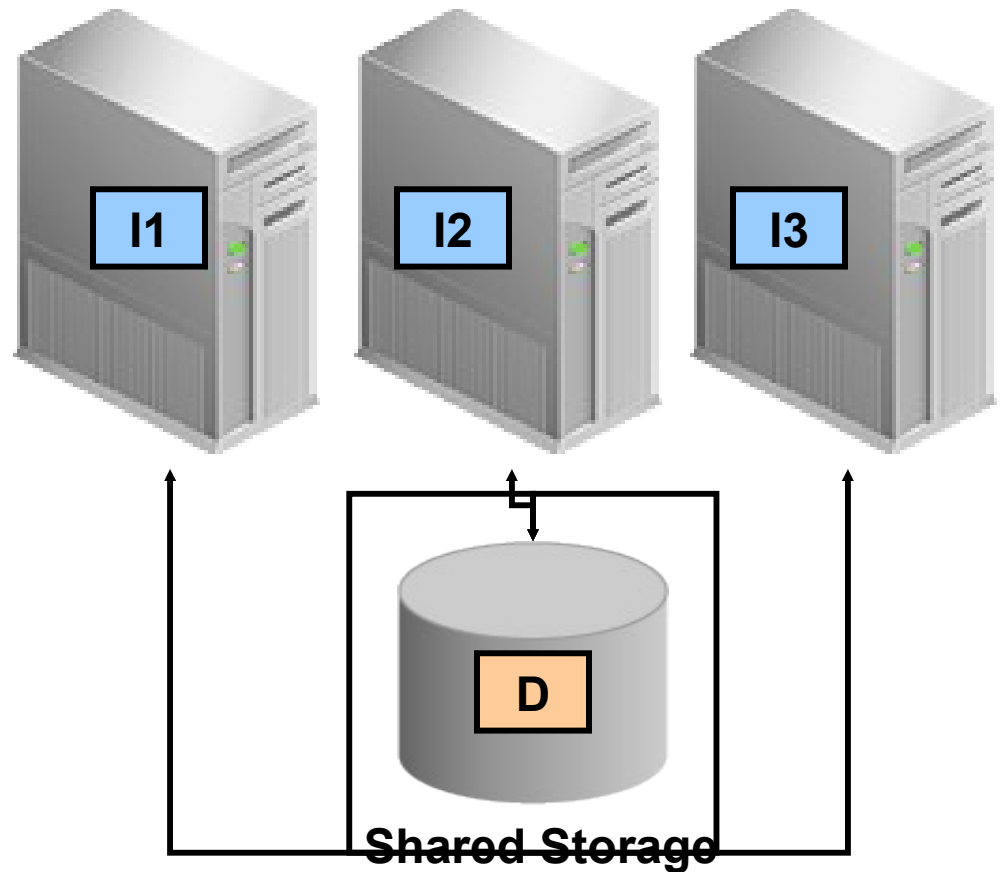
Connecting to the Database Instance

- Connection: Communication between a user process and an instance

- Session: Specific connection of a user to an instance through a user process

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Oracle Database Memory Structures

Program Global Area (PGA)

PGA

Stack Space	User Global Area

Stack Space	User Global Area

Server process 1

Server process 2

System Global Area (SGA)

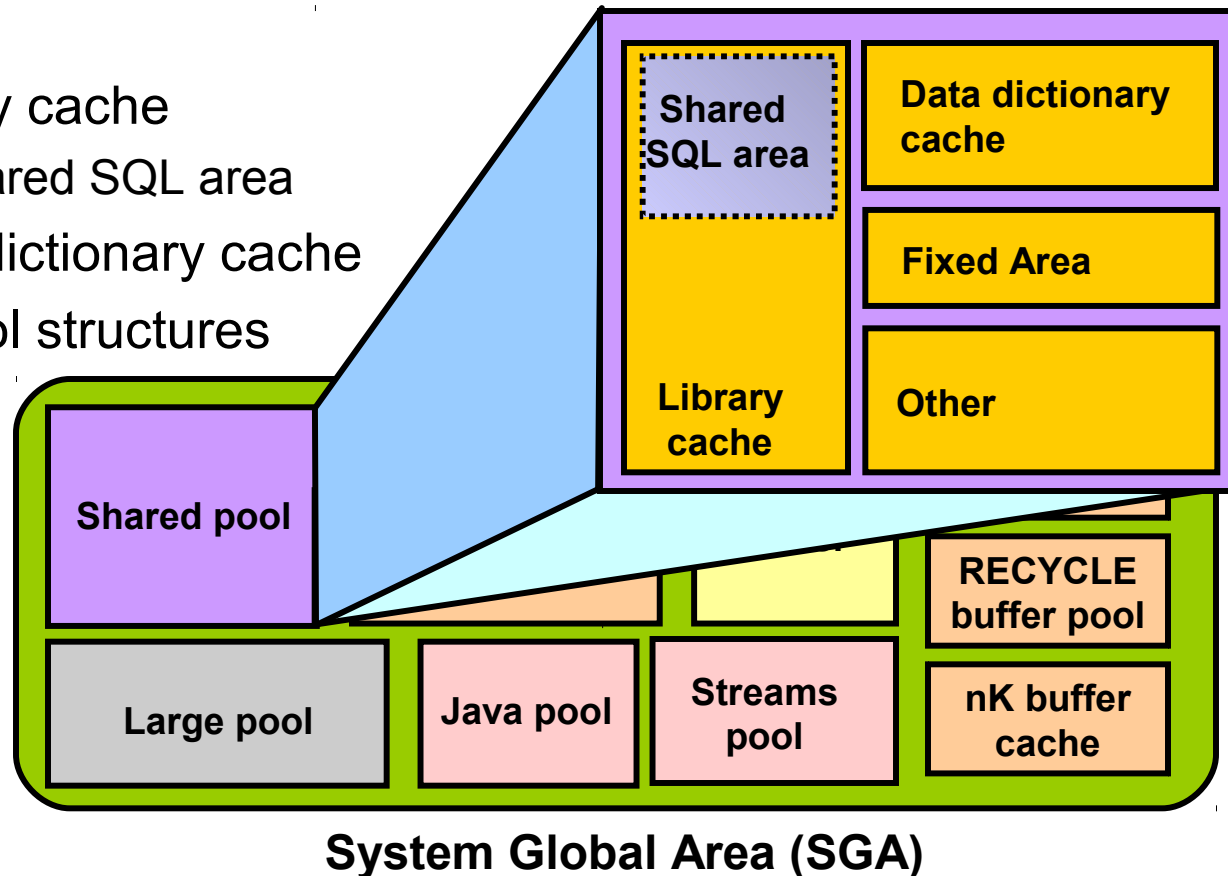| Shared pool | Database buffer cache | Redo log buffer | KEEP buffer pool |
| Large pool | Java pool | Streams pool | RECYCLE buffer pool |
| | | | nK buffer cache |

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Shared Pool

- Is a portion of the SGA
- Contains:
  - Library cache
    - Shared SQL area
  - Data dictionary cache
  - Control structures

Shared SQL area

Data dictionary cache

Fixed Area

Library cache

Other

Shared pool

Large pool

Java pool

Streams pool

RECYCLE buffer pool

nK buffer cache

System Global Area (SGA)

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Database Buffer Cache

- Is part of the SGA

- Holds copies of data blocks that are read from data files

- Is shared by all concurrent users


System Global Area (SGA)

ORACLE
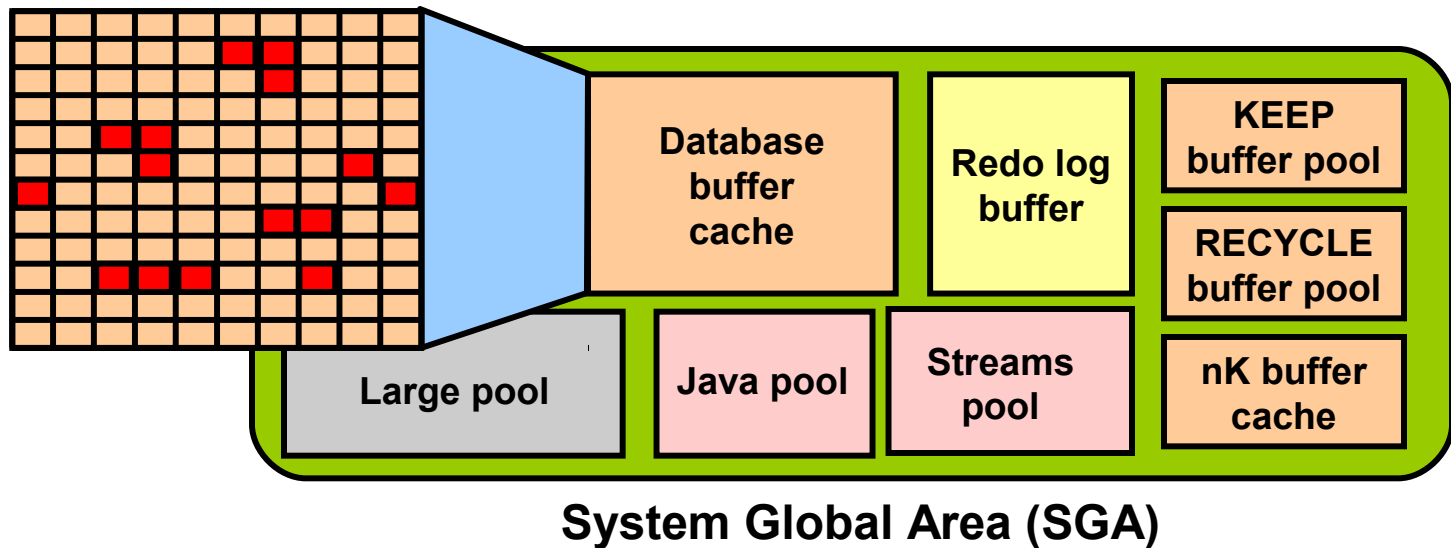
Redo Log Buffer

- Is a circular buffer in the SGA
- Holds information about changes made to the database
- Contains redo entries that have the information to redo changes made by operations such as DML and DDL

System Global Area (SGA)
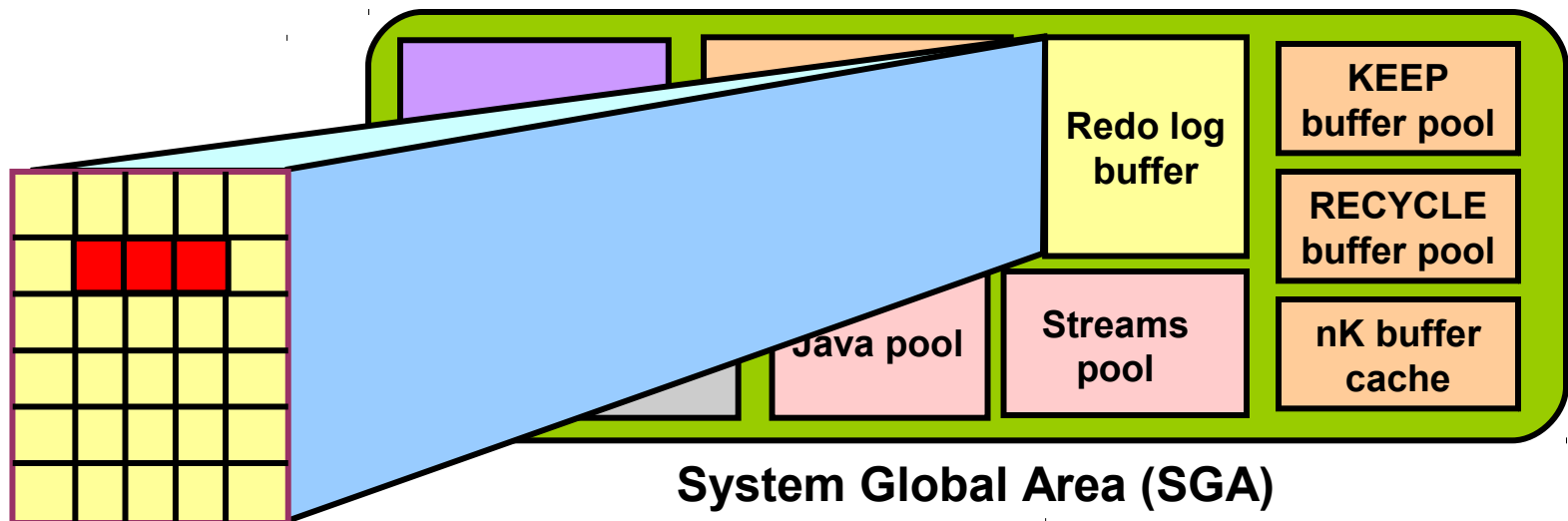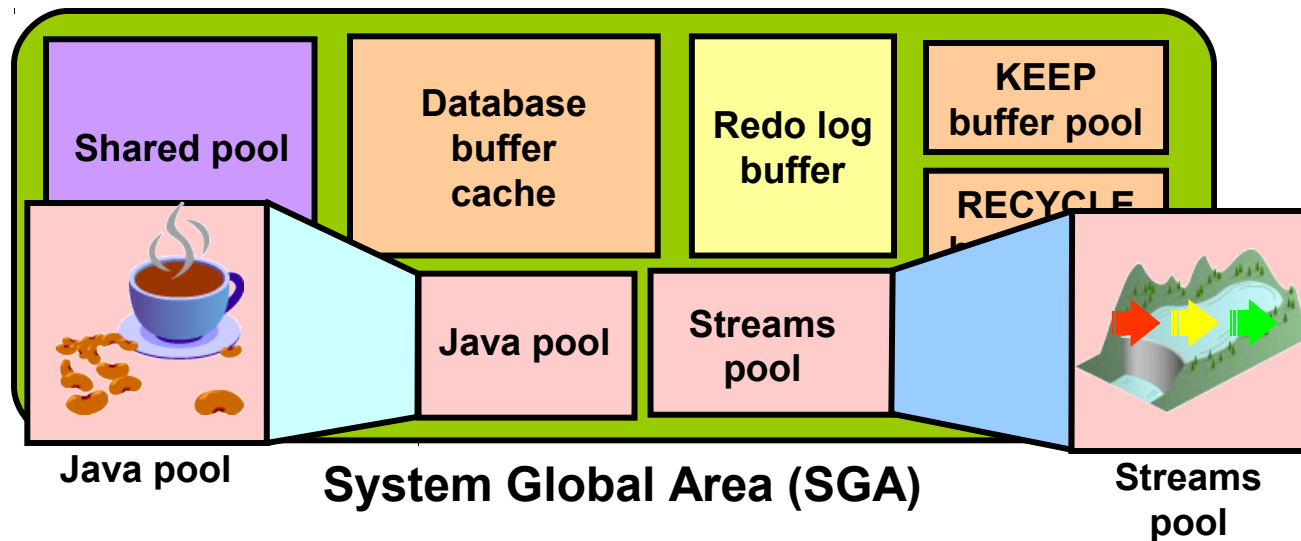
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Large Pool

Provides large memory allocations for:

- Session memory for the shared server and the Oracle XA interface
- I/O server processes
- Oracle Database backup and restore operations

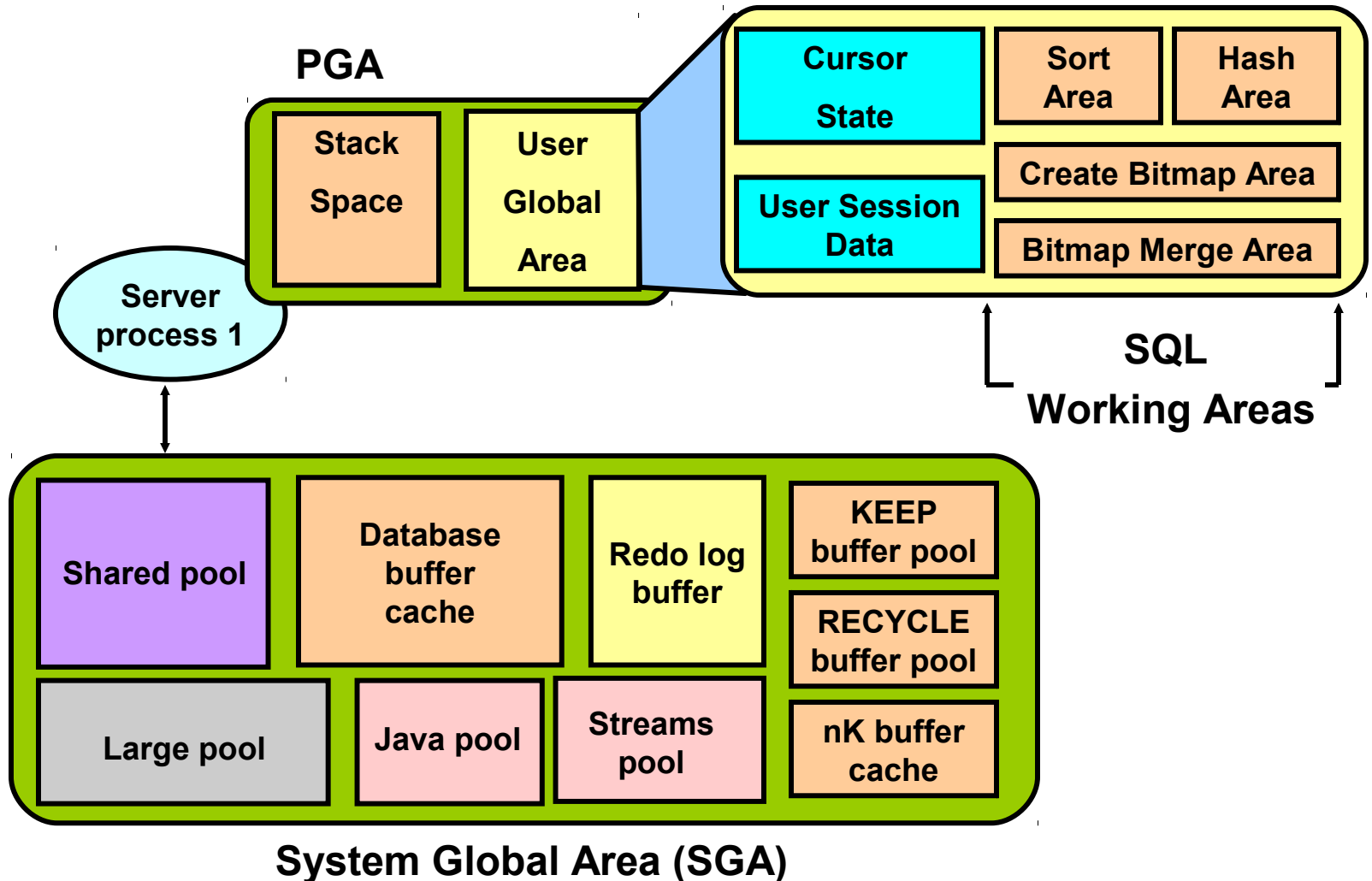
System Global Area (SGA)
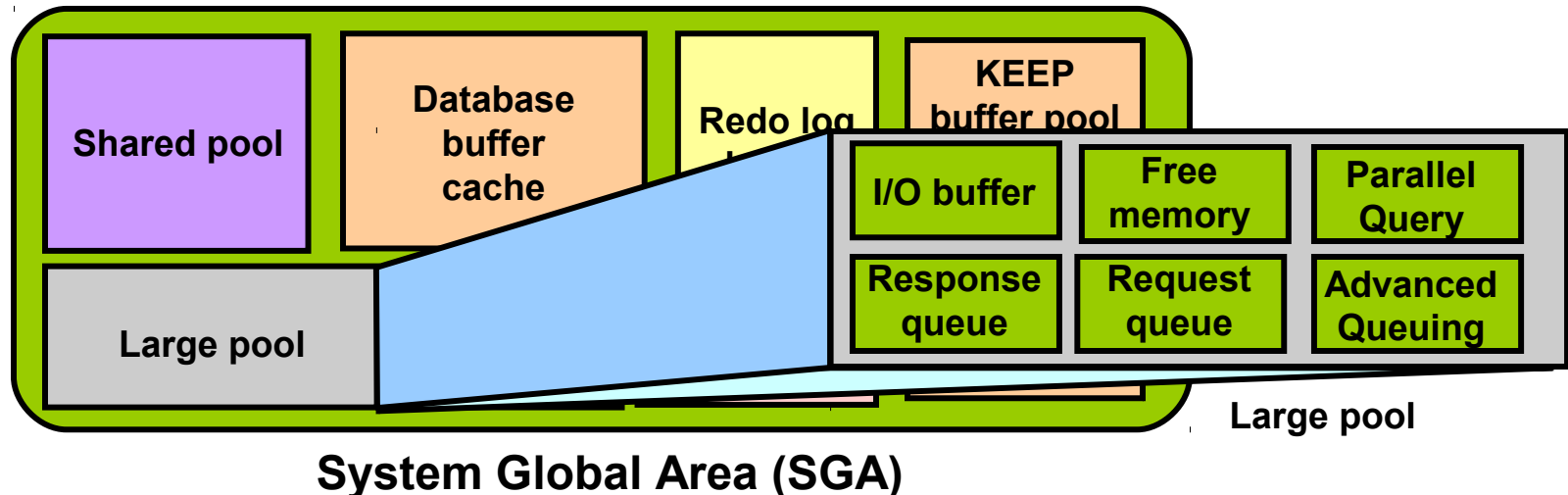
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Java Pool and Streams Pool

- Java pool memory is used to store all session-specific Java code and data in the JVM.

- Streams pool memory is used exclusively by Oracle Streams to:
  - Store buffered queue messages
  - Provide memory for Oracle Streams processes

Shared pool

Database buffer cache

Redo log buffer

KEEP buffer pool

RECYCLE

Java pool

Streams pool

Java pool

Streams pool

System Global Area (SGA)

ORACLE

Program Global Area (PGA)

PGA

Stack Space

User Global Area

Cursor State

Sort Area

Hash Area

User Session Data

Create Bitmap Area

Bitmap Merge Area

Server process 1

SQL Working Areas

Shared pool

Database buffer cache

Redo log buffer

KEEP buffer pool

RECYCLE buffer pool

Large pool

Java pool

Streams pool

nK buffer cache

System Global Area (SGA)

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Quiz

Memory region that contains data and control information for a server or background process is called:

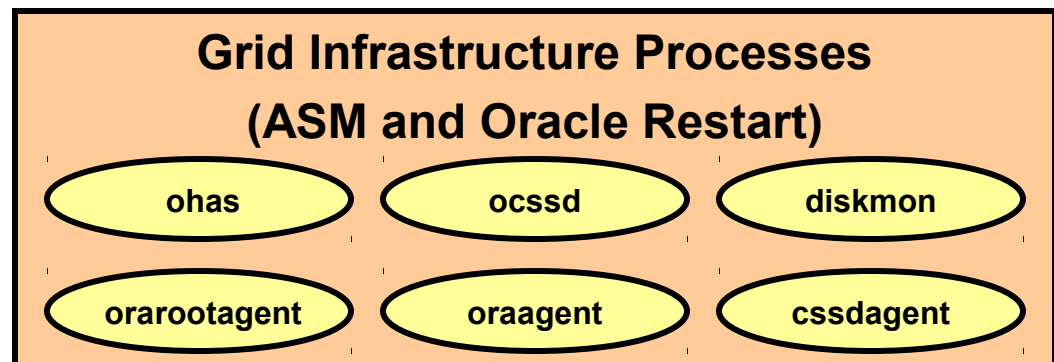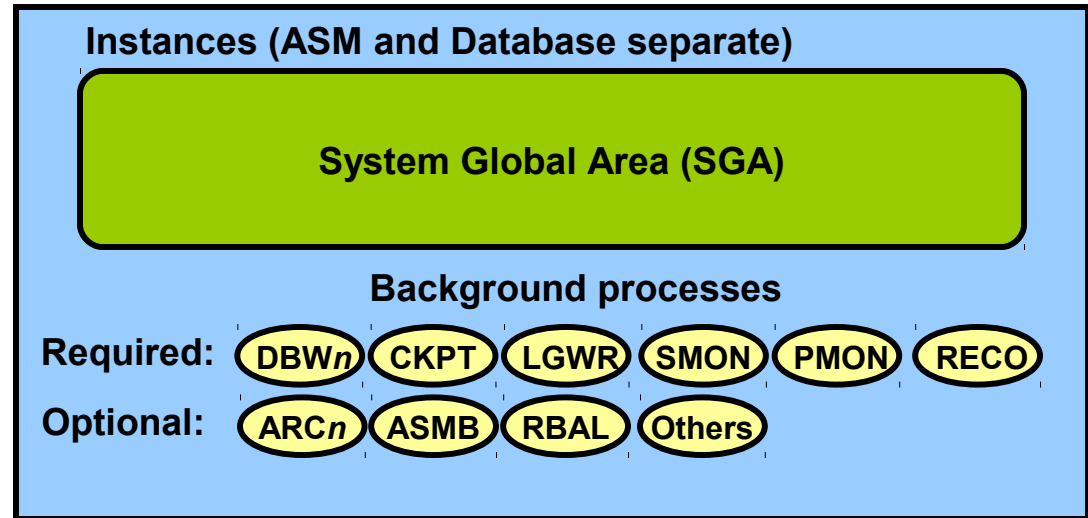1. Shared Pool
2. PGA
3. Buffer Cache
4. User session data

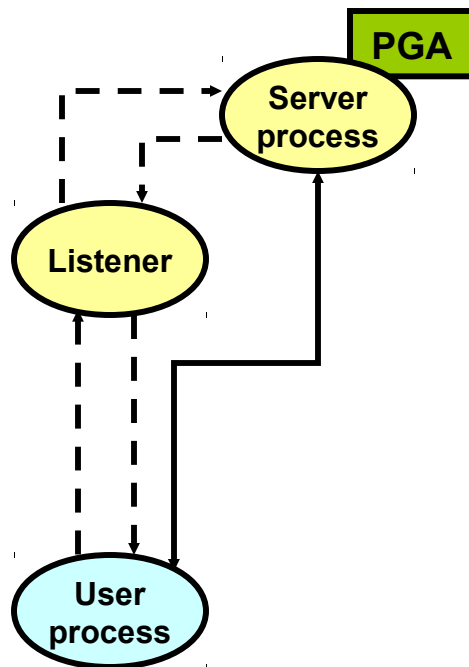**ORACLE**

Quiz

What is read into the Database Buffer Cache from the data files?

1. Rows
2. Changes
3. Blocks
4. SQL

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Process Architecture

- User process
  - Is the application or tool that connects to the Oracle database

- Database processes
  - Server process: Connects to the Oracle instance and is started when a user establishes a session
  - Background processes: Are started when an Oracle instance is started

- Daemon / Application processes
 - Networking listeners
  - Grid infrastructure daemons

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Process Structures

Instances (ASM and Database separate)

System Global Area (SGA)

Background processes

Required: DBW*n* CKPT LGWR SMON PMON RECO

Optional: ARC*n* ASMB RBAL Others

PGA

Server process

Listener

User process

Grid Infrastructure Processes
(ASM and Oracle Restart)

ohas   ocssd   diskmon

orarootagent   oraagent   cssdagent

ORACLE

Database Writer Process (DBWn)

Writes modified (dirty) buffers in the database buffer cache to disk:

- Asynchronously while performing other processing
- To advance the checkpoint

Database buffer cache → **DBW*n*** (Database writer process) → **Data files**

ORACLE
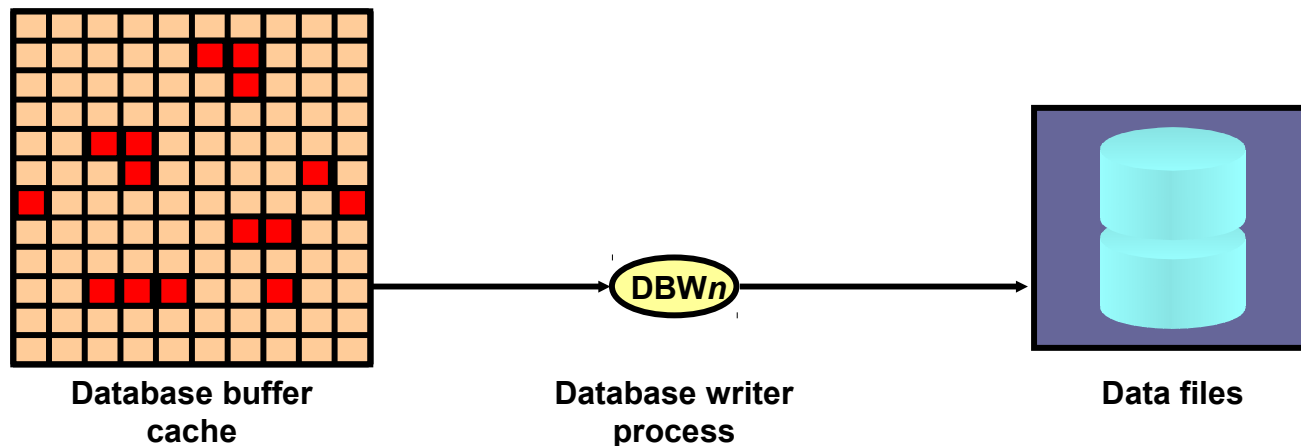
Log Writer Process (LGWR)

- Writes the redo log buffer to a redo log file on disk

- Writes:

  - When a user process commits a transaction
  - When the redo log buffer is one-third full
  - Before a DBWn process writes modified buffers to disk
 - Every 3 seconds

Redo log buffer   **Log Writer process**   **Redo log files**

ORACLE
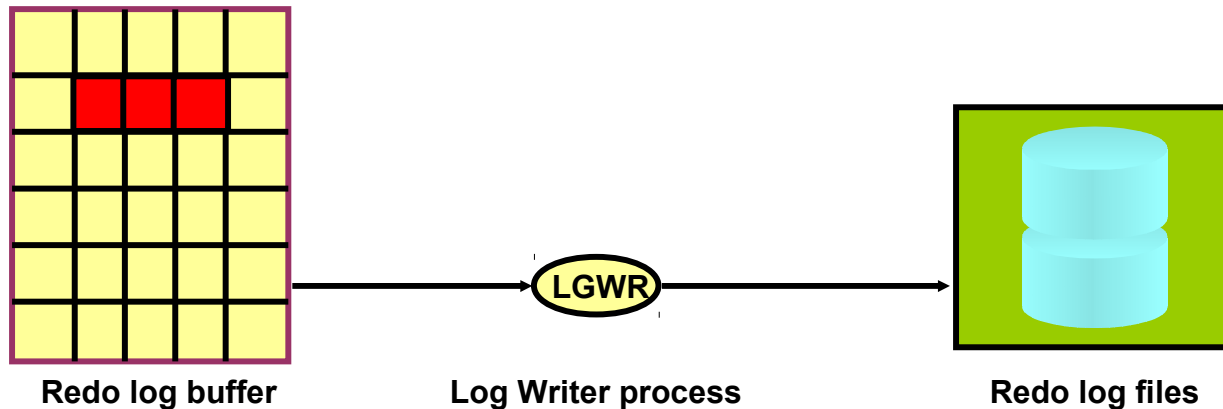
Checkpoint Process (CKPT)

- Records checkpoint information in
  - Control file
  - Each data file header

CKPT

**Checkpoint process**

Control file

Data files

ORACLE
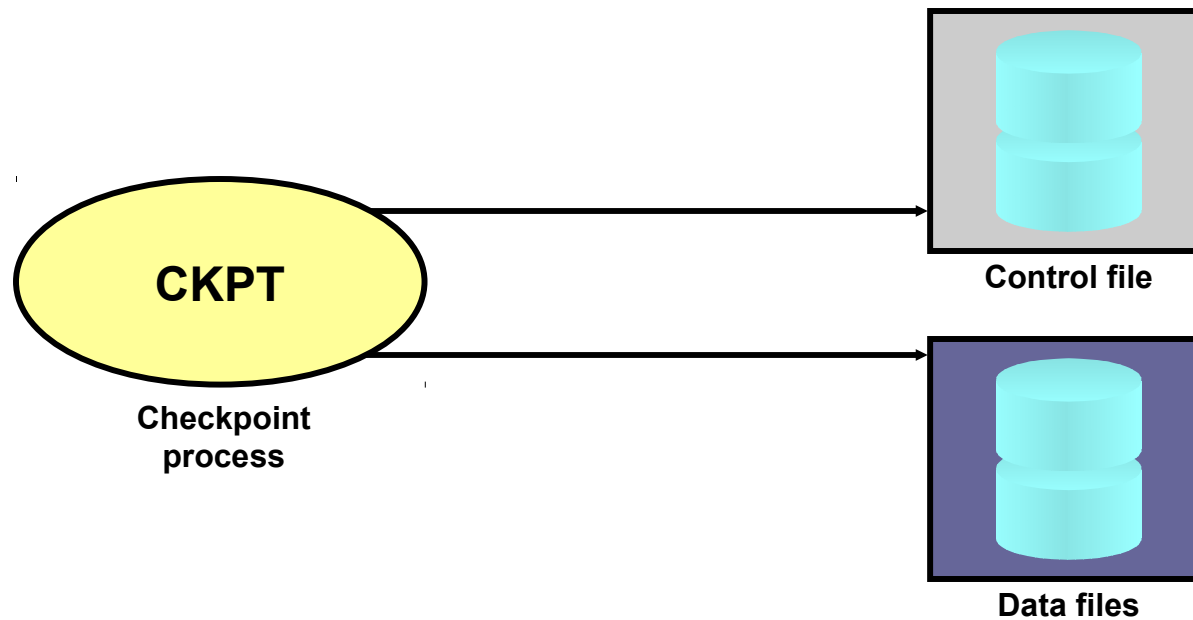
System Monitor Process (SMON)

- Performs recovery at instance startup

- Cleans up unused temporary segments

SMON

System Monitor process

**Instance**

Temporary segment

ORACLE
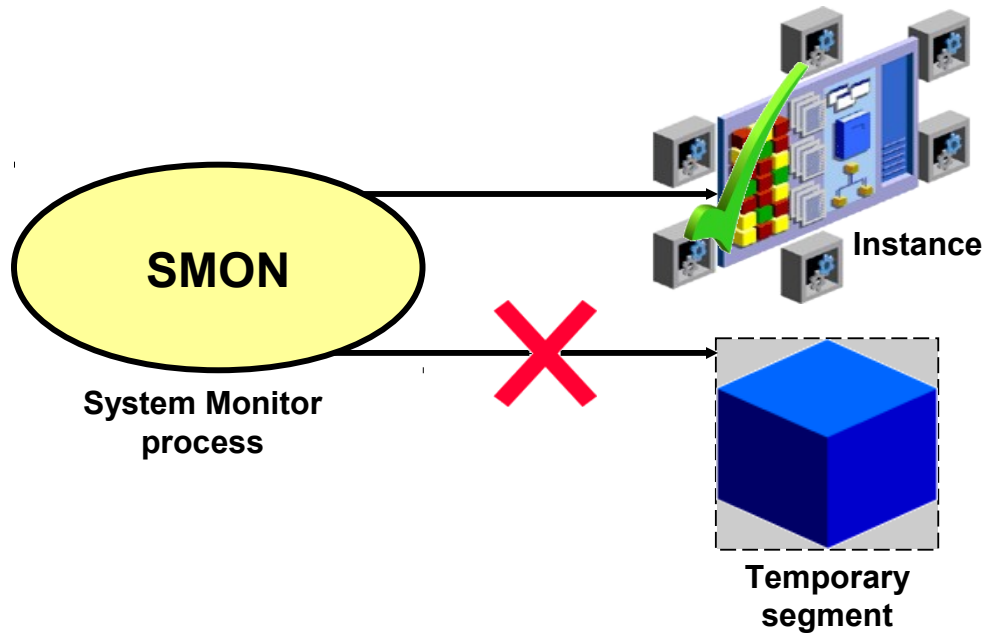
Process Monitor Process (PMON)

- Performs process recovery when a user process fails
  - Cleans up the database buffer cache
  - Frees resources that are used by the user process
- Monitors sessions for idle session timeout
- Dynamically registers database services with listeners

Failed user process

Process Monitor process

Database buffer cache

ORACLE
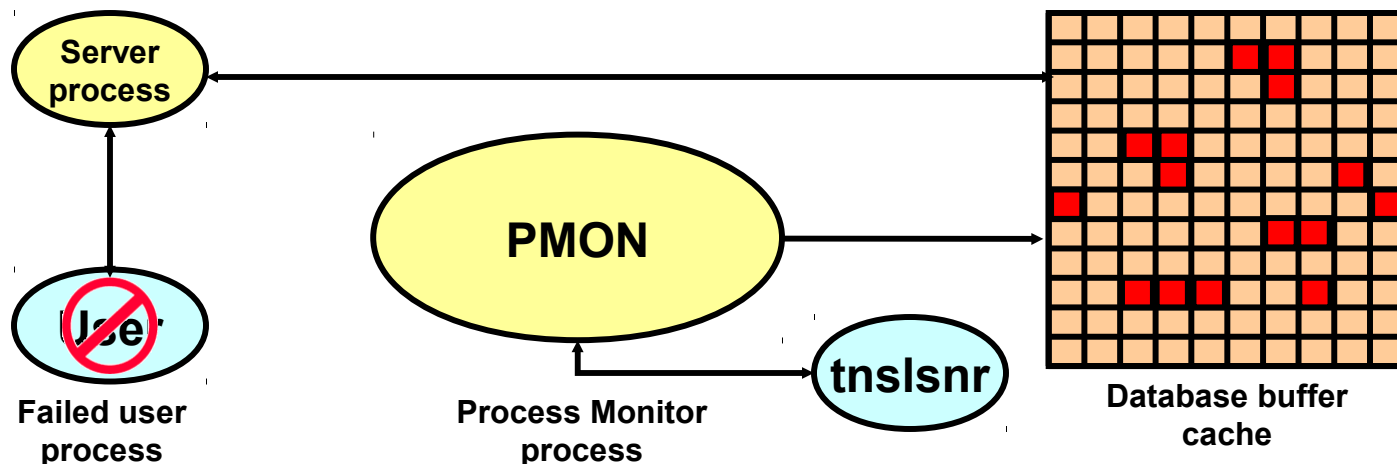
Recoverer Process

- Used with the distributed database configuration
- Automatically connects to other databases involved in in-doubt distributed transactions
- Automatically resolves all in-doubt transactions
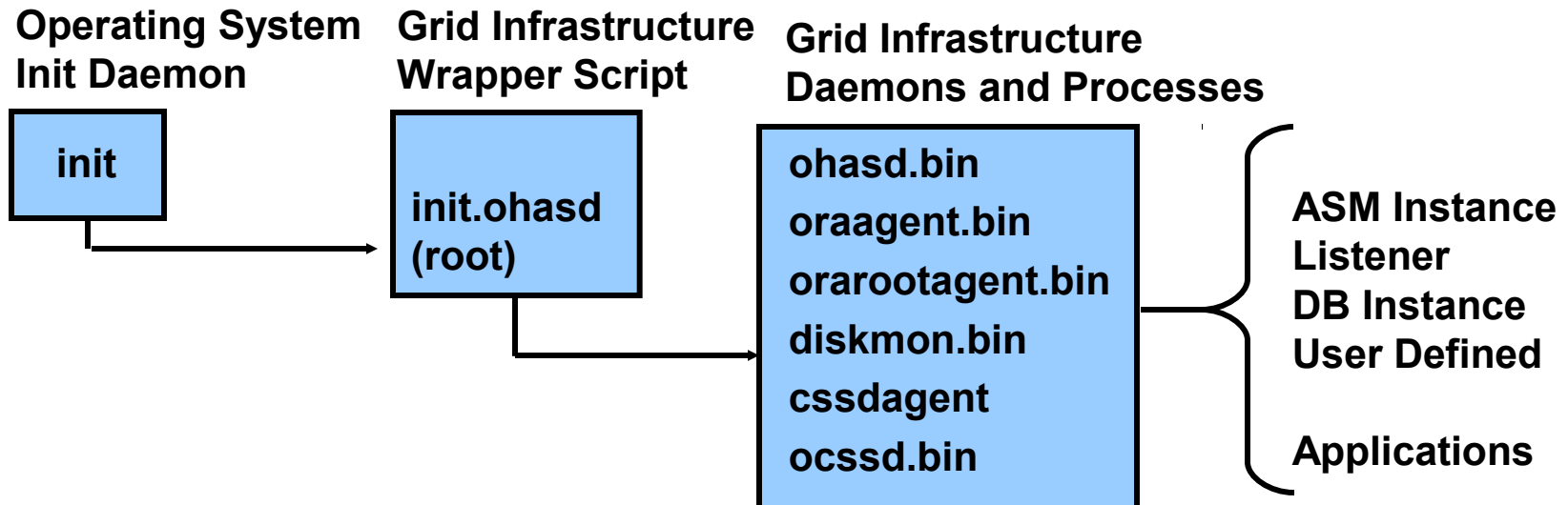- Removes any rows that correspond to in-doubt transactions

Recoverer process in database A

In-doubt transaction in database B
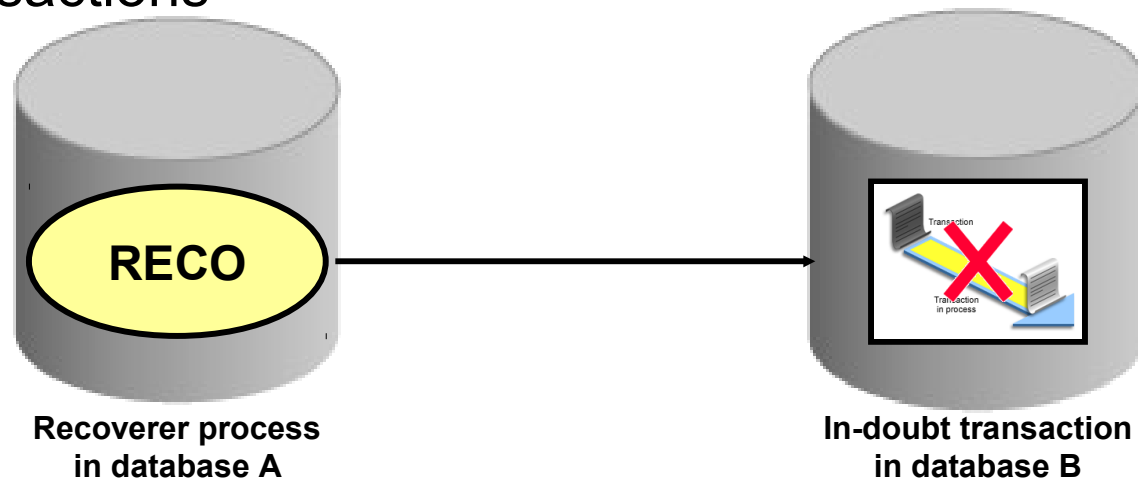
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Archiver Processes (ARC*n*)

- Copy redo log files to a designated storage device after a log switch has occurred

- Can collect transaction redo data and transmit that data to standby destinations

Archiver process   **Copies of redo log files**   **Archive destination**
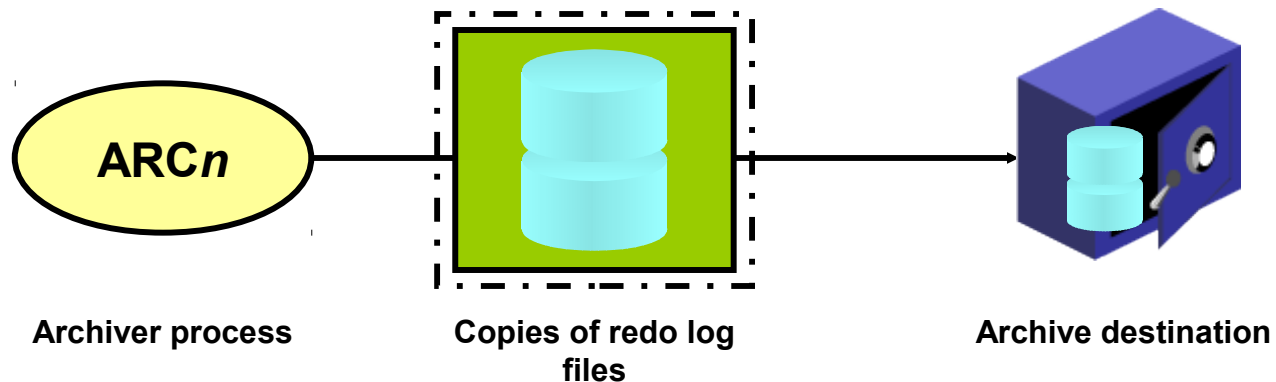
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Process Startup Sequence

- Oracle Grid Infrastructure is started by the OS init daemon.

Operating System Init Daemon

Grid Infrastructure Wrapper Script

Grid Infrastructure Daemons and Processes

init

init.ohasd (root)

ohasd.bin **oraagent.bin** **orarootagent.bin** **diskmon.bin** **cssdagent** **ocssd.bin**

ASM Instance
Listener
DB Instance
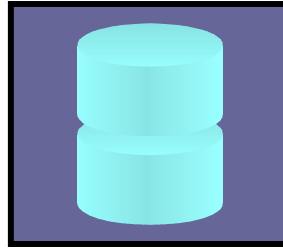**User Defined**

Applications

- Oracle Grid Infrastructure installation modifies the `/etc/inittab` file to ensure startup every time machine is started in corresponding run level.

```
# cat /etc/inittab
..
h1:35:respawn:/etc/init.d/init.ohasd run >/dev/null 2>&1 </dev/null
```
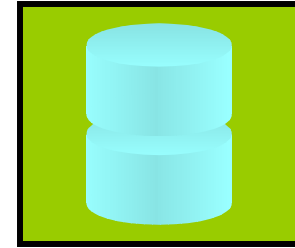
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Database Storage Architecture
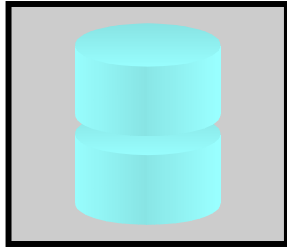
Control files

Data files

Online redo log files

Parameter file
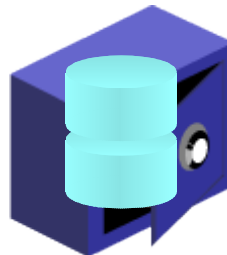
Backup files
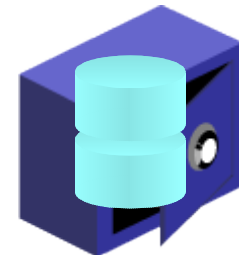
Archived redo log files

Password file
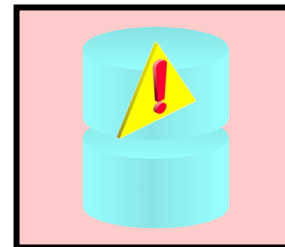
Alert log and trace files

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Logical and Physical Database Structures

Logical

Physical

Logical	Physical
Database	
Tablespace	**Data file**
Segment	**Storage System**
Extent	• **SAN** • **NFS**
Oracle data block	• **NAS** • **ASM**
	• **Exadata** • **RAW**
	• **File System**

ORACLE
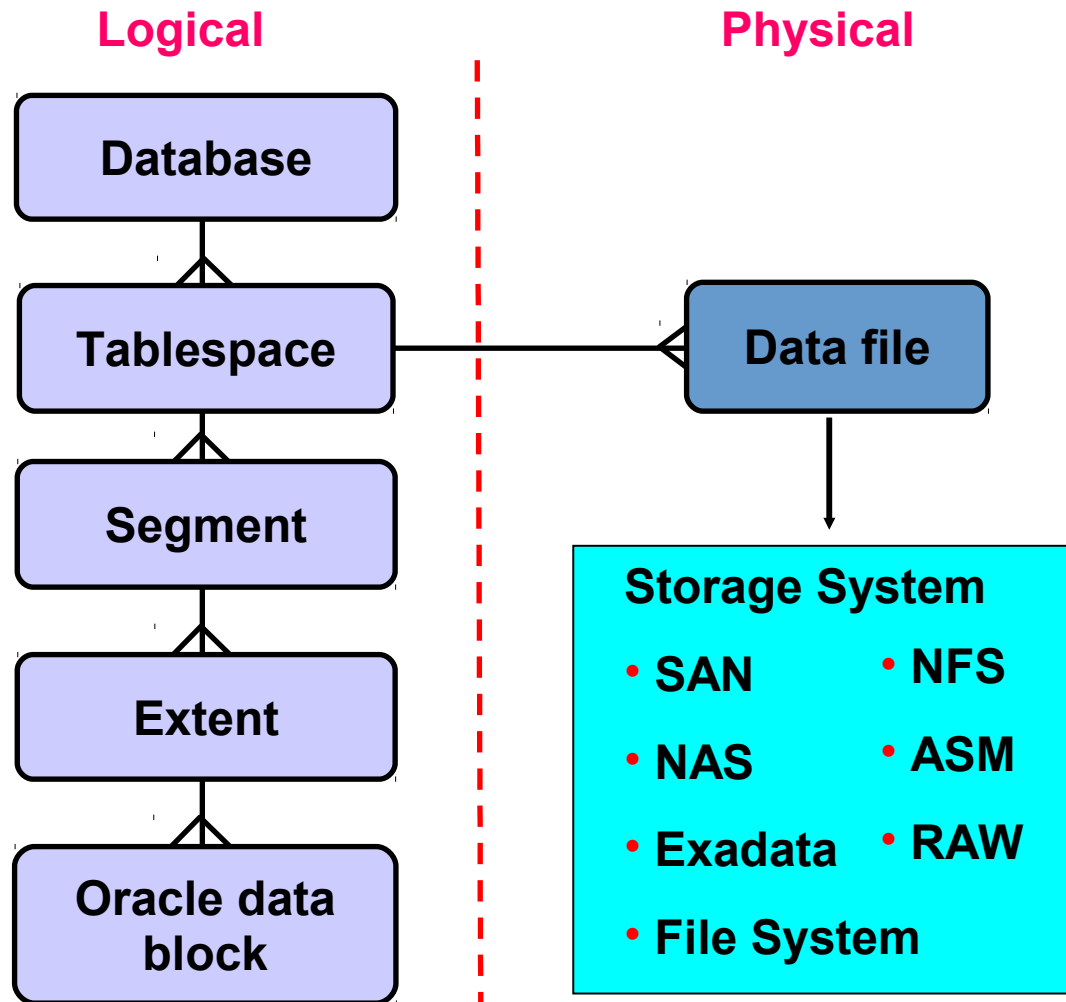
Segments, Extents, and Blocks

- Segments exist in a tablespace.
- Segments are collections of extents.
- Extents are collections of data blocks.
- Data blocks are mapped to disk blocks.
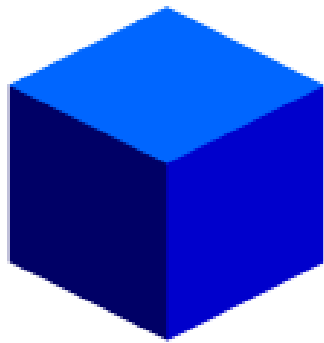
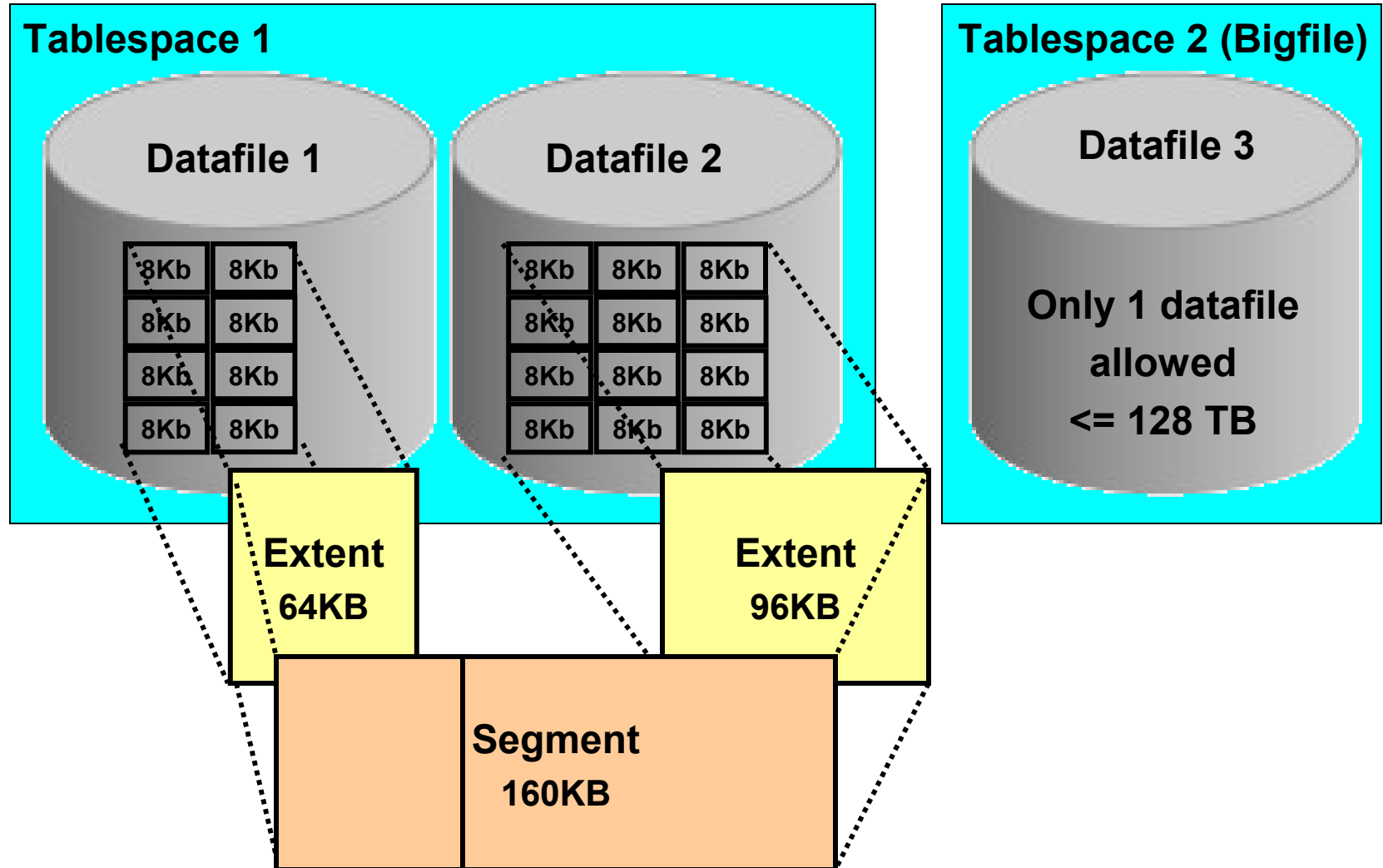**Segment**   **Extents**   **Data blocks**   **Disk blocks (File System Storage)**

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Tablespaces and Data Files

Tablespace 1

Datafile 1

8Kb	8Kb
8Kb	8Kb
8Kb	8Kb
8Kb	8Kb

Datafile 2

8Kb	8Kb	8Kb
8Kb	8Kb	8Kb
8Kb	8Kb	8Kb
8Kb	8Kb	8Kb

Tablespace 2 (Bigfile)

Datafile 3

Only 1 datafile allowed

<= 128 TB

Extent 64KB

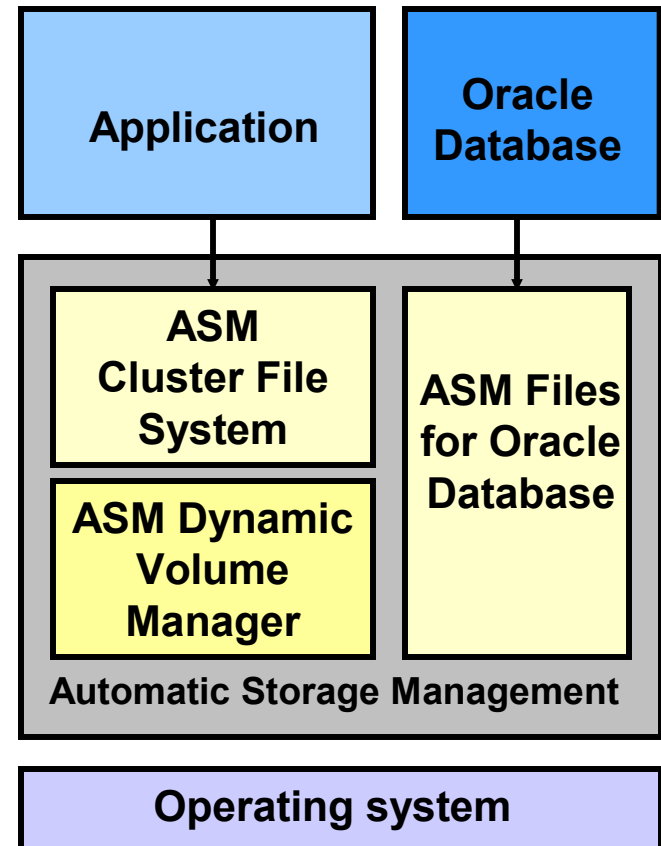**Extent 96KB**

Segment 160KB
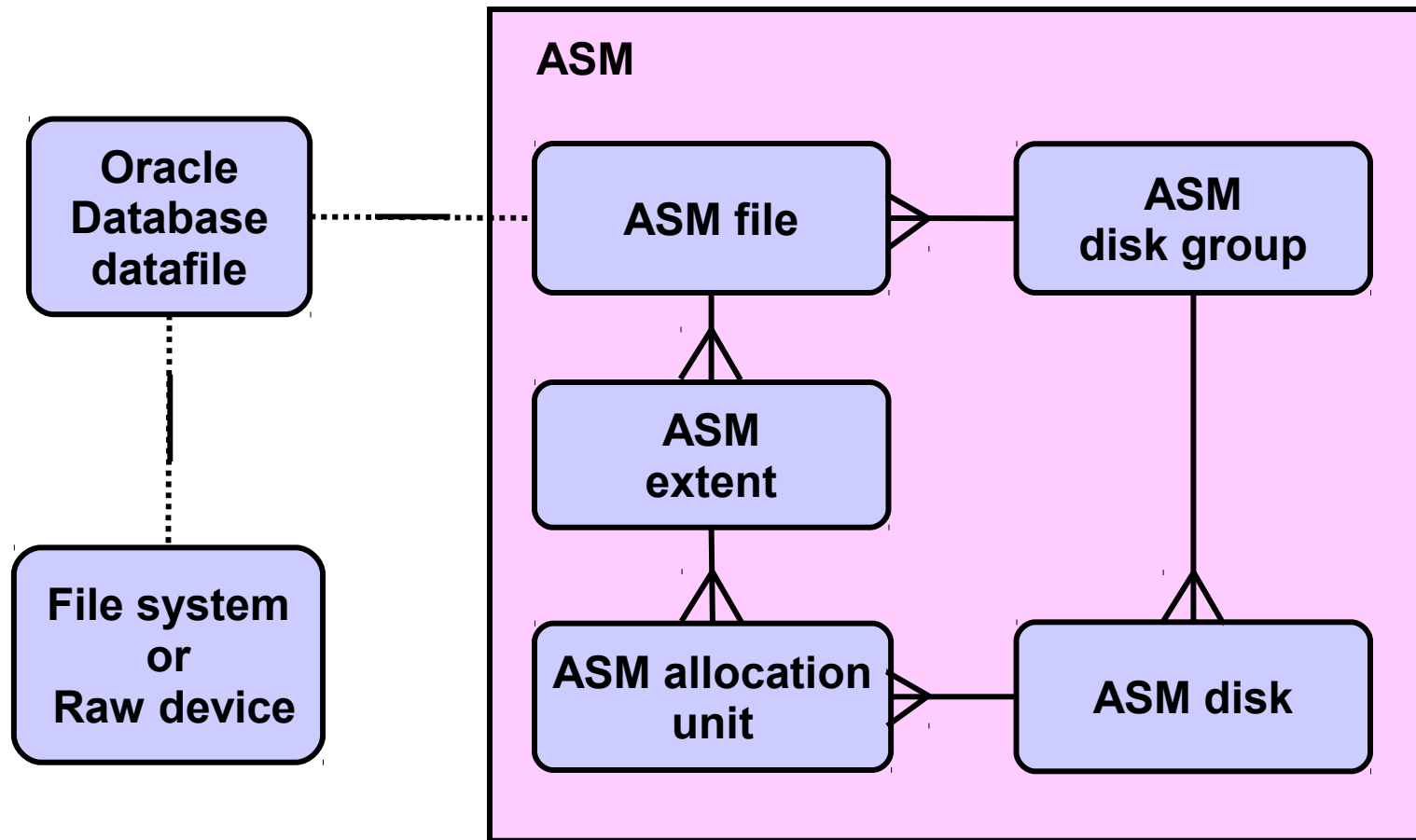
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`SYSTEM` and `SYSAUX` Tablespaces

- The `SYSTEM` and `SYSAUX` tablespaces are mandatory tablespaces that are created at the time of database creation. They must be online.

- The `SYSTEM` tablespace is used for core functionality (for example, data dictionary tables).

- The auxiliary `SYSAUX` tablespace is used for additional database components (such as the Enterprise Manager Repository).

- The `SYSTEM` and `SYSAUX` tablespaces are not recommended to be used to store application's data.

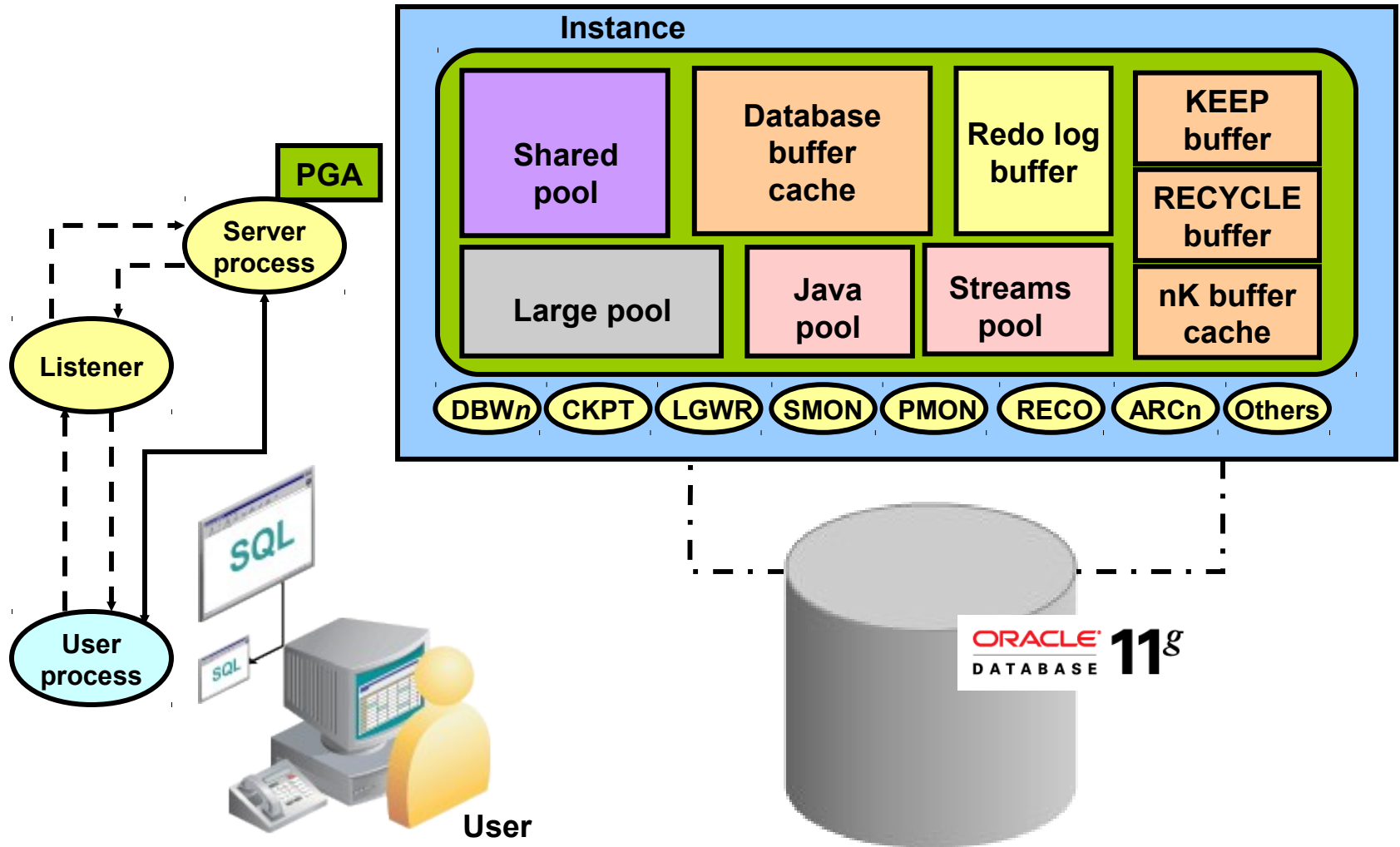**ORACLE**

Automatic Storage Management

- Is a portable and high-performance cluster file system

- Manages Oracle database files

- Manages application files with ASM Cluster File System (ACFS)

- Spreads data across disks to balance load

- Mirrors data in case of failures

- Solves storage-management challenges

Application	Oracle Database

ASM Cluster File System

ASM Dynamic Volume Manager

ASM Files for Oracle Database

Automatic Storage Management

Operating system

ORACLE

ASM Storage Components

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ORACLE

Interacting with an Oracle Database: Memory, Processes and Storage

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Quiz

The Process Monitor process (PMON):

1. Performs recovery at instance startup
2. Performs process recovery when a user process fails
3. Automatically resolves all in-doubt transactions
4. Writes the redo log buffer to a redo log file

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Quiz

ASM Files are accessed by which types of instances?

1. RDBMS Instances only

2. ASM Instances only

3. Both RDBMS and ASM Instances

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Summary

In this lesson, you should have learned how to:

- List the major architectural components of Oracle Database

- Explain the memory structures

- Describe the background processes

- Correlate the logical and physical storage structures

- Describe the ASM storage components

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Practice 1: Overview

This is a paper practice with questions about:

- Database architecture
- Memory
- Processes
- File structures

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