



DBMS Architecture: Oracle DB Engine

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Outline

- Database Architectures
 - Tiered Architectures
- Oracle DBMS Architecture
 - Shared Memory
 - Background Processes
 - Data Files
- Query Processing
- Update Processing
- COMMIT Processing

- Oracle Storage Architecture



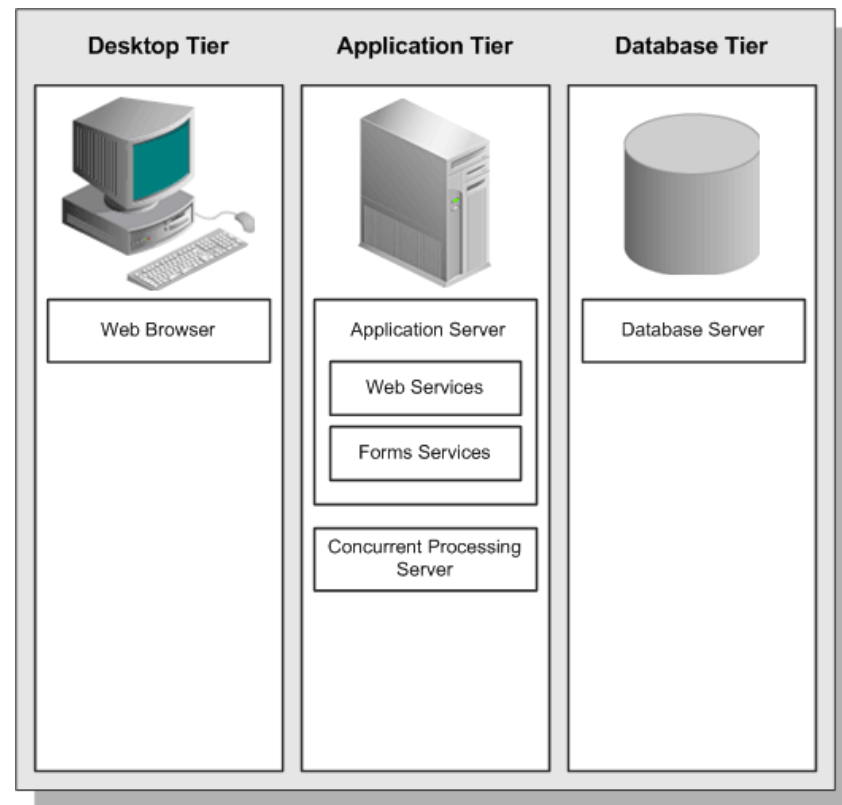
Database Architectures

<i>Computation/ Communication</i>	Single Processor	Parallel Processors
Centralized Database	Traditional DBs I/O Costs	Parallel DBs I/O Costs Computation Costs
Distributed Databases	Distributed DBs I/O Costs Communication Costs	“Real Life” All Costs



Database Architectures

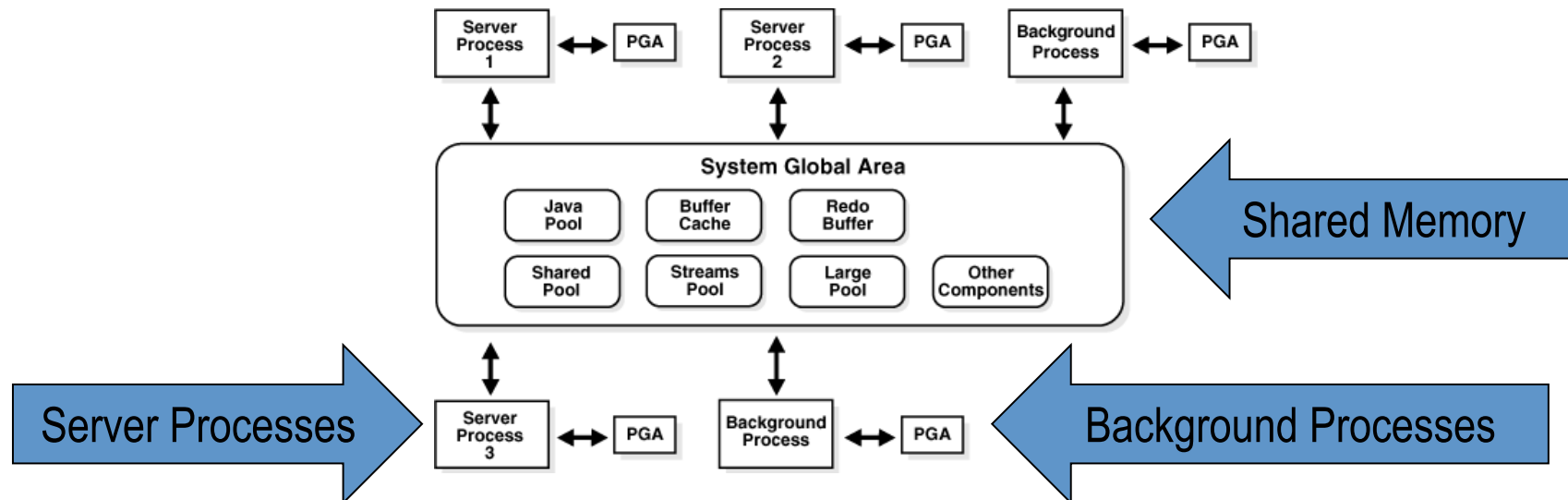
- Database architectures often implemented in **tiers**, or logical groupings of services.
- A three-tiered architecture isolates the desktop or end user, application code (often Web services), and the database services.
- A logical tier is typically composed of multiple computing nodes or servers.



[Oracle E-Business Suite Concepts](#)



Oracle DBMS Architecture

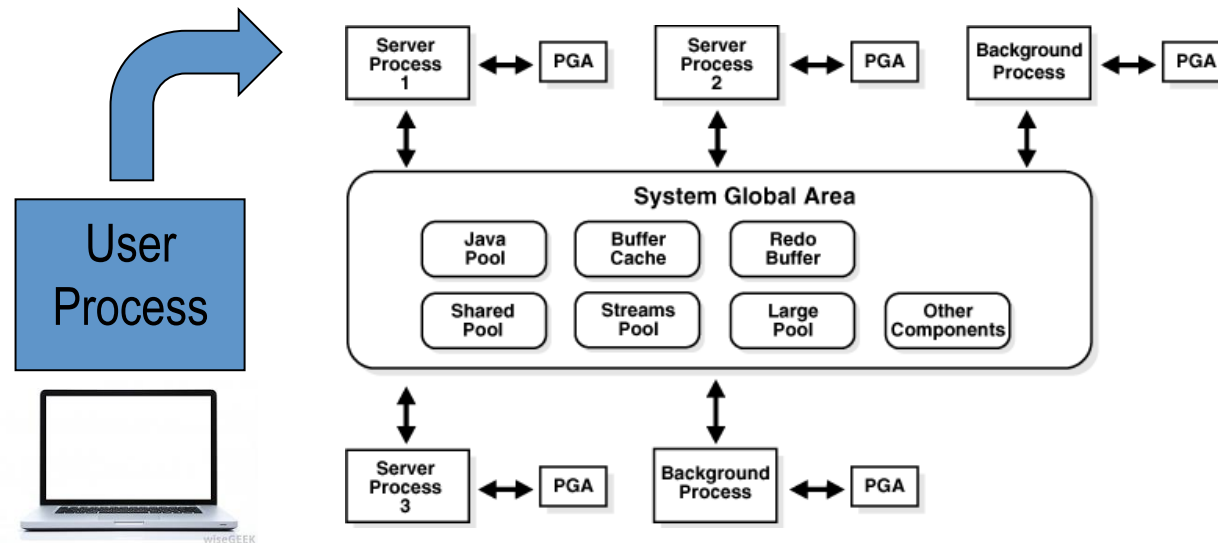


- Oracle uses a global **shared memory** for inter-process communications (IPC), divided into different components.
- **Server processes** interact with user process to provide access to the database.
- **Background processes** provide all database functions.

[Oracle Database Concepts 11g: Memory Architecture](#)



Oracle DBMS Architecture



- Client-side user processes interact with the database via server processes (with dedicated program memory).
 - ❑ Example: SQL Developer runs as a client-side user process.
- Background processes provide the database functions, such as query processing and optimization, database I/O (all the file reads and writes), security, and recovery.



Program Global Area (PGA)

Oracle Enterprise Manager (SYS) - Memory Parameters - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites Media Print Window Help

Address http://144.25.8.226:5500/em/console/database/instance/memory?target=ord.us.oracle.com&type=oracle_database

ORACLE Enterprise Manager 10g Database Control

Database: ord.us.oracle.com > Memory Parameters

Memory Parameters

SGA PGA

The Program Global Area (PGA) is a memory buffer that contains data and control information for a server process started.

Aggregate PGA Target 24 MB **Advice**

Current PGA Allocated (KB) 49929

Maximum PGA Allocated (KB) 79688 (since startup)

Cache Hit Percentage (%) 100

PGA Memory Usage Details

☒ TIP The sum of PGA and SGA should be less than the total system memory minus memory required by the

SGA PGA

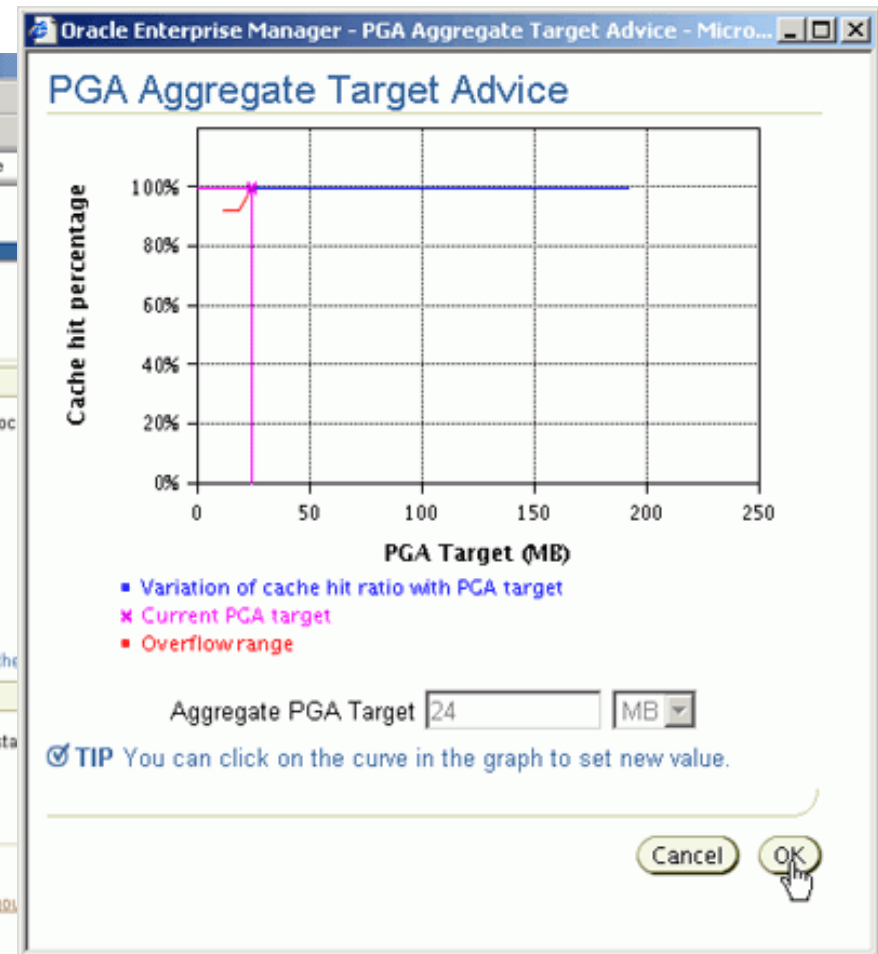
☐ Apply changes to SPFILE only. Otherwise the changes are made to both the SPFILE and the running instance static parameters.

☒ TIP * indicates controls, if changed, must restart database to invoke.

Database | Setup | Preferences | Help | Logout

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About Oracle Enterprise Manager 10g Database Control

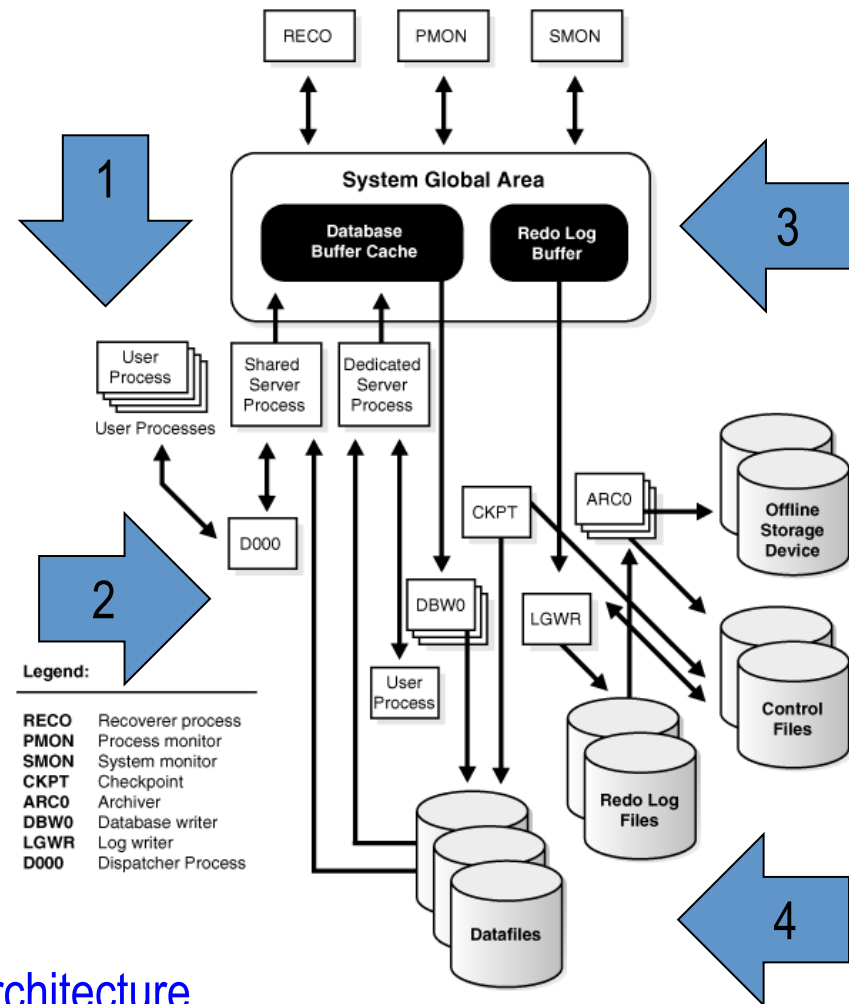
http://144.25.8.226:5500/em/console/database/instance/memory?target=ord.us.oracle.com&type=oracle_database#





DBMS Architecture: Overview

1. First, the overview shows user processes interacting with server processes.
2. Background processes provide a range of database functions.
3. All communication uses shared memory (SGA).
4. A range of database files provide persistent storage (data/metadata).

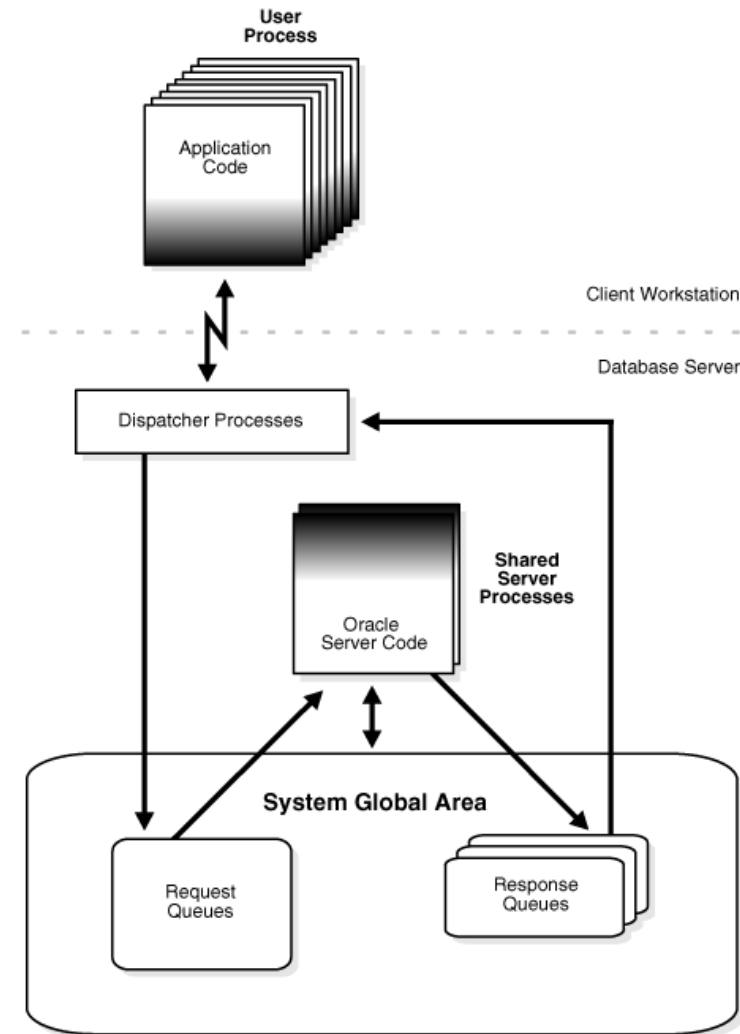


[Oracle Database Concepts 11g: Process Architecture](#)



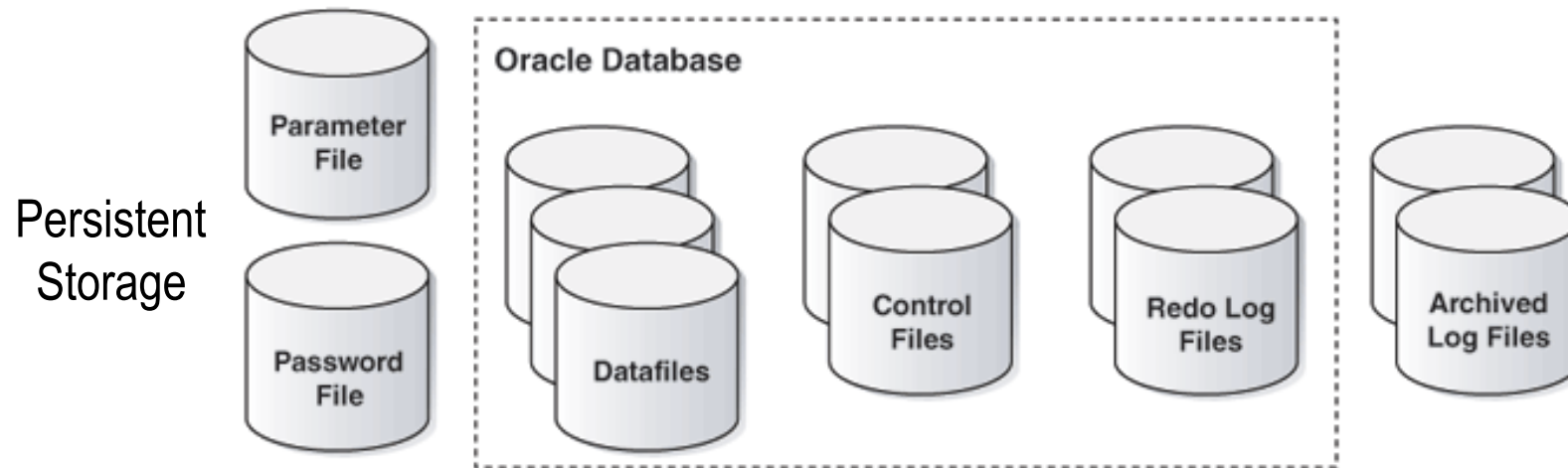
Shared Server Processes

- Web applications often require large numbers of database connections.
- In order to handle more connections and requests, while conserving resources, server processes can be shared through *request/response queues* and *dispatchers*.
- Re-visit this in distributed databases ...





External Database Files

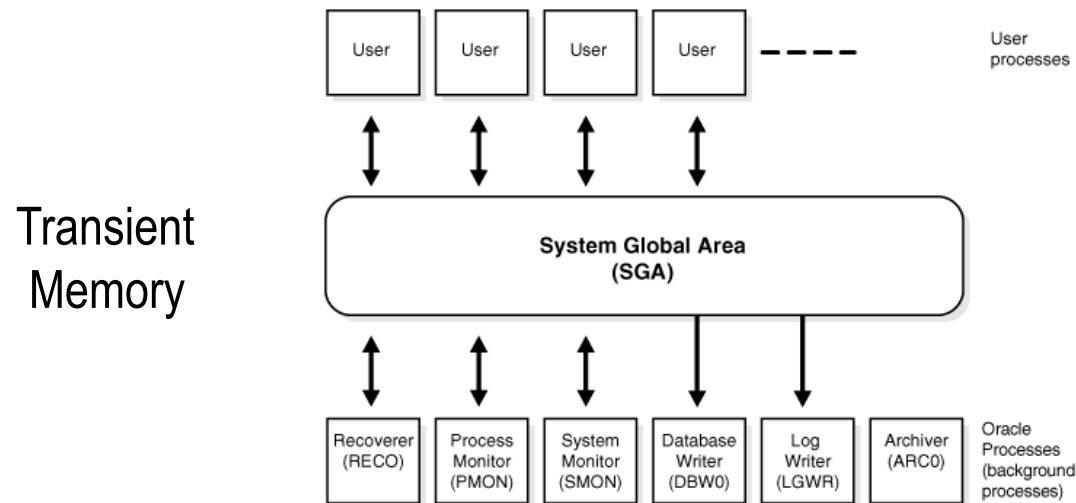


Database:

- One or more data files.
- One or more control files.
- Two or more online redo logs.



Instance Background Processes



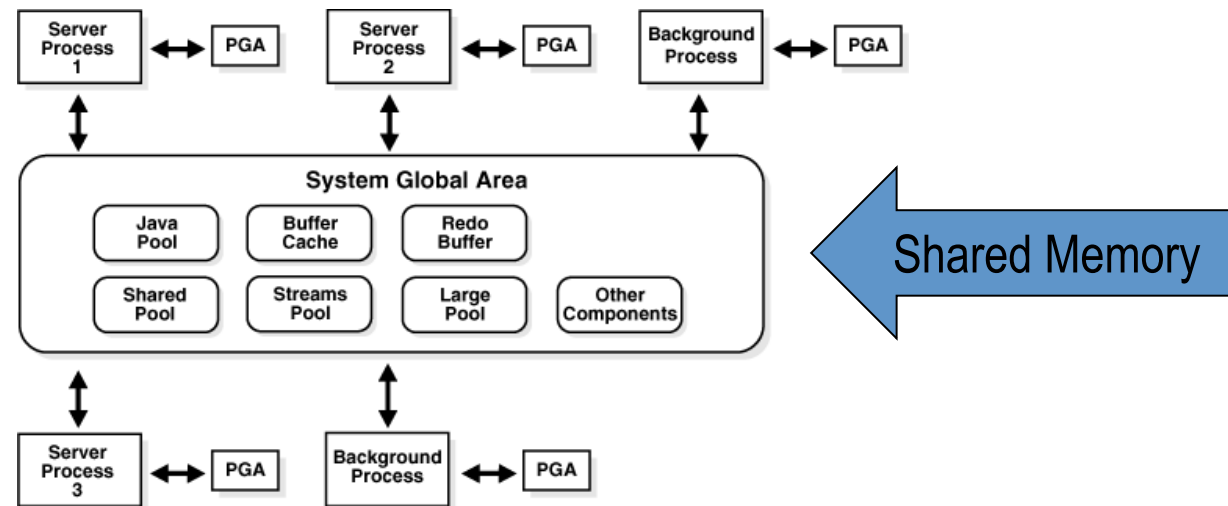
[Oracle Database Concepts 11g: Process Architecture](#)

- Recoverer Process (RECO) – Resolves distributed transaction failures.
- Process Monitor (PMON) – Automated process cleanup and recovery.
- System Monitor (SMON) – Automated system cleanup and recovery.
- Database Writers (DBWn) – Writes from cache buffers to data files.
- Log Writer (LGWR) – Writes redo log data to sequential log files.
- Archiver Processes (ARCn) – Copies redo log files to backup locations.



System Global Area (SGA)

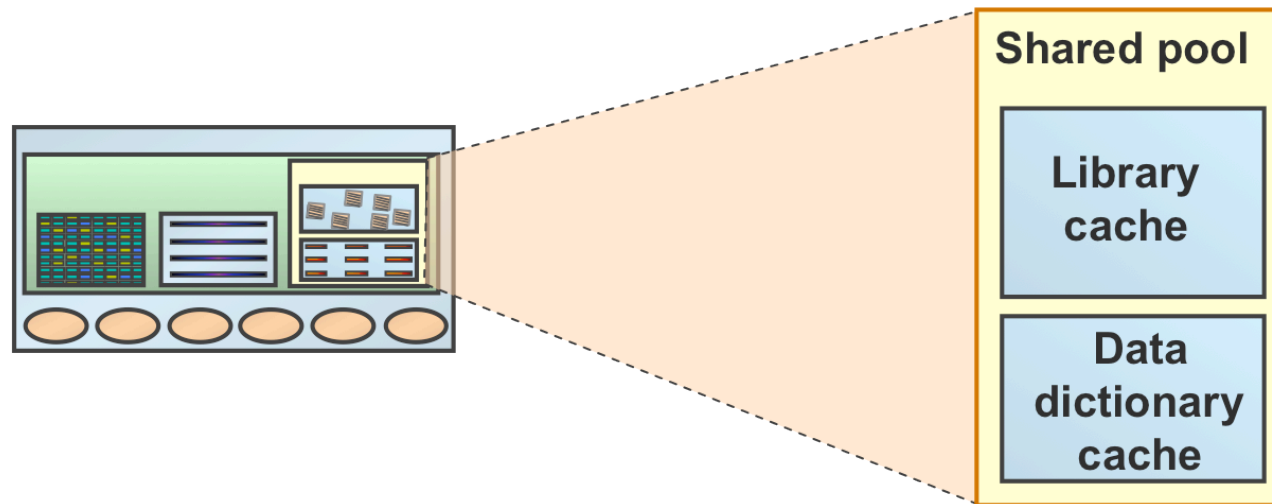
*Why have
separate shared
memory
components?*



- Java Pool – Dedicated memory for Java (JVM) execution.
- Buffer Cache – Database buffer cache (block oriented).
- Redo Buffer – Redo (or write ahead) log for after images.
- Shared Pool – Library, dictionary, and query result caches.
- Streams Pool – Shared buffer for message queues.
- Large Pool – Memory for large database operations.



Shared Pool

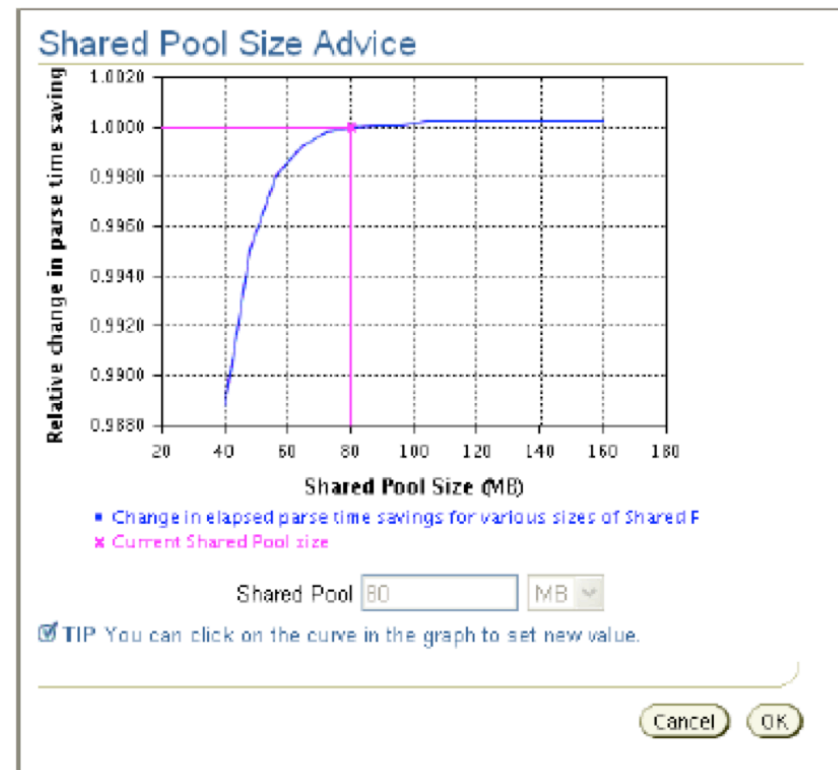


- SHARED_POOL_SIZE parameter controls size.
- Library cache contains statement text, parsed code, and an execution plan.
- Data dictionary cache contains table and column definitions and privileges.



Self-Managing Databases

- Automatic shared memory management (as of 10g) allows the DBA to specify limits (SGA_MAX_SIZE) and targets (SGA_TARGET) for shared memory usage, with the engine dynamically re-allocating the various regions.





Self-Managing Databases

Oracle Enterprise Manager (SYS) - Memory Parameters - Microsoft Internet Explorer

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Address http://144.25.8.226:5500/em/console/database/instance/memory?target=ord.us.oracle.com&type=oracle_database Go Links

The System Global Area (SGA) is a group of shared memory structures that contains data and control information for one Oracle database system. The SGA is allocated in memory when an Oracle database instance is started.

Automatic Shared Memory Management **Enabled**

Total SGA Size (MB)

SGA Component	Current Allocation (MB)
Shared Pool	80
Buffer Cache	24
Large Pool	8
Java Pool	48
Other	4

2%
29%
49%
5%
15%

■ Shared Pool(48.8%)
■ Buffer Cache(14.6%)
■ Large Pool(4.9%)
■ Java Pool(29.3%)
■ Other(2.4%)

Maximum SGA Size

The Maximum SGA Size specifies how much memory is allocated when the database starts up. If you specify the Maximum SGA Size, you can later dynamically change the Total SGA Size above (provided Total SGA Size does not exceed the Maximum SGA Size).

Maximum SGA Size* (MB)

SGA PGA

☐ Apply changes to SPFILE only. Otherwise the changes are made to both the SPFILE and the running instance which requires that you restart the database to invoke static parameters.

☒ **TIP** * indicates controls, if changed, must restart database to invoke.

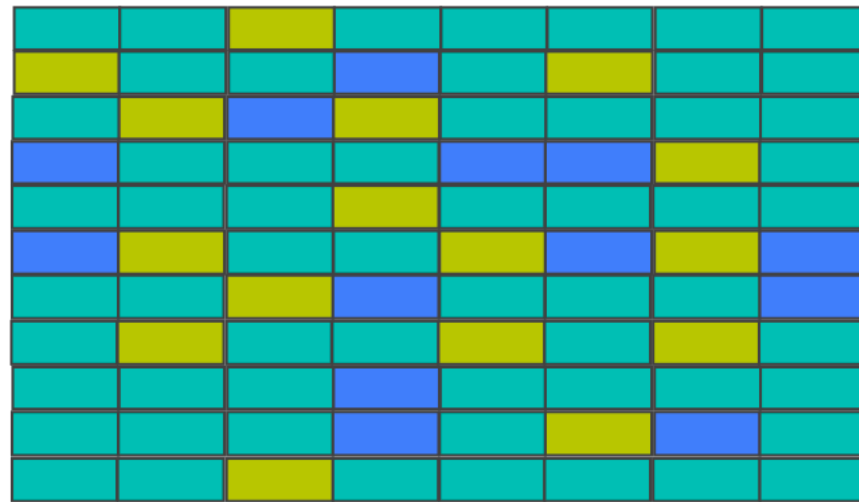
Database | [Setup](#) | [Preferences](#) | [Help](#) | [Logout](#)

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[About Oracle Enterprise Manager 10g Database Control](#)

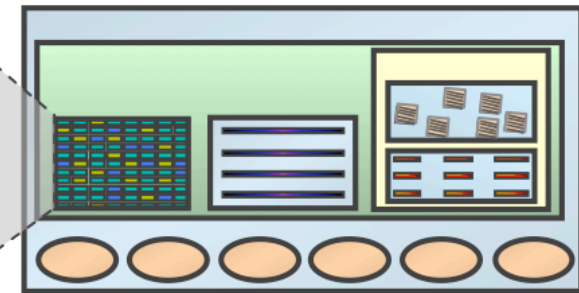
http://144.25.8.226:5500/em/console/database/instance/memory?target=ord.us.oracle.com&type=oracle_database# Internet



Database Buffer Caches



Buffer Cache Advisory
(DB_CACHE_ADVICE)



Least Recently Used (LRU) Algorithm

- Stores the most recently used blocks.
- Can be dynamically resized.
 - ❑ ALTER SYSTEM SET DB_CACHE_SIZE = 96M
- Size of the standard buffer based on DB_BLOCK_SIZE.
 - ❑ DB_CACHE_SIZE (default buffer cache)
 - ❑ DB_KEEP_CACHE_SIZE (keep cache for likely-to-be-reused blocks)
 - ❑ DB_RECYCLE_CACHE_SIZE (recycle cache for blocks not reused)



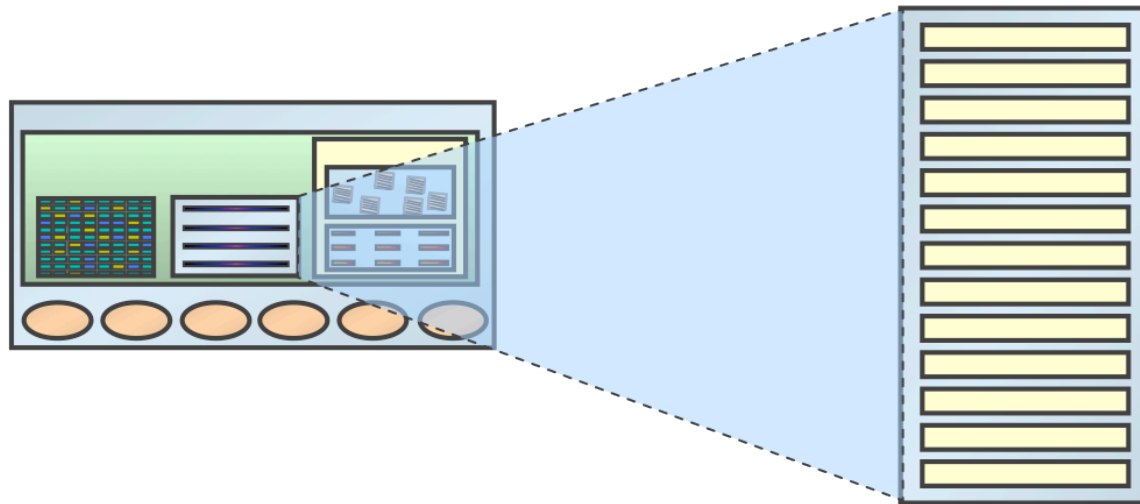
Database Buffer Caches: LRU

- When a database block is requested by a user process, the buffer cache is searched first (a cache hit), and if not found, a physical I/O operation fetches the block from a data file on disk (a cache miss).
- LRU policy used to manage the cache.
 - ❑ Write list: identifies modified/dirty blocks.
 - ❑ LRU list: holds “free” blocks, “pinned” (in-use) blocks, and the odd “dirty” blocks.
 - ❑ In-demand blocks move to the MRU end (except full table scans - CACHE clause).



Redo Log Buffer

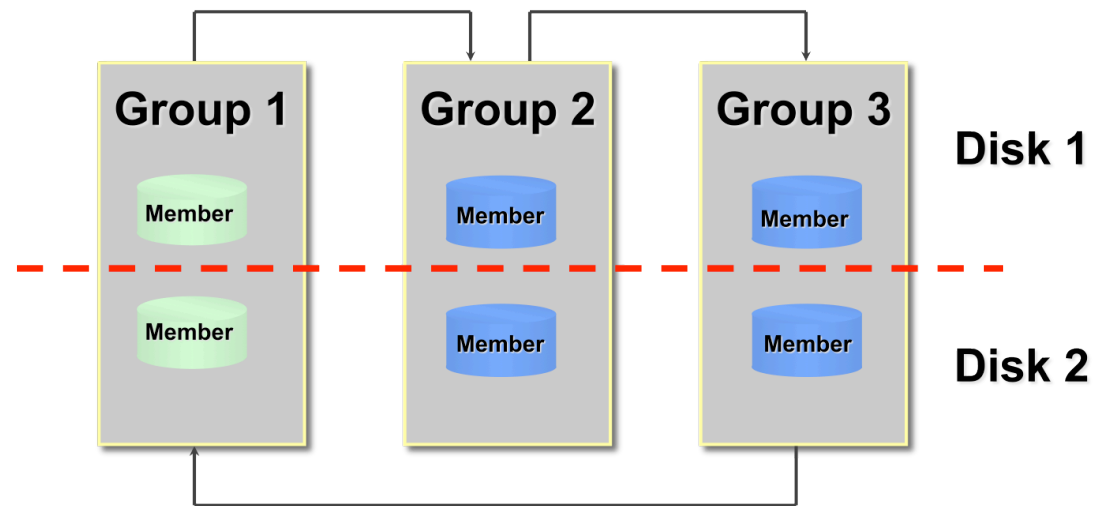
Records the
after-images.



- Redo log (or write ahead log) records the database changes necessary to roll forward during recovery.
- LOG_BUFFER parameter controls size.
- Records changes made through the database instance.
- Circular buffer used sequentially.



Redo Log Groups



- Redo logs are replicated on different devices to ensure availability for database recovery.
- Log files are applied in order to roll forward in time.



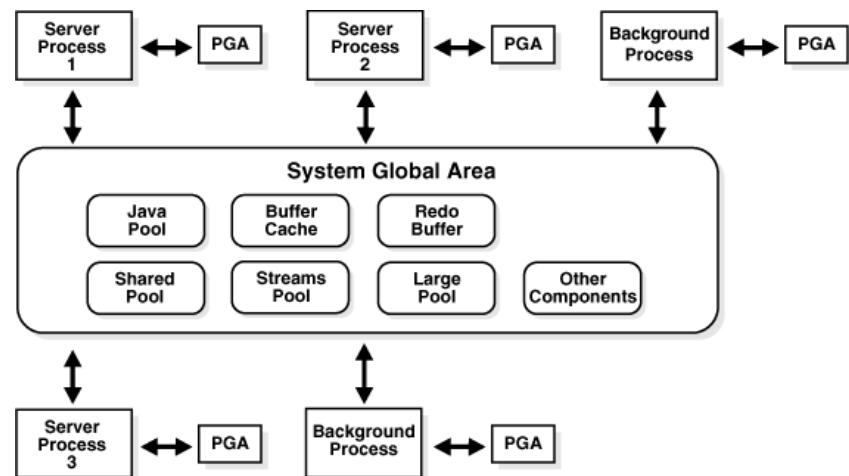
Large Pool and Java Pool

■ Large Pool

- ❑ Optional area in the SGA.
- ❑ Reduces Shared Pool demand for I/O processes, parallel execution, backup and restore operations.
- ❑ LARGE_POOL_SIZE

■ Java Pool

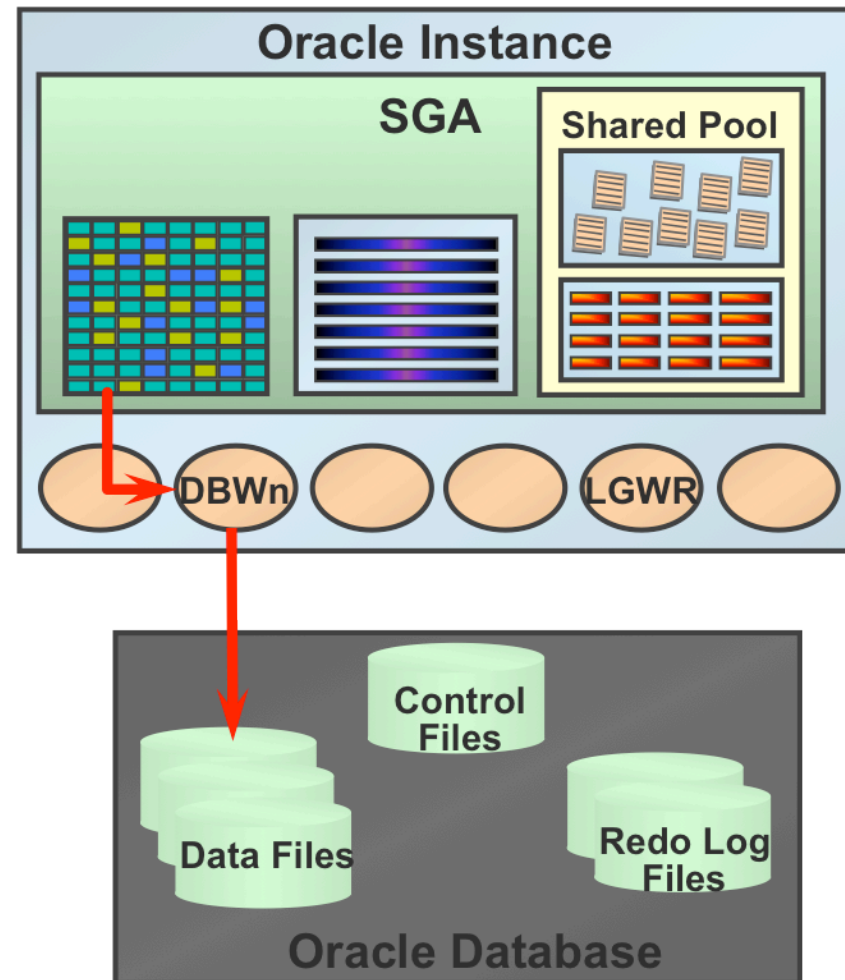
- ❑ Optional area in the SGA.
- ❑ Supports parsing requirements for Java.
- ❑ JAVA_POOL_SIZE





Database Writer (DBWn)

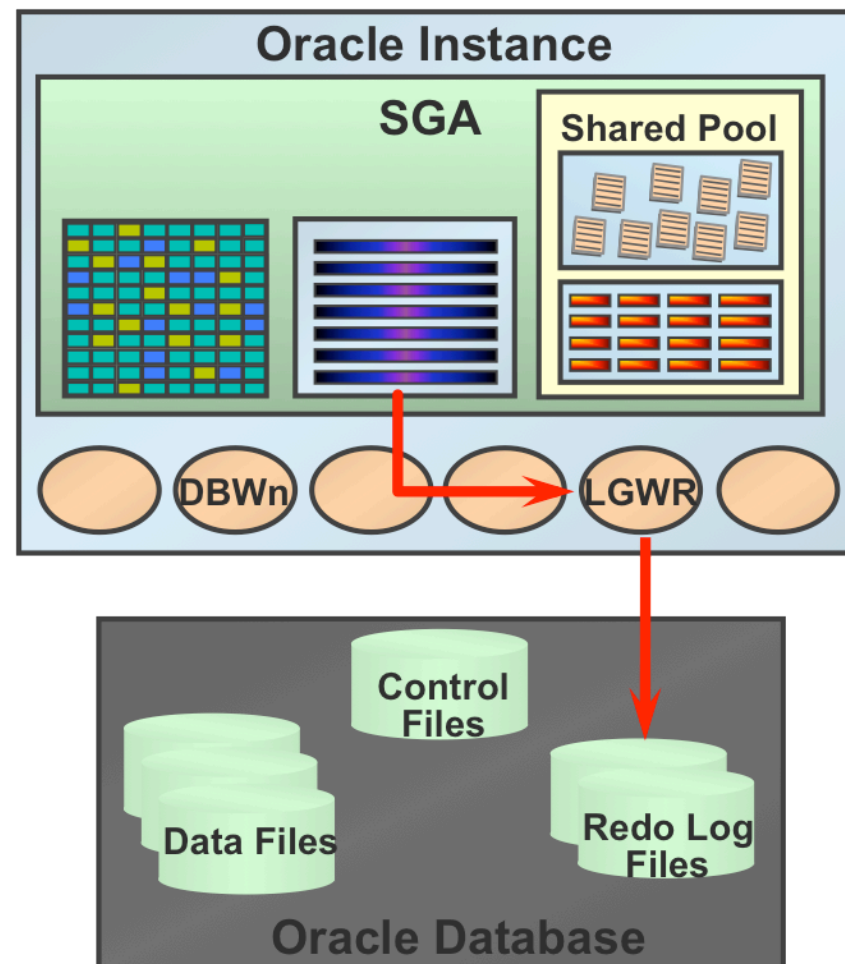
- Server processes update undo and data blocks in the database buffer cache.
- DB writers write when:
 - ❑ Checkpoints occur.
 - ❑ Dirty buffer thresholds are reached.
 - ❑ Free buffer scans take too long.
 - ❑ Changes in tablespace status.
 - ❑ Table drops/truncations.





Log Writer (LGWR)

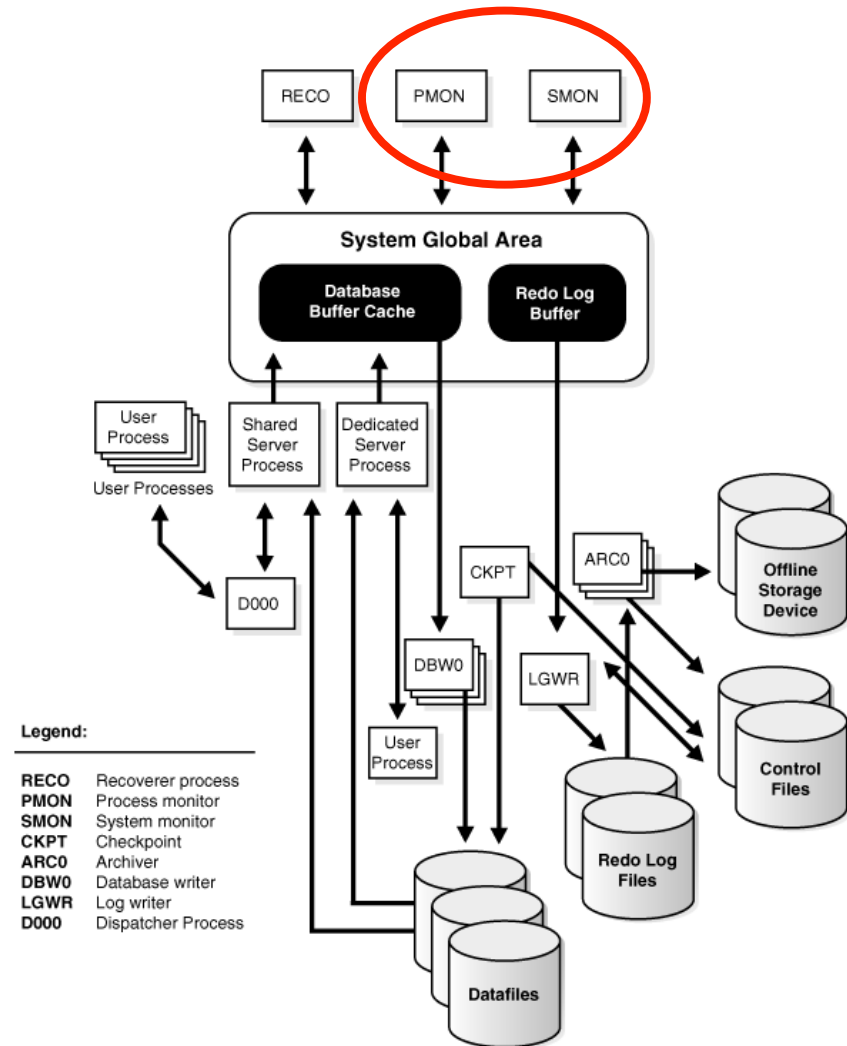
- The log writer does sequential writes from shared memory to disk.
- Log writes occur when:
 - ❑ Transactions commit.
 - ❑ The log buffer is 1/3 full.
 - ❑ Threshold of changes is reached.
 - ❑ Before DBWn writes (can also invoke LGWR).
 - ❑ Every 3 seconds or so.





Process Monitor (PMON)

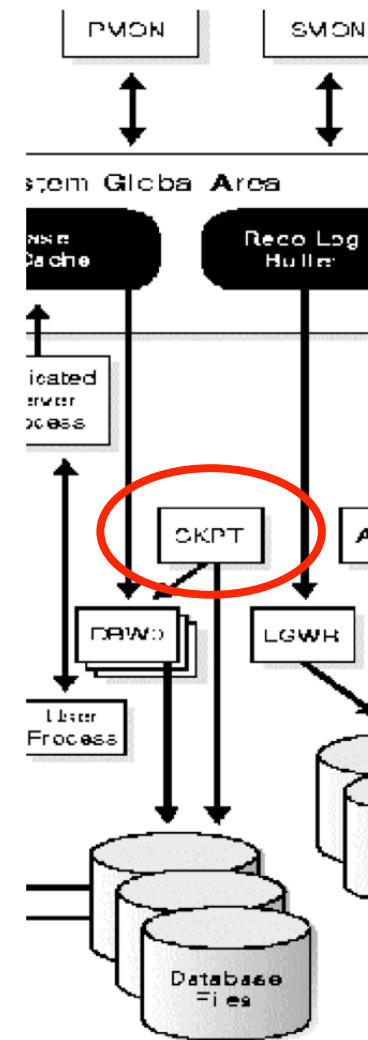
- The process monitor handles zombie or failed processes by cleaning up resources.
- Clean up includes:
 - ❑ Rolling back uncommitted transactions.
 - ❑ Freeing locks and other resources.
 - ❑ Restarting necessary processes (e.g. dispatchers).





Checkpoint (CKPT)

- Every so often (say 3 seconds) the checkpoint process updates the control files, noting where recovery should start in the redo logs (managing recovery time).
- Checkpoints involve:
 - ❑ Updating control file information.
 - ❑ Updating data file headers with checkpoint information.
 - ❑ Signaling DBWn to handle data block writes.





DBMS Startup and Shutdown

General

 **Status** Up Shutdown

Up Since Dec 10, 2003 11:16:04 AM

Time Zone PST

Availability (%) 100
(Last 24 hours)

Instance Name s031209

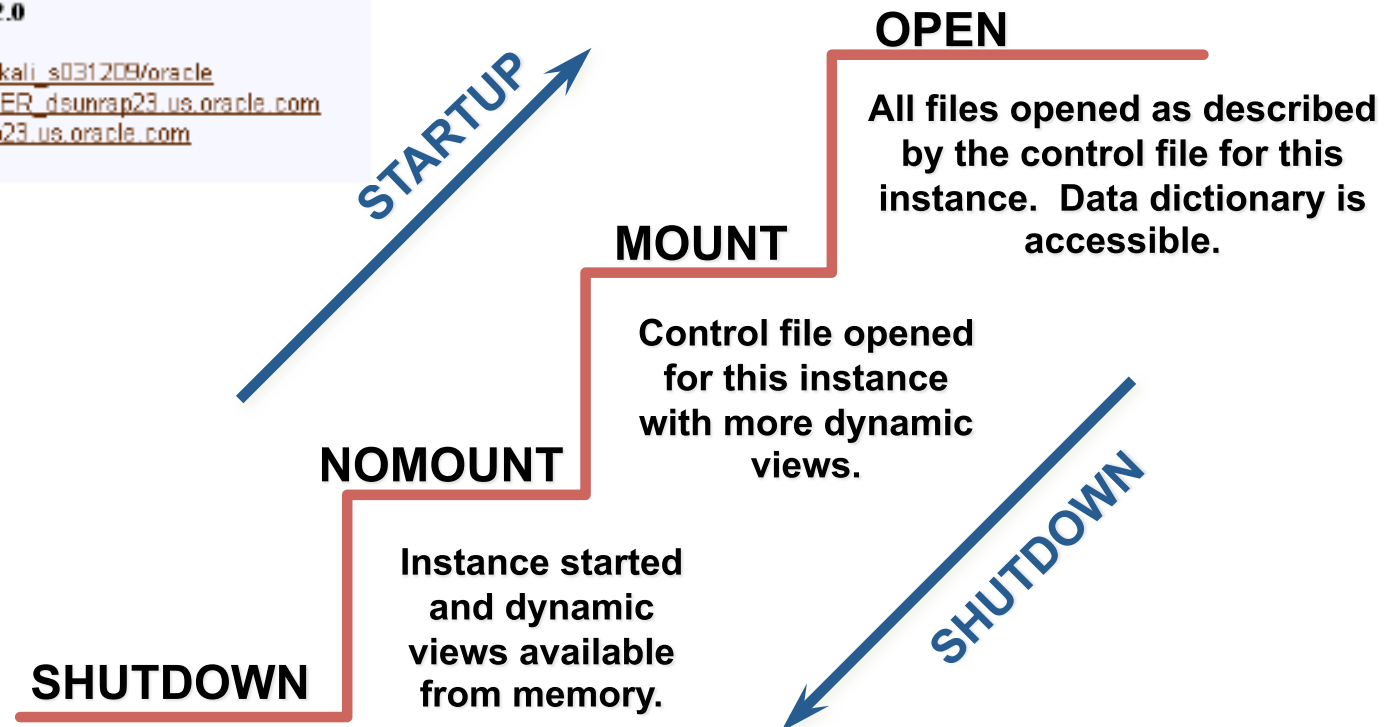
Version 10.1.0.2.0

Read Only No

Oracle Home /ade/hakali_s031209/oracle

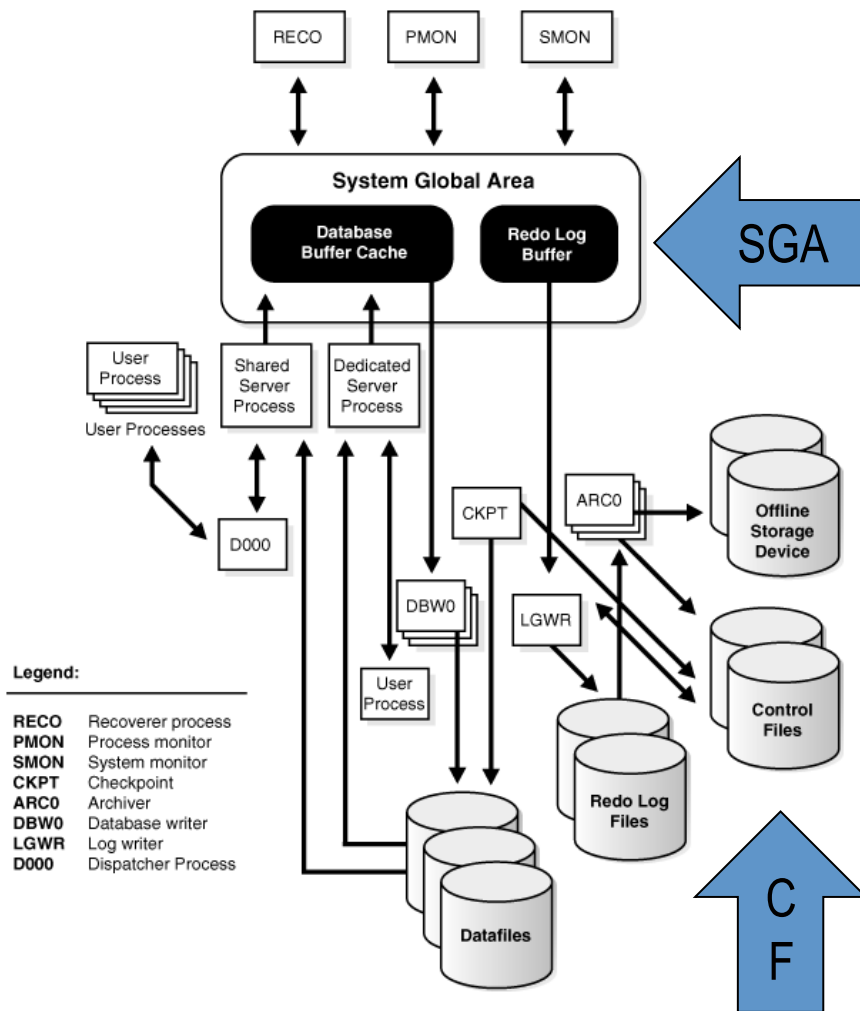
Listener LISTENER_dsunrap23.us.oracle.com

Host dsunrap23.us.oracle.com





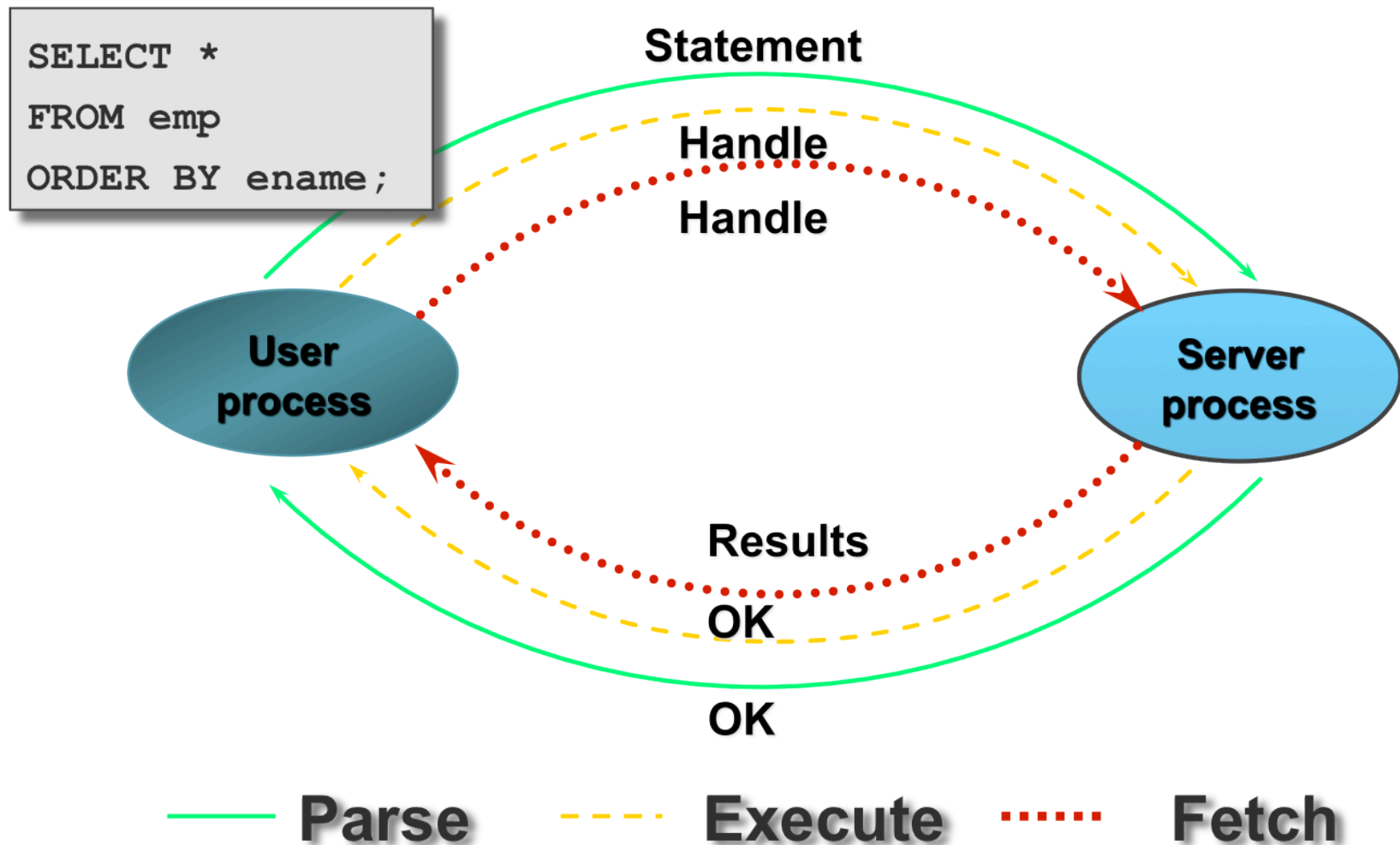
Dynamic Performance Views



- V\$PARAMETER
- V\$SGA
- V\$OPTION
- V\$PROCESS
- V\$SESSION
- V\$VERSION
- V\$INSTANCE
- V\$THREAD
- V\$CONTROLFILE
- V\$DATABASE
- V\$DATAFILE
- V\$DATAFILE_HEADER
- V\$LOGFILE

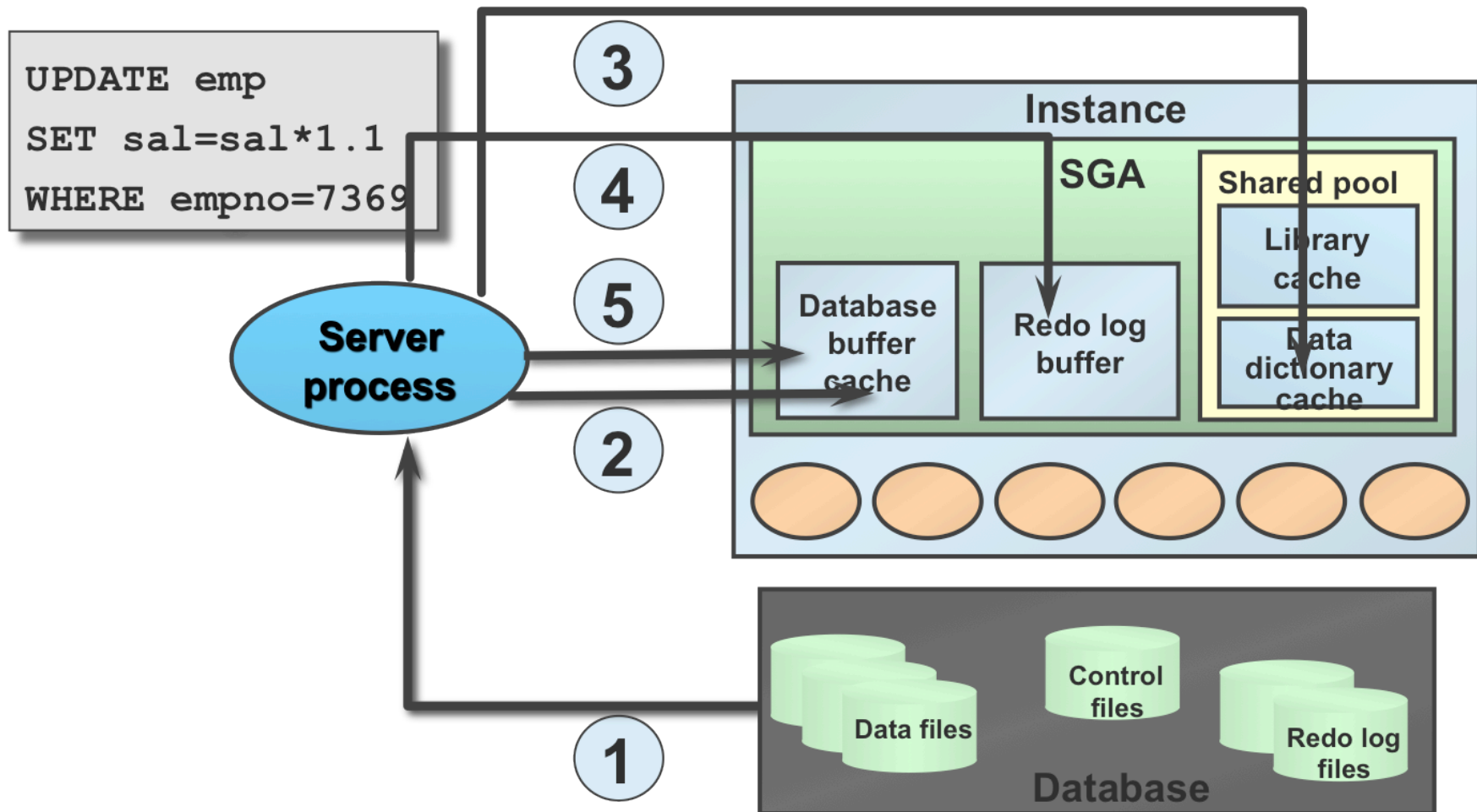


Query Processing



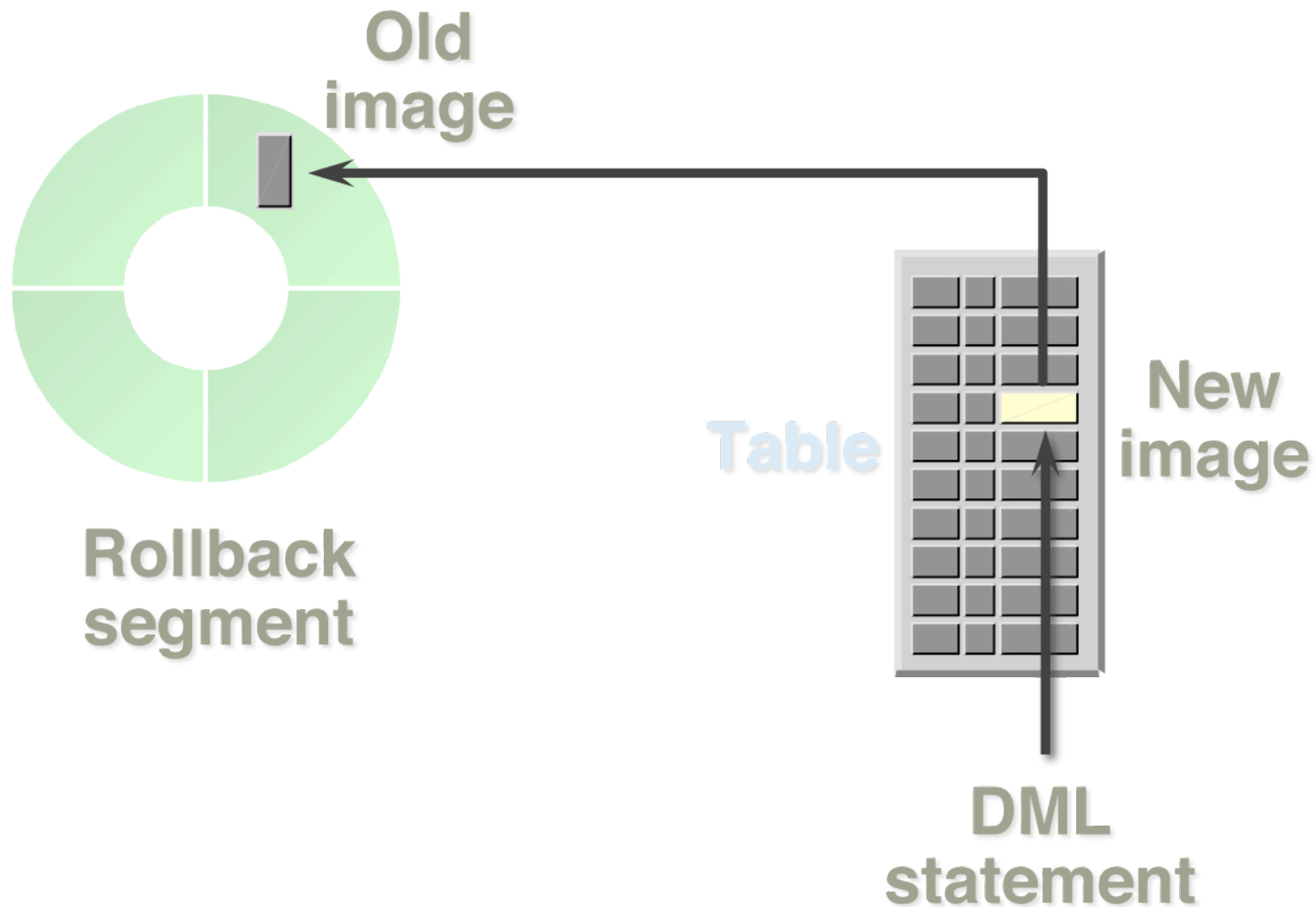


Update Processing



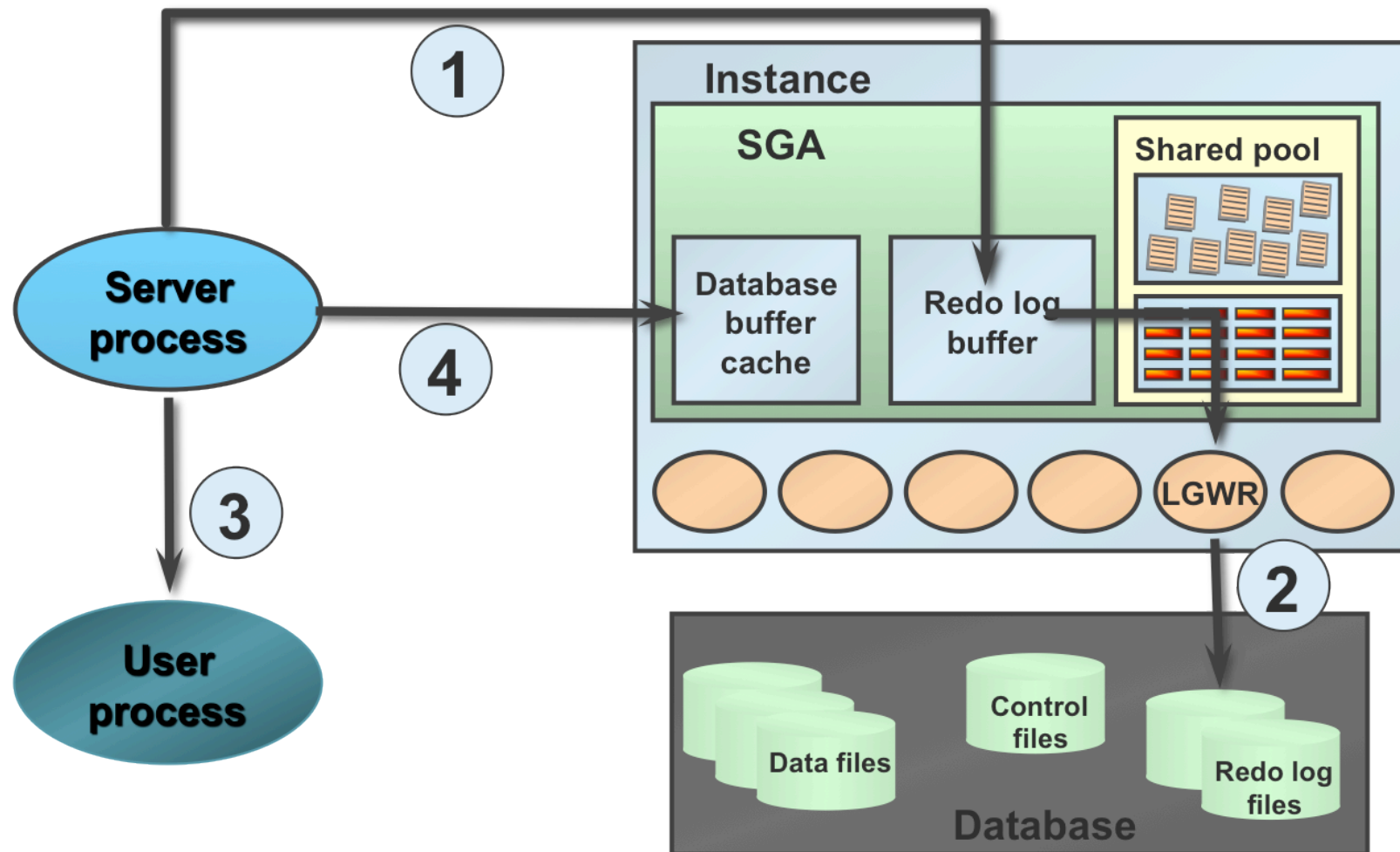


Rollback Processing





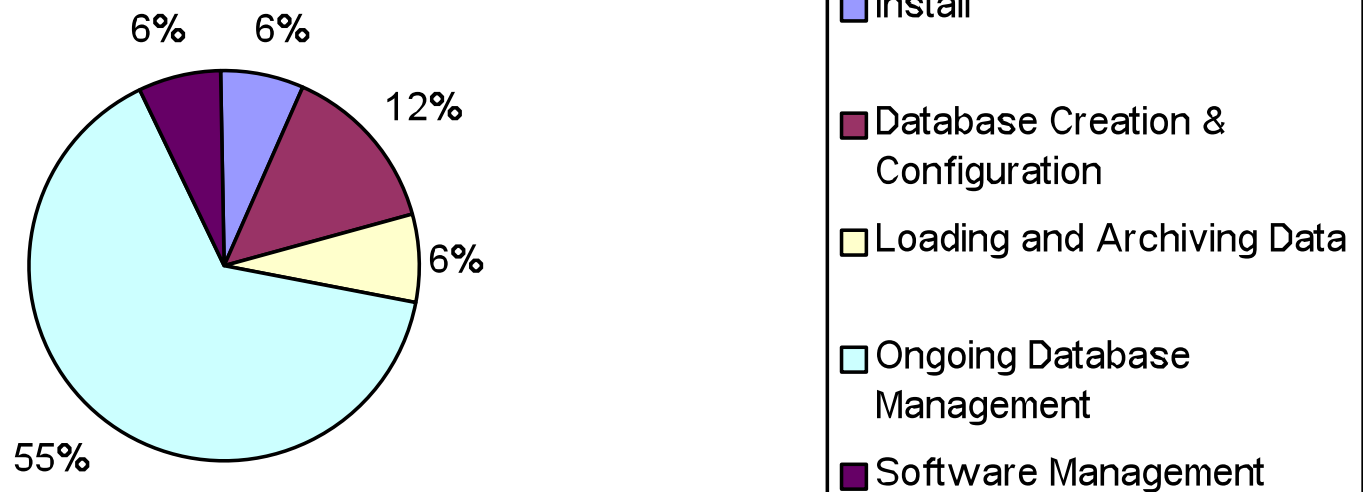
COMMIT Processing





DB Administration

Where DBAs Spend Their Time?





The End

- Database Architectures
- Oracle DBMS Architecture
- Query Processing
- Update Processing
- COMMIT Processing
- Oracle Storage Architecture

