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

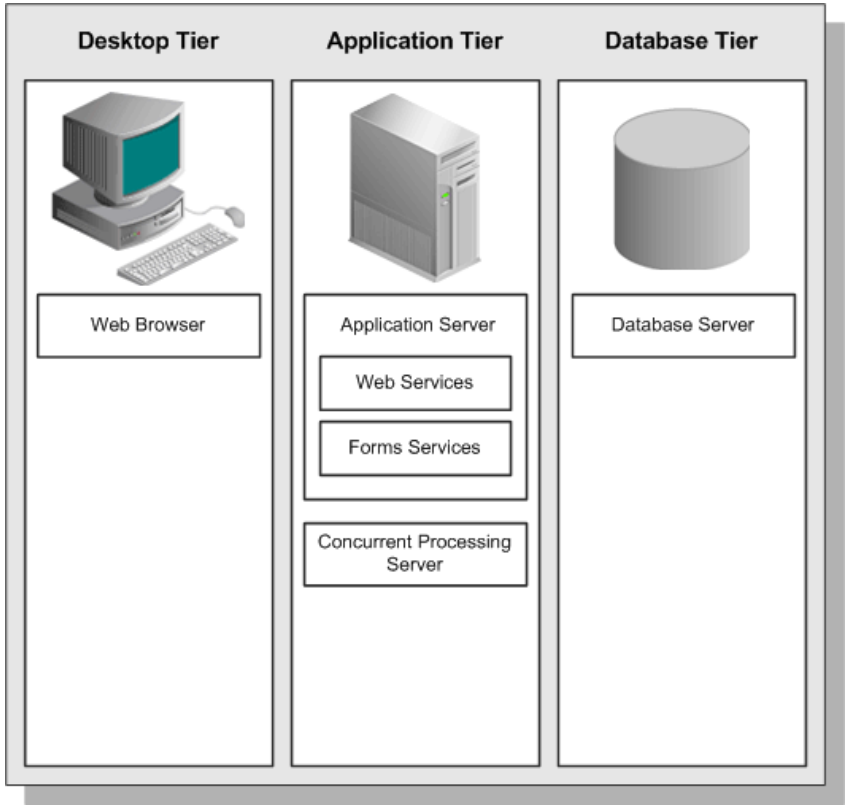
- Oracle Storage Architecture

Database Architectures

Computation/ Communication	**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

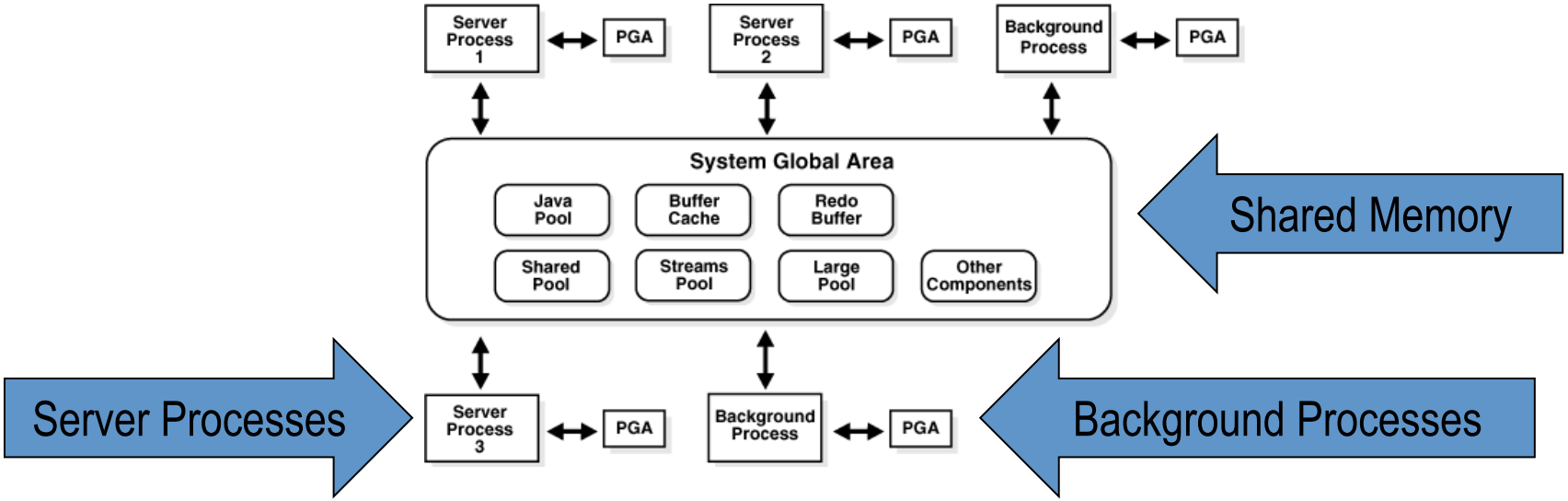
Database Architectures

- 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

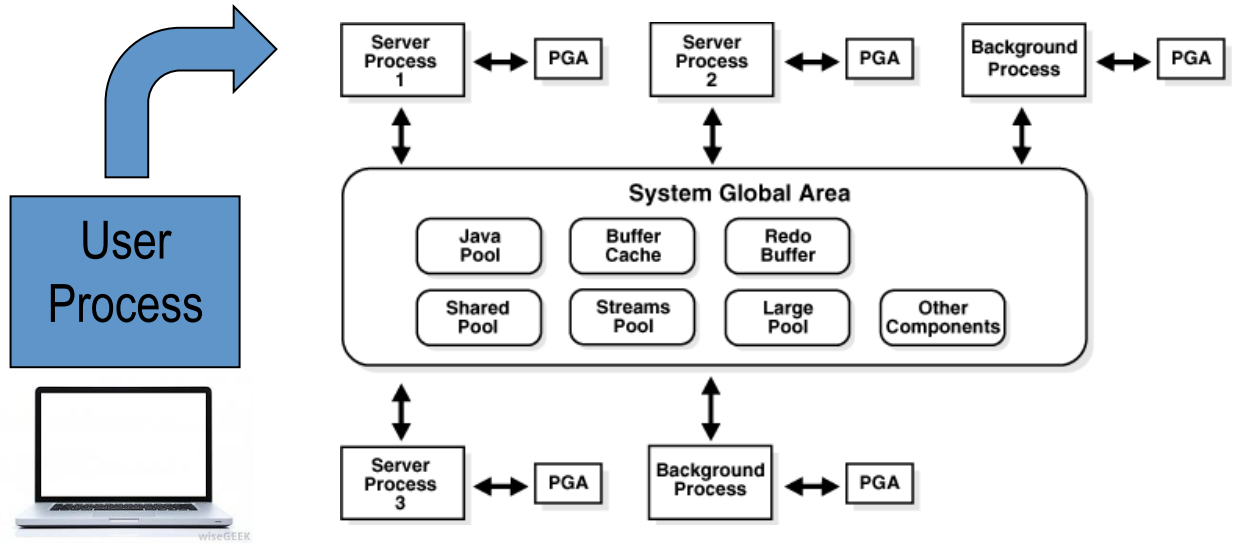
Oracle DBMS Architecture



- 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.

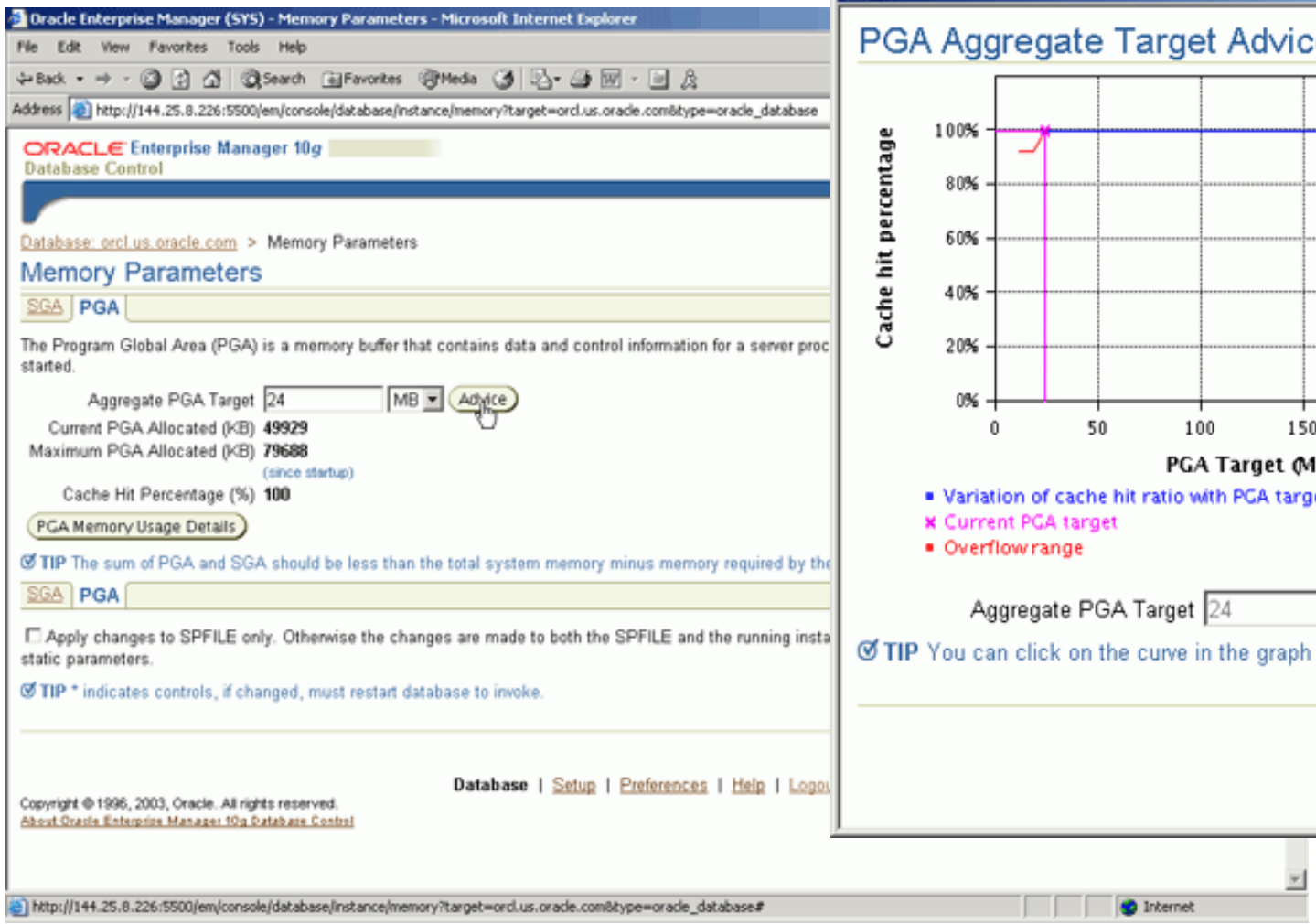
Oracle Database Concepts 11g: Memory Architecture

Oracle DBMS Architecture



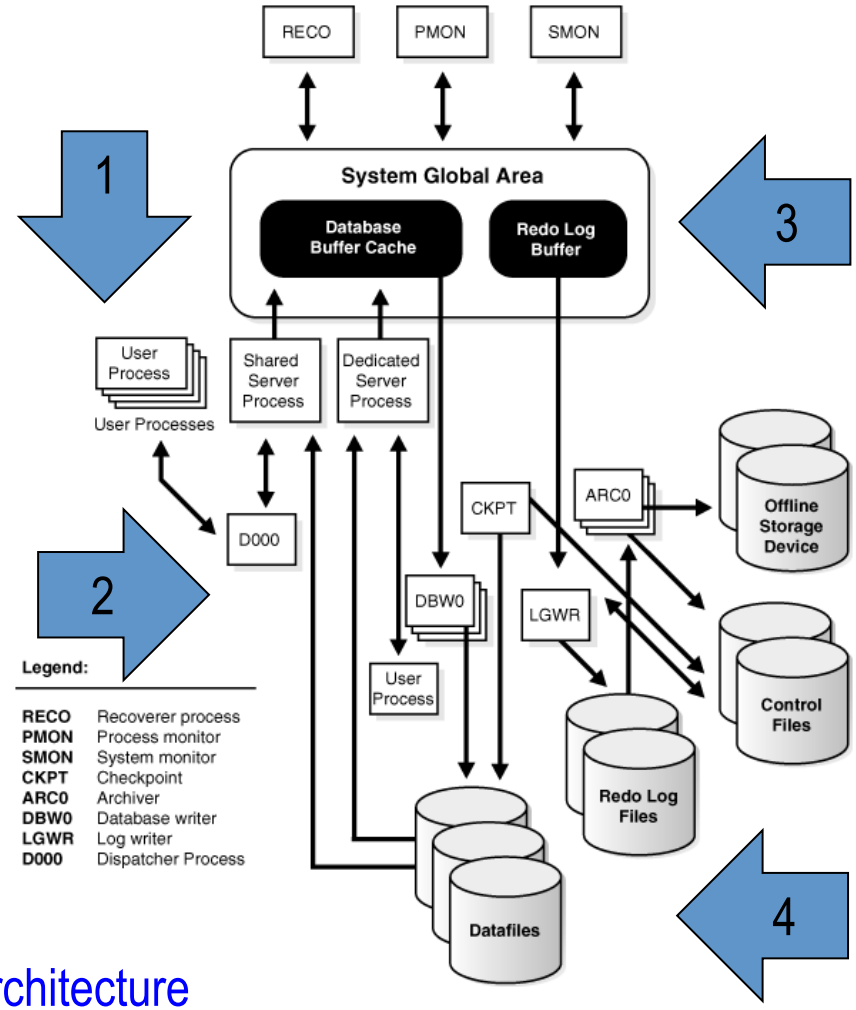
- Client-side user processes interact with the database via server processes (with dedicated program memory).
  - Example: SQL Developer runs as a client-side user process.
- Background processes provide the database functions, such as query processing and optimization, database I/O (all the file reads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

Program Global Area (PGA)



DBMS Architecture: Overview

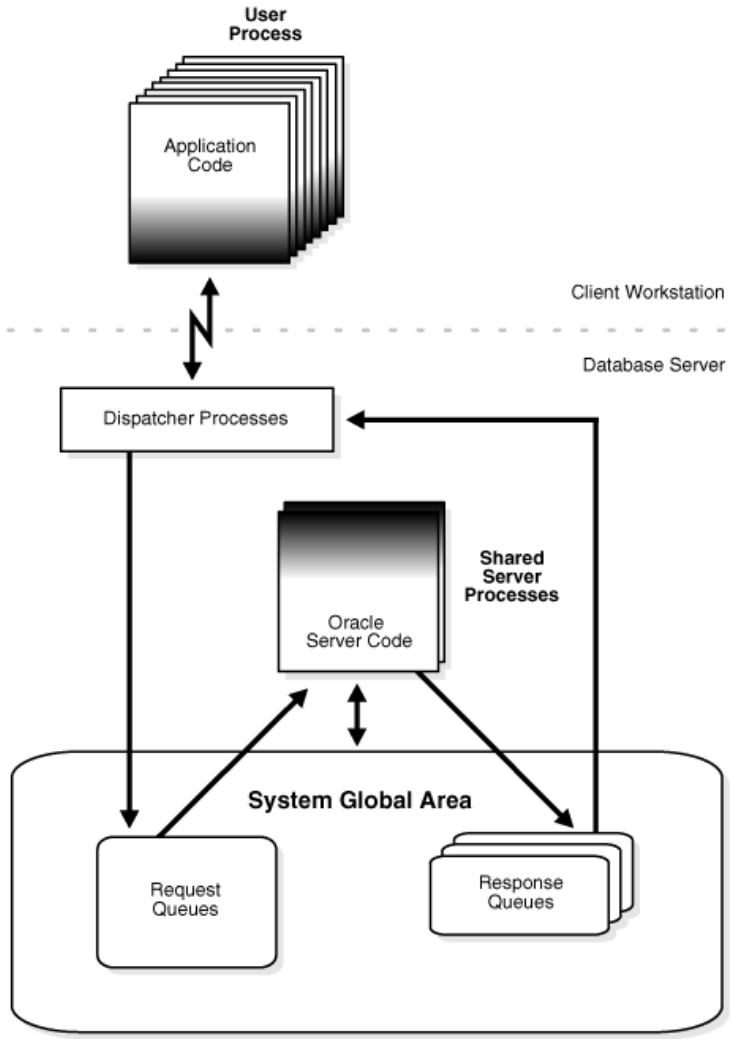
1. First, the overview shows user processes interacting with server processes.
2. Background processes provide a range of database functions.
3. All communication uses shared memory (SGA).
4. A range of database files provide persistent storage (data/metadata).



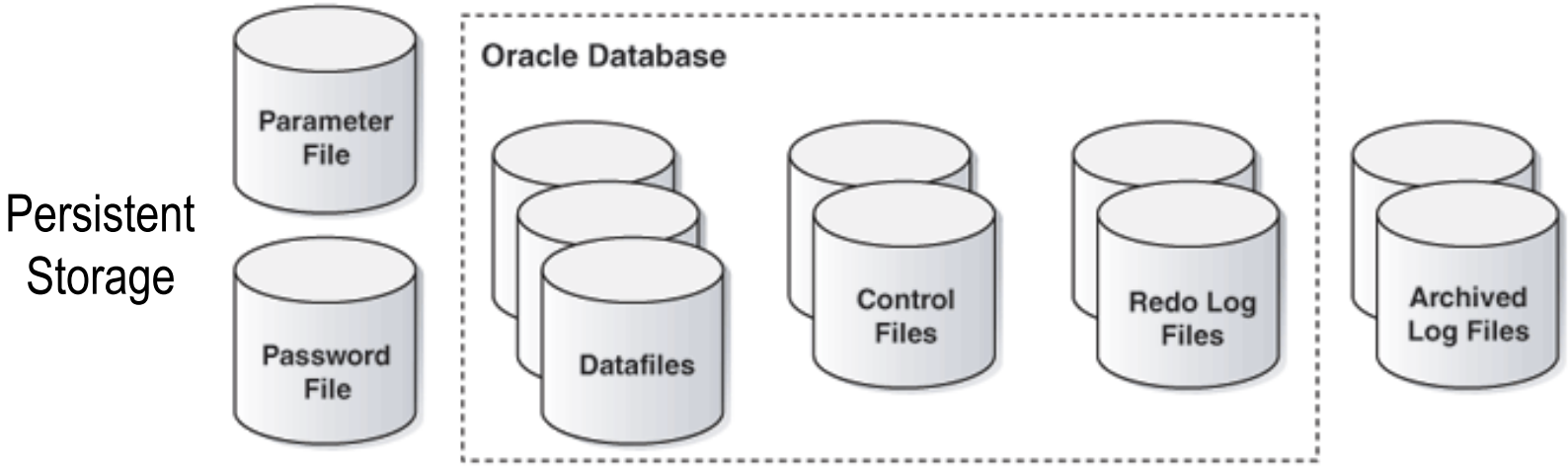
Oracle Database Concepts 11g: Process Architecture

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 …



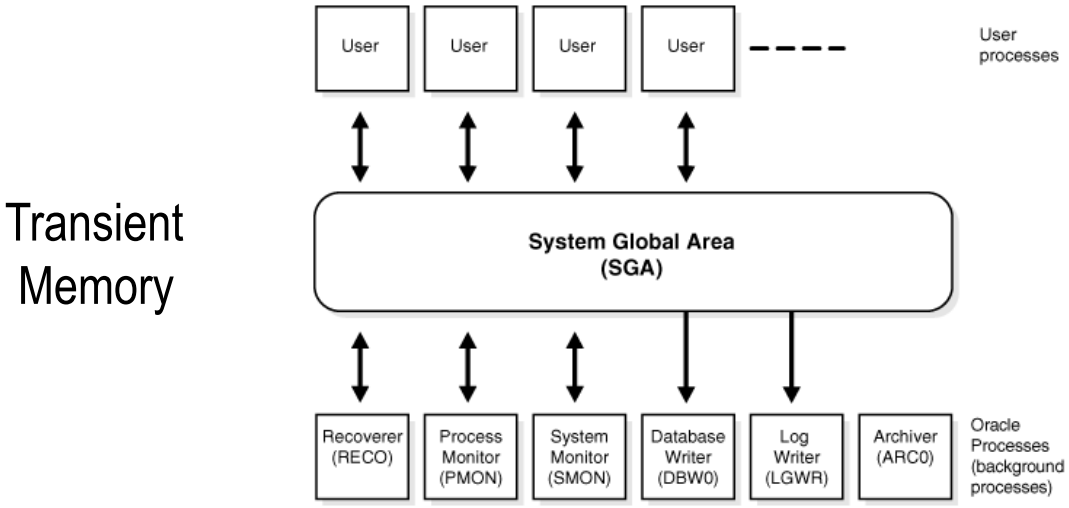
External Database Files



Database:

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

Instance Background Processes

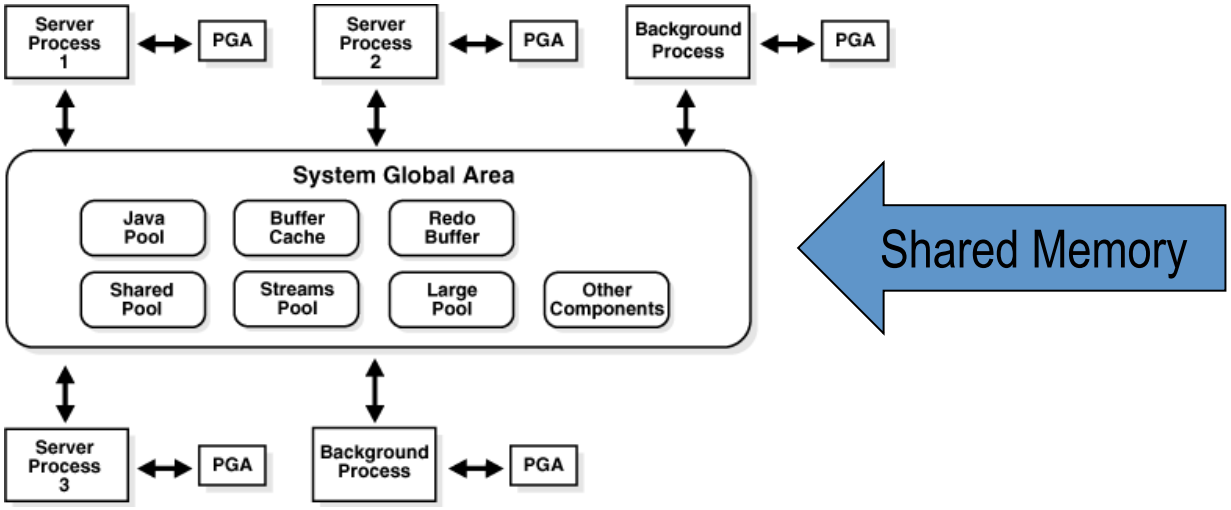


Oracle Database Concepts 11g: Process Architecture

- 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.

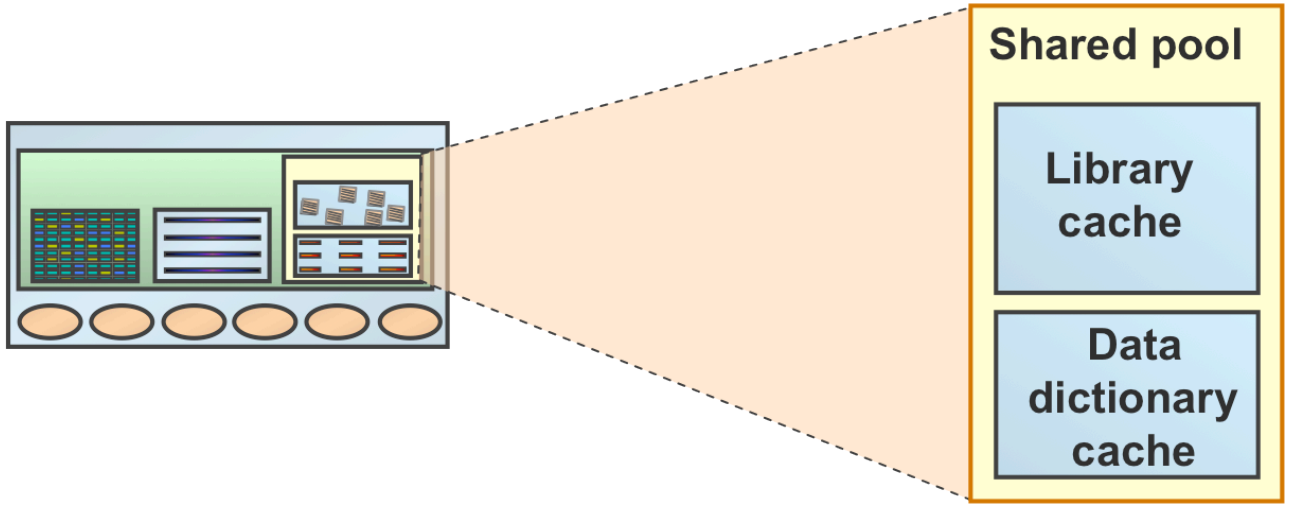
System Global Area (SGA)

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.
- Steams Pool – Shared buffer for message queues.
- Large Pool – Memory for large database operations.

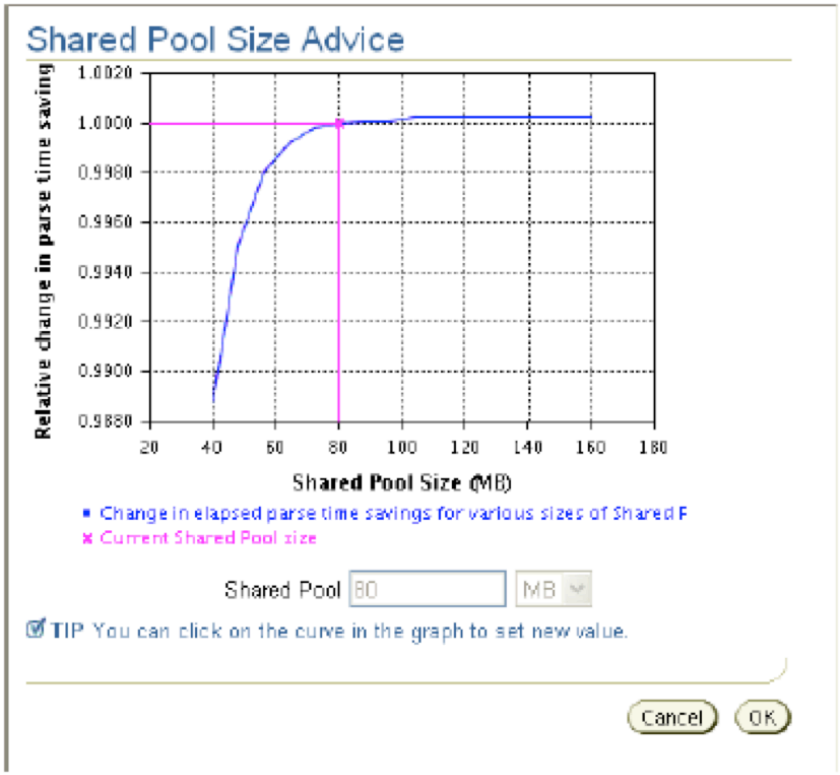
Shared Pool



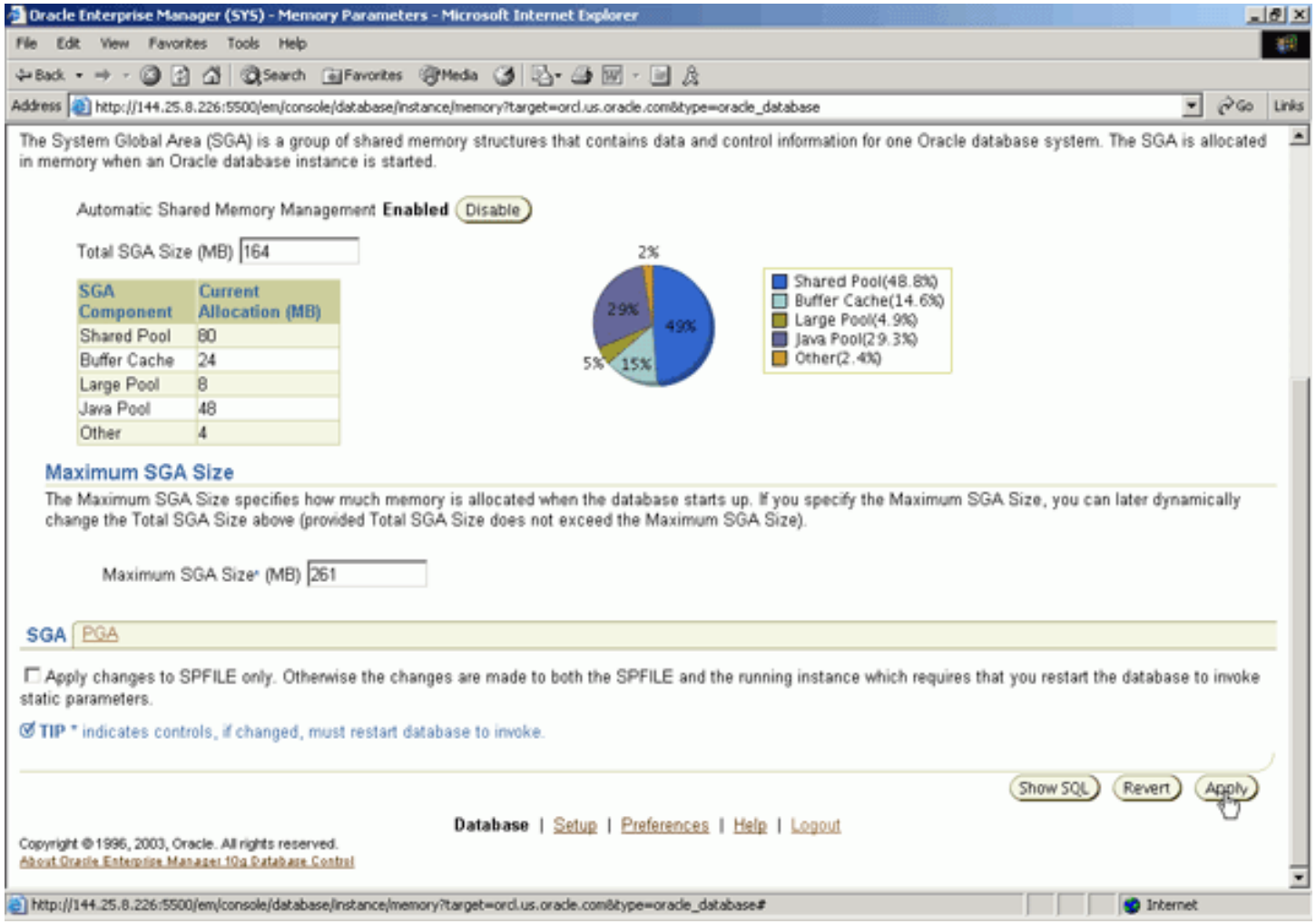
- SHARED_POOL_SIZE parameter controls size.
- Library cache contains statement text, parsed code, and an execution plan.
- Data dictionary cache contains table and column definitions and privileges.

Self-Managing Datases

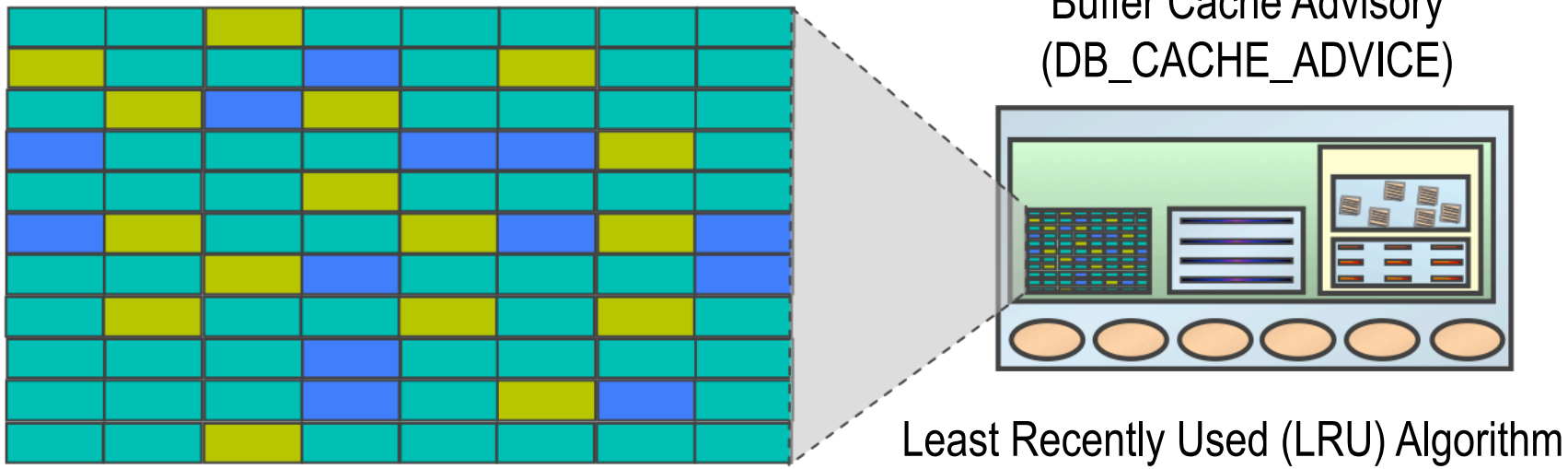
- Automatic shared memory management (as of 10g) allows the DBA to specify limits (SGA_MAX_SIZE) and targets (SGA_TARGET) for shared memory usage, with the engine dynamically re-allocating the various regions.



Self-Managing Databases



Database Buffer Caches



- 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)

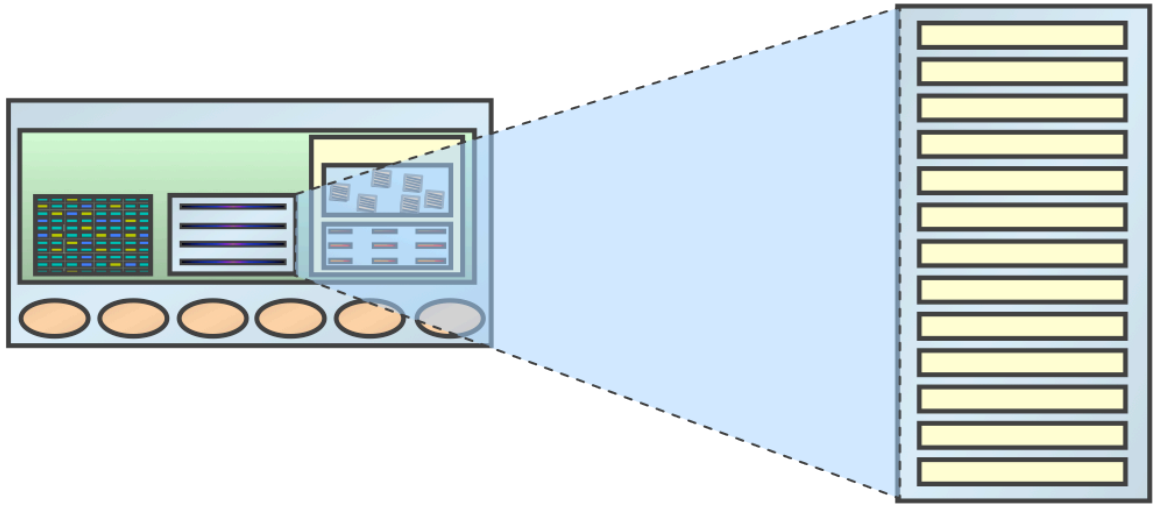
Database Buffer Caches: LRU

- 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).

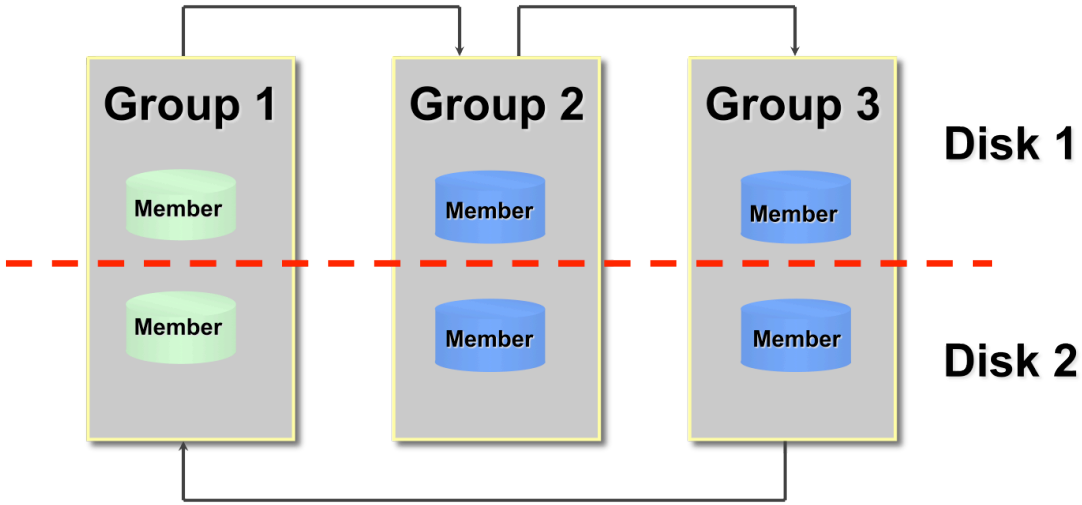
Redo Log Buffer

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.

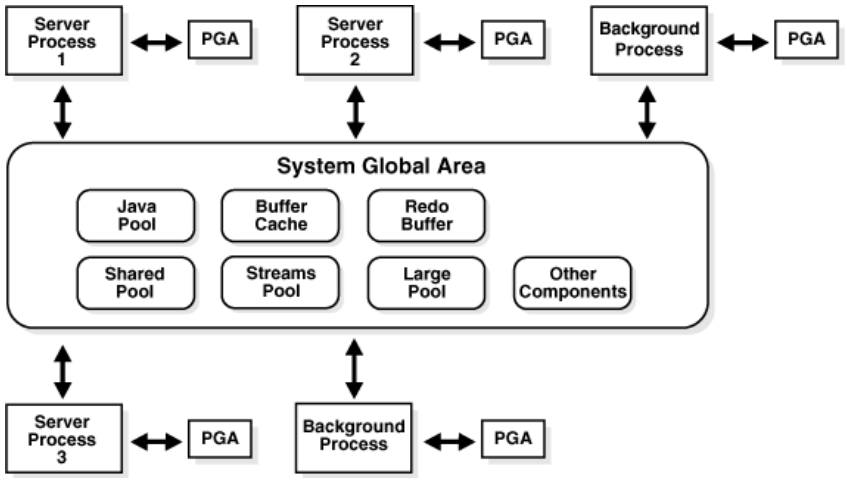
Redo Log Groups



- 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

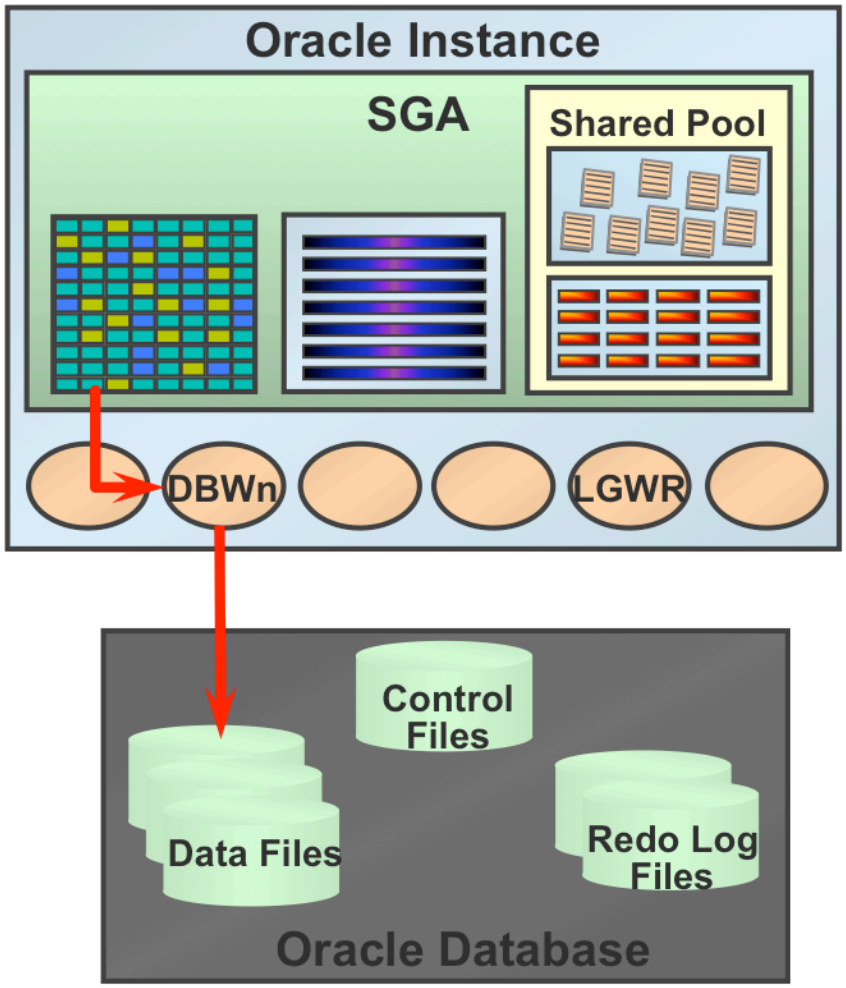
- Large Pool
  - Optional area in the SGA.
  - Reduces Shared Pool demand for I/O processes, parallel execution, backup and restore operations.
  - LARGE_POOL_SIZE



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

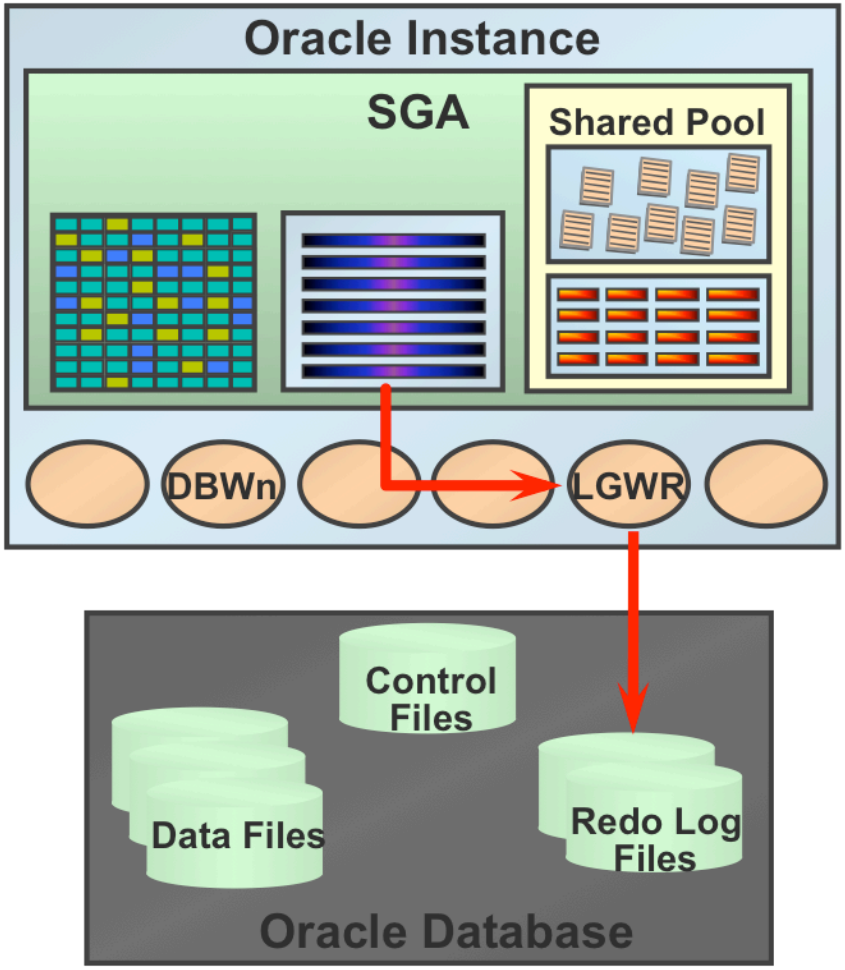
Database Writer (DBWn)

- 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.



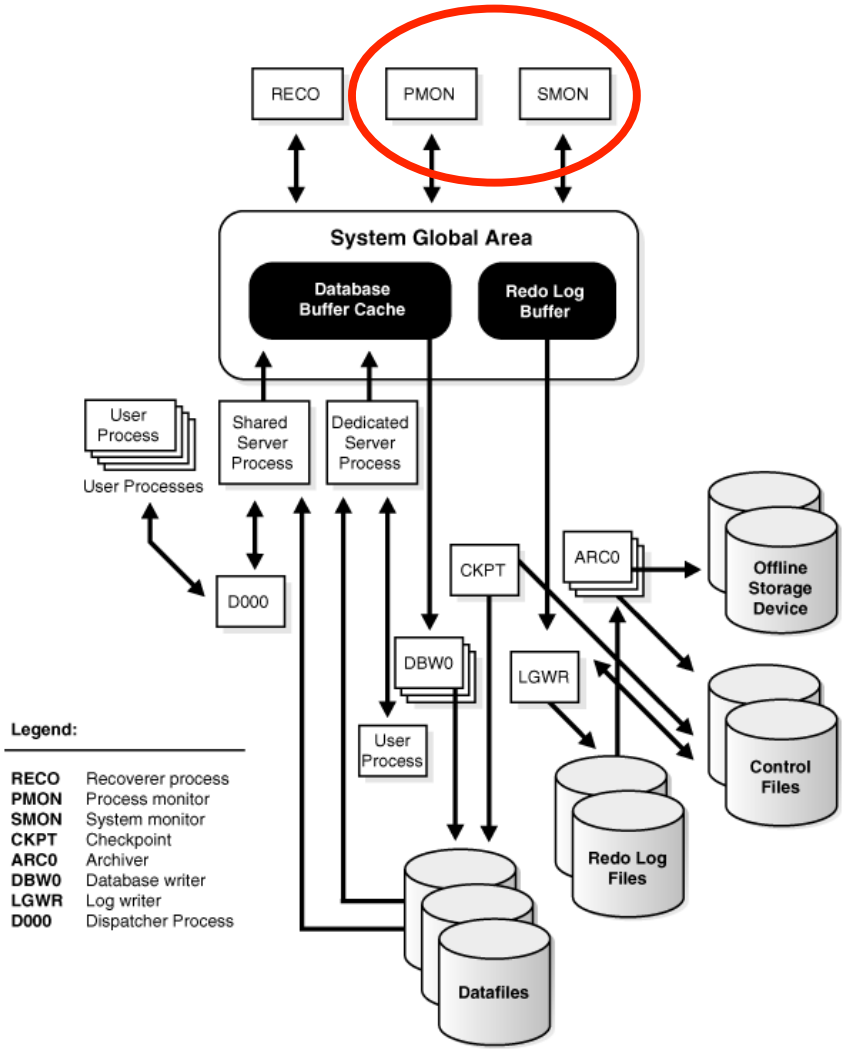
Log Writer (LGWR)

- 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.



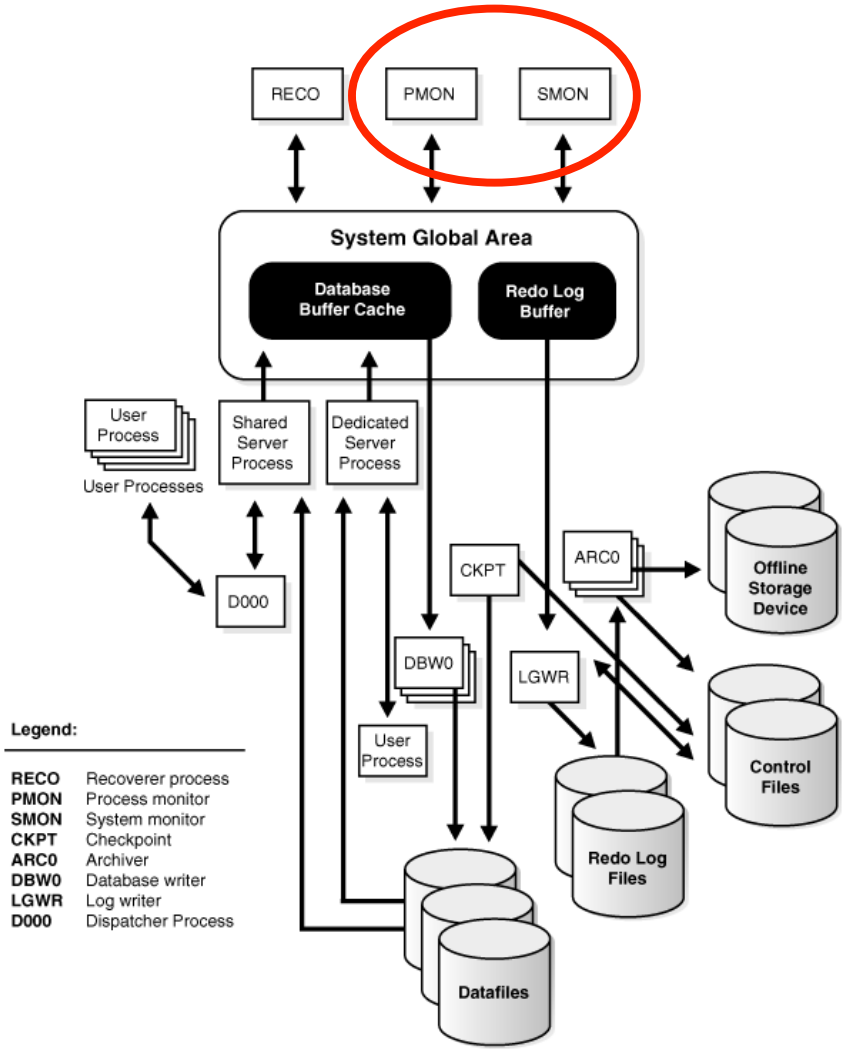
System Monitor (SMON)

- The system monitor performs automatic instance recovery when a database is re-opened.
- Recovery involves:
  - Rolling forward committed transactions using redo logs.
  - Applying changes to data blocks.
  - Rolling back uncommitted transactions.
  - Opening the database.
  - Free space maintenance.



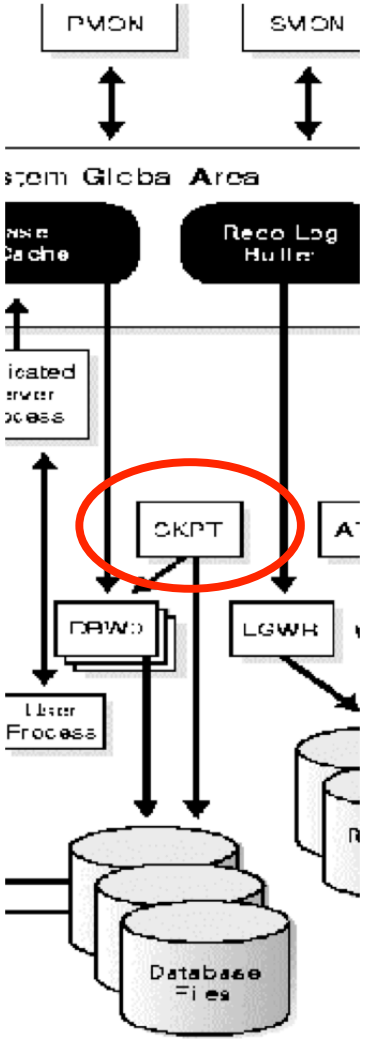
Process Monitor (PMON)

- 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).

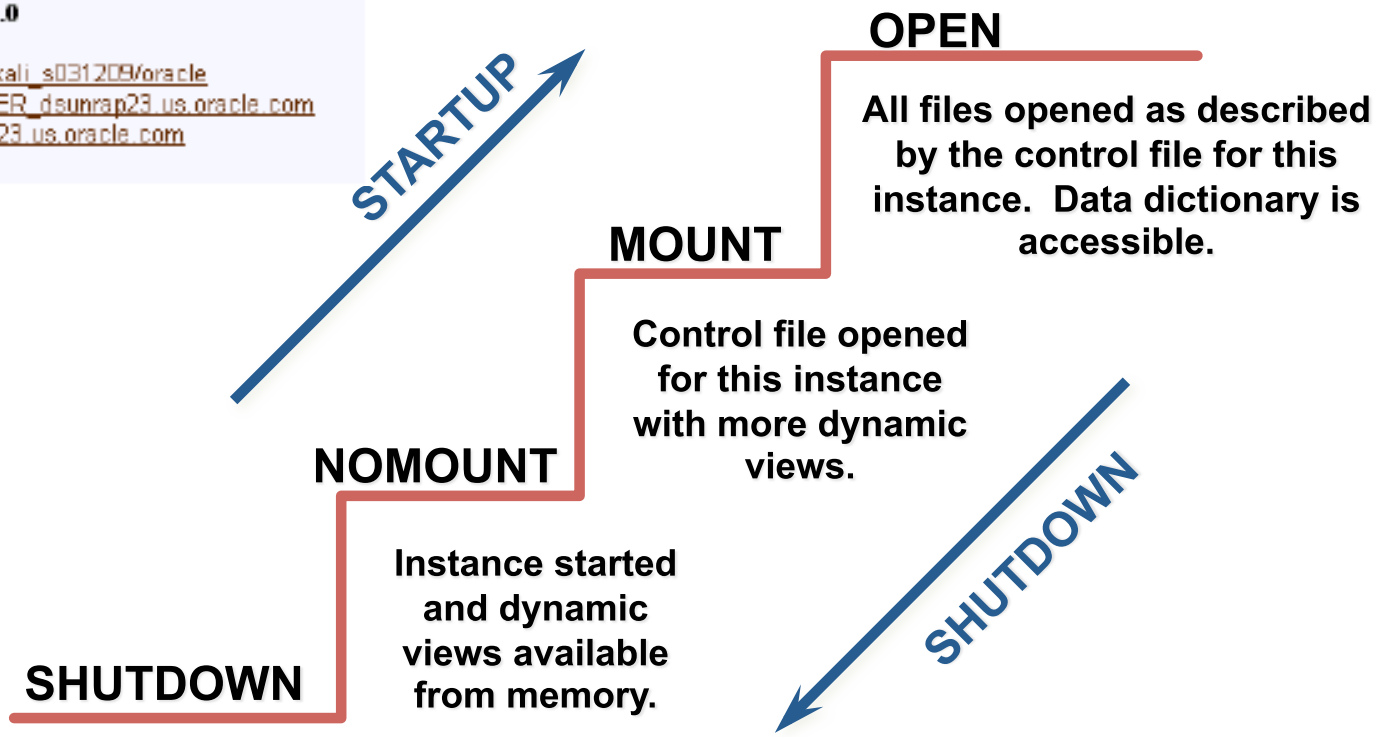


Checkpoint (CKPT)

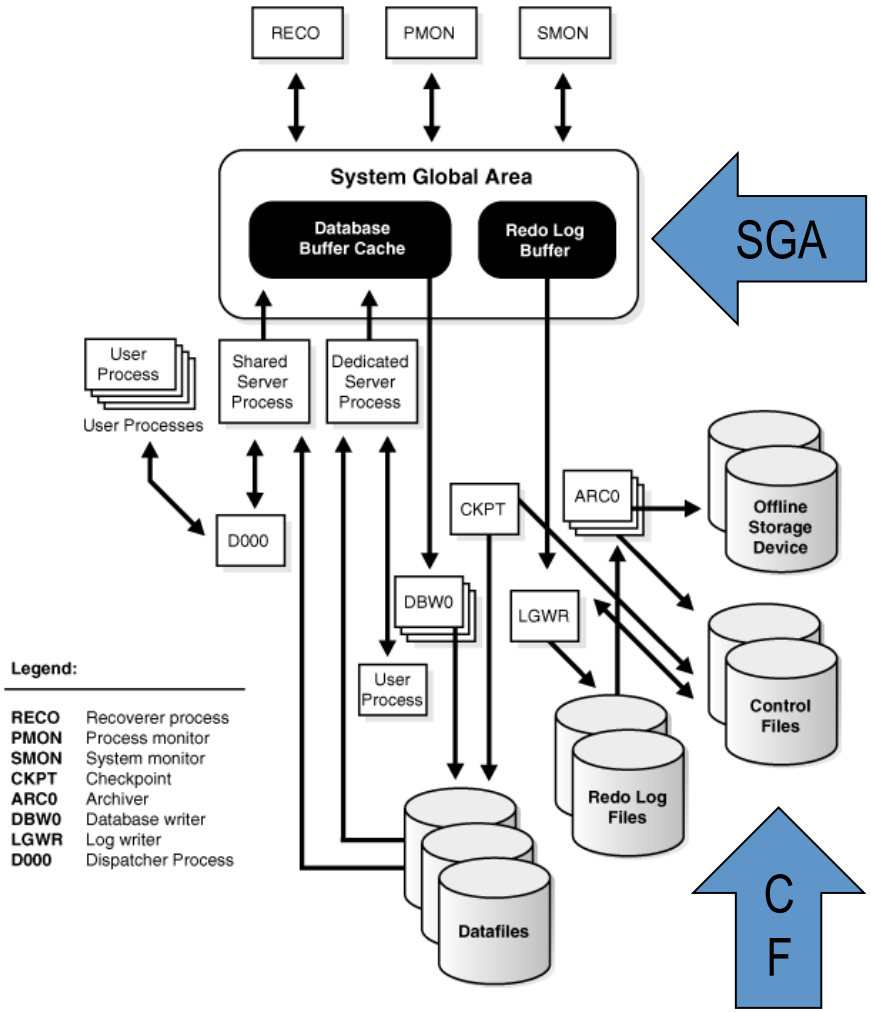
- Every so often (say 3 seconds) the checkpoint process updates the control files, noting where recovery should start in the redo logs (managing recovery time).
- Checkpoints involve:
  - Updating control file information.
  - Updating data file headers with checkpoint information.
  - Signaling DBWn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



DBMS Startup and Shutdown



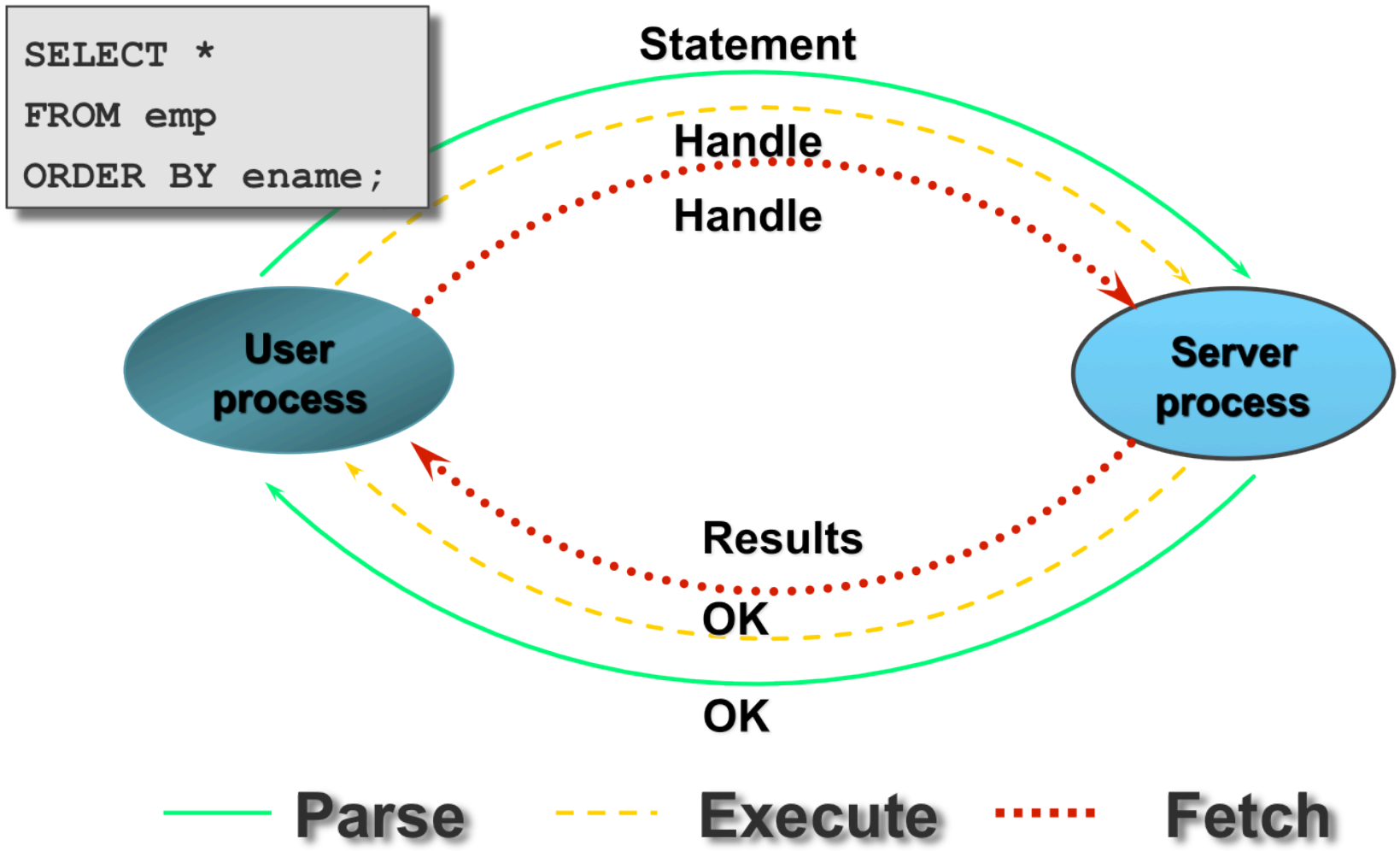
Dynamic Performance Views



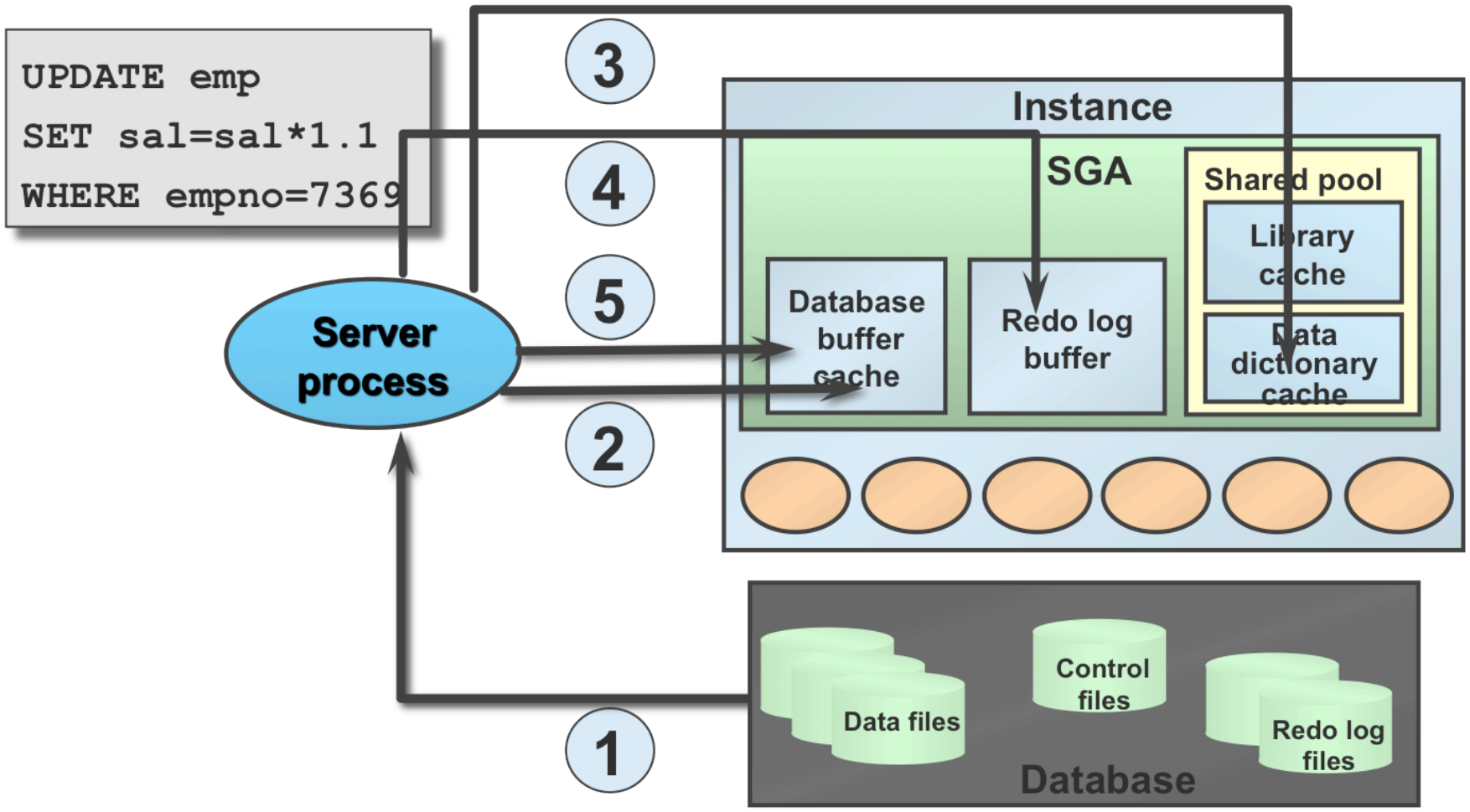
- V$PARAMETER
- V$SGA
- V$OPTION
- V$PROCESS
- V$SESSION
- V$VERSION
- V$INSTANCE

- V$THREAD
- V$CONTROLFILE
- V$DATABASE
- V$DATAFILE
- V$DATAFILE_HEADER
- V$LOGFILE

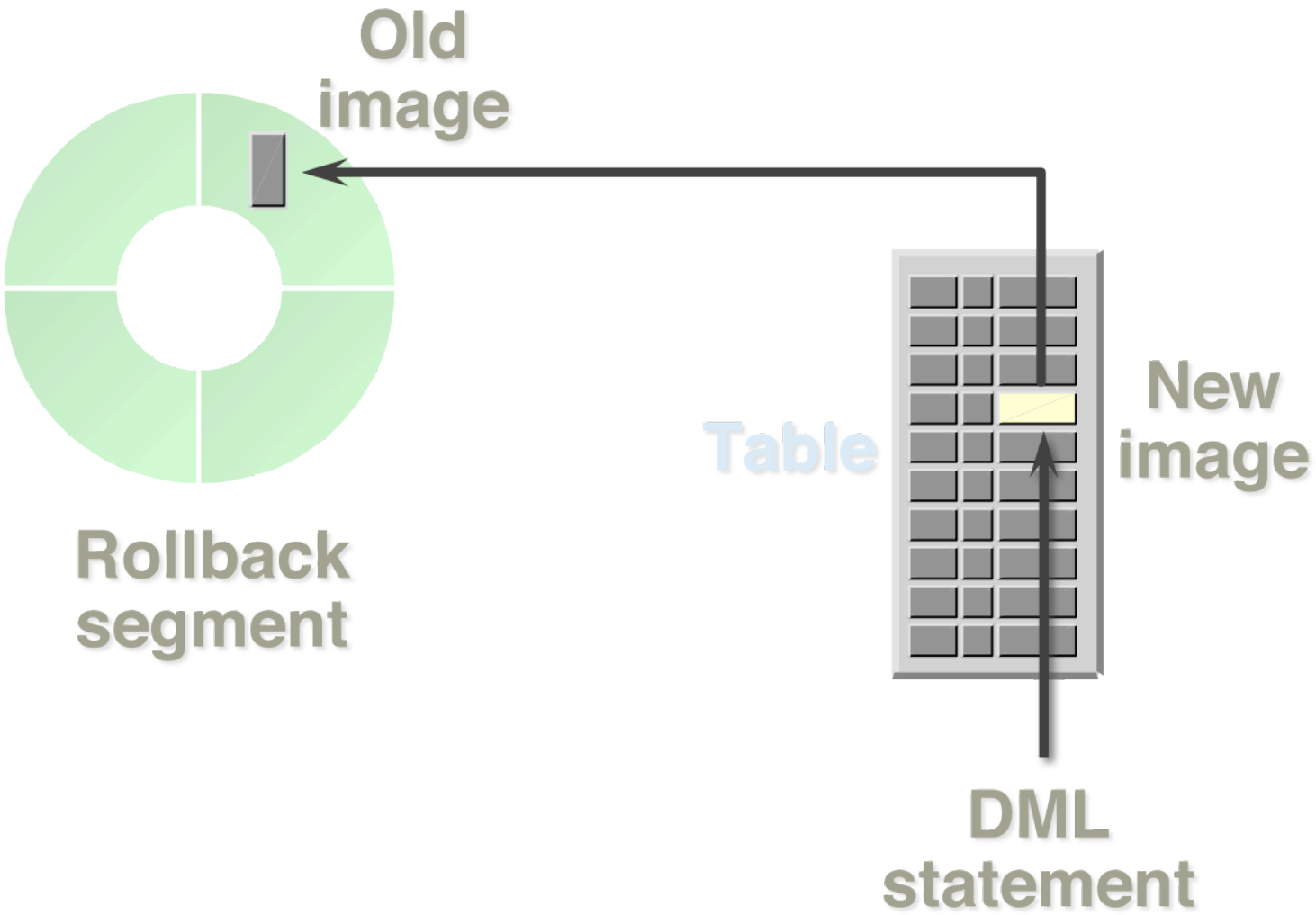
Query Processing



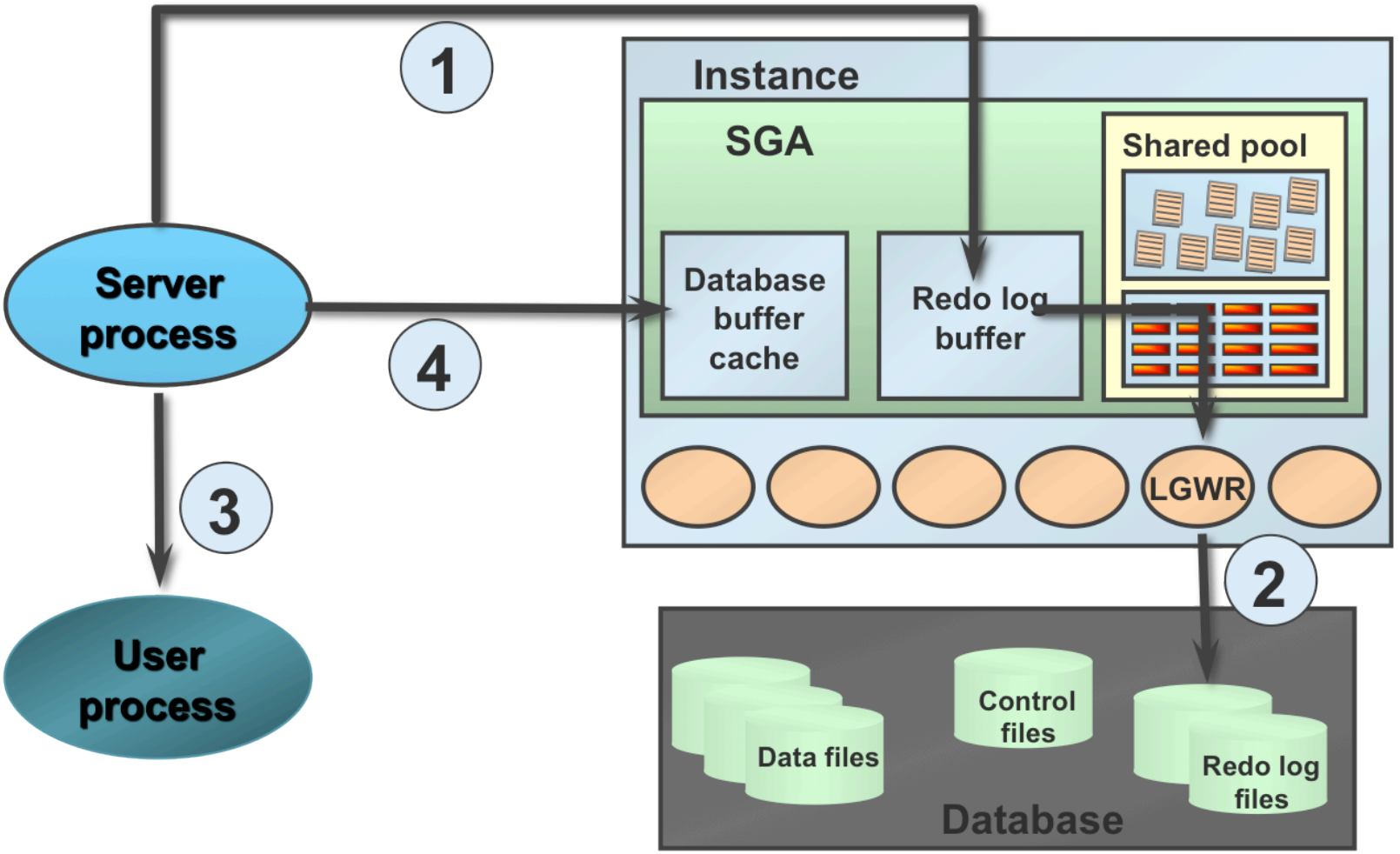
Update Processing



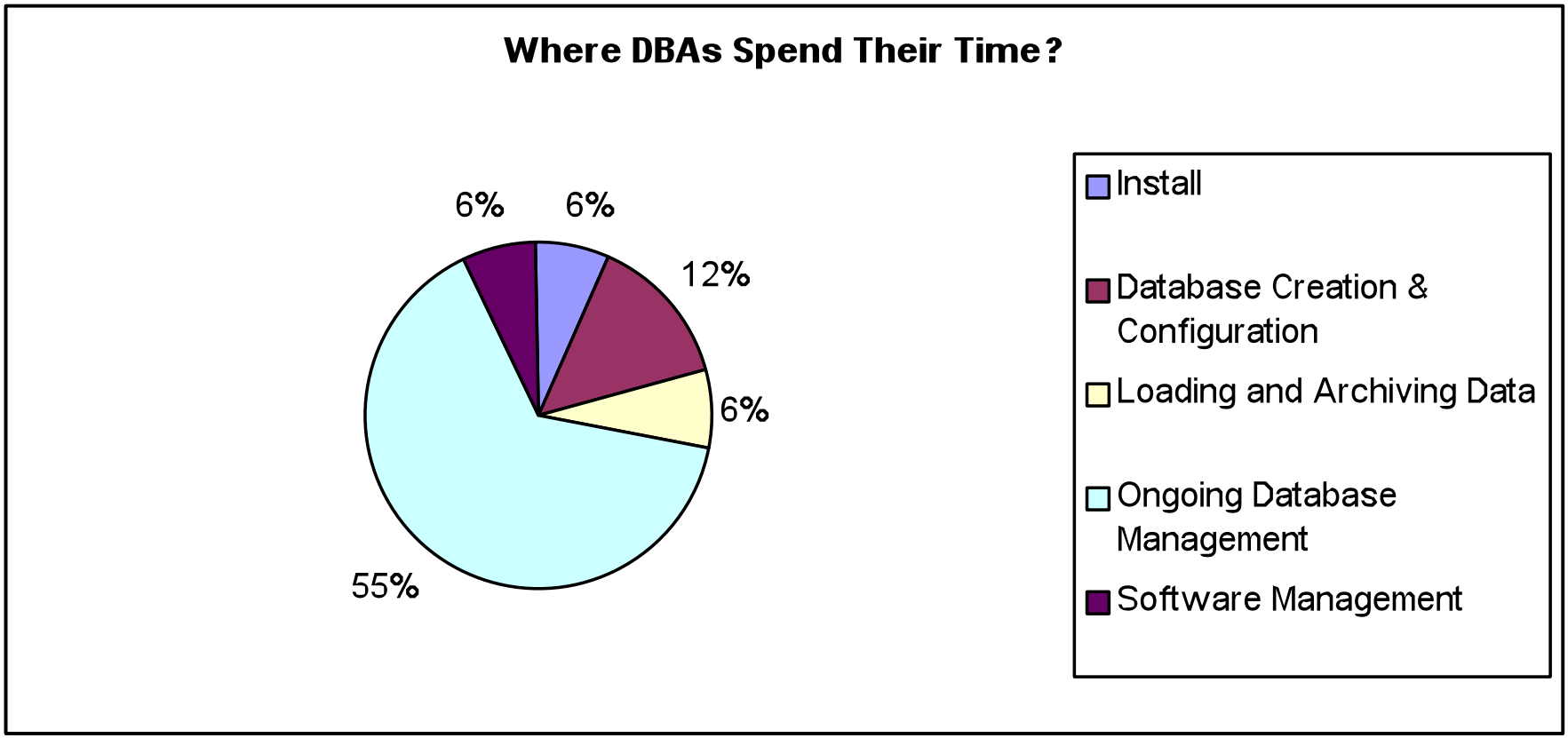
Rollback Processing



COMMIT Processing



DB Administration



The End

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

Next Up