Oracle Architecture

Overview
Oracle Architecture
The Oracle Server
Oracle Architecture

Instance Architecture

- SGA
  - Database Buffer Cache
  - Redo Log Buffer
  - Shared pool
    - Library Cache
    - Data Dictionary Cache

- Instance

- Processors:
  - DBWR
  - LGWR
  - SMON
  - PMON
  - ARCn
  - RECO
  - CKPT
  - LCKn
  - SNPn
  - Dnnn
  - Snnn
An Oracle instance:
- Is a means to access an Oracle database
- Always opens one and only one database

Consists of:
- Internal memory structures
- Processes
Oracle Architecture
Interaction with the Database (Dedicated Server)
Oracle Architecture
Interaction with the Database (Shared Server)
Oracle Architecture
Internal Memory Structures SGA

System or ‘shared’ Global Area (SGA)

- Database buffer cache
- Redo log buffer
- Shared pool
- Request & response queues (shared server)
Oracle Architecture
Database buffer cache

- Used to hold data blocks read from datafiles by server processes
- Contains ‘dirty’ or modified blocks and ‘clean’ or unused or unchanged bocks
- ‘Dirty’ and ‘clean’ blocks are managed in lists called the dirty list and the LRU
- Free space is created by DBWR writing out ‘dirty’ blocks or aging out blocks from the LRU
- Size is managed by the parameter DB_BLOCK_BUFFERS
Oracle Architecture
Least Recently Used (LRU)

- LRU and the database buffer cache
  - Every time a data block is read from disk it is placed in the database buffer cache at the head of the LRU list
  - If a block is already in the cache and it is read again it is moved to the head of the list
  - Data not used frequently is ‘aged’ out of the cache while frequently used data remains
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Redo Log Buffer

- A circular buffer that contains redo entries
  - Redo entries reflect changes made to the database
- Redo entries take up contiguous, sequential space in the buffer
- Data stored in the redo log buffer is periodically written to the online redo log files
- Size is managed by the parameter LOG_BUFFER
  - Default is 4 times the maximum data block size for the operating system
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Shared Pool

- Consists of multiple smaller memory areas
  - Library cache
    - Shared SQL area
      - Contains parsed SQL and execution plans for statements already run against the database
    - Procedure and package storage
  - Dictionary cache
    - Names of all tables and views in the database
    - Names and datatypes of columns in the database tables
    - Privileges of all users

- Managed via an LRU algorithm
- Size determined by the parameter SHARED_POOL_SIZE
Oracle Architecture
Least Recently Used (LRU)

- LRU and the shared pool
  - Every time a SQL statement is parsed it is placed in the shared pool for reuse
  - If a SQL statement is already in the shared pool it will not re-parse but it is placed at the head of the LRU
  - SQL statements not used frequently are ‘aged’ out of the shared pool while frequently used statements remain
  - A SQL statement may be artificially retained at the head of the LRU by ‘pinning’ the statement
Program or ‘process’ Global Area (PGA)
- Used for a single process
- Not shareable with other processes
- Writable only by the server process
- Allocated when a process is created and deallocated when a process is terminated
- Contains:
  - Sort area – Used for any sorts required by SQL processing
  - Session information – Includes user privileges
  - Cursor state – Indicates stage of SQL processing
  - Stack space – Contains session variables
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Background Processes - DBWR

- Writes contents of database buffers to datafiles
- Primary job is to keep the database buffer ‘clean’
- Writes least recently used (LRU) ‘dirty’ buffers to disk first
- Writes to datafiles in optimal batch writes
- Only process that writes directly to datafiles
- Mandatory process
Oracle Architecture
Background Processes - DBWR

- DBWR writes to disk when:
  - A server process cannot find a clean reusable buffer
  - A timeout occurs (3 sec)
  - A checkpoint occurs
  - DBWR cannot write out ‘dirty’ buffers before they have been written to the online redo log files
The SQL command **COMMIT** allows users to save transactions that have been made against a database. This functionality is available for any **UPDATE, INSERT, or DELETE** transaction; it is not available for changes to database objects (such as **ALTER TABLE** commands).
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Background Processes - LGWR

- Writes contents of redo log buffers to online redo log files
- Primary job is to keep the redo log buffer ‘clean’
- Writes out redo log buffer blocks sequentially to the redo log files
- May write multiple redo entries per write during high utilization periods
- Mandatory process
Oracle Architecture
Background Processes - LGWR

- LGWR writes to disk when:
  - A transaction is COMMITED
  - A timeout occurs (3 sec)
  - The redo log buffer is 1/3 full
  - There is more than 1 megabyte of redo entries
  - Before DBWR writes out ‘dirty’ blocks to datafiles
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Background Processes - SMON

- Performs automatic instance recovery
- Reclaims space used by temporary segments no longer in use
- Merges contiguous areas of free space in the datafiles (if PCTINCREASE > 0)
- SMON ‘wakes up’ regularly to check whether it is needed or it may be called directly
- Mandatory process
SMON recovers transactions marked as DEAD within the instance during instance recovery
  - All non committed work will be rolled back by SMON in the event of server failure
  - SMON makes multiple passes through DEAD transactions and only applies a specified number of undo records per pass, this prevents short transactions having to wait for long transactions to recover

SMON primarily cleans up server-side failures
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Background Processes - PMON

- Performs automatic process recovery
  - Cleans up abnormally terminated connections
  - Rolls back non committed transactions
  - Releases resources held by abnormally terminated transactions
- Restarts failed shared server and dispatcher processes
- PMON ‘wakes up’ regularly to check whether it is needed or it may be called directly
- Mandatory process
Oracle Architecture
Background Processes - PMON

• Detects both user and server aborted database processes
• Automatically resolves aborted processes
  – PMON rolls back the current transaction of the aborted process
  – Releases resources used by the process
  – If the process is a background process the instance most likely cannot continue and will be shut down
• PMON primarily cleans up client-side failures
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Background Processes - CKPT

- Forces all modified data in the SGA to be written to datafile
  - Occurs whether or not the data has been committed
  - CKPT does not actually write out buffer data only DBWR can write to the datafiles
- Updates the datafile headers
  - This ensures all datafiles are synchronized
- Helps reduce the amount of time needed to perform instance recovery
- Frequency can be adjusted with parameters
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Background Processes - ARCH

• Automatically copies online redo log files to designated storage once they have become full
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Server Processes

- Services a single user process in the dedicated server configuration or many user processes in the shared server configuration
- Use an exclusive PGA
- Include the Oracle Program Interface (OPI)
- Process calls generated by the client
- Return results to the client in the dedicated server configuration or to the dispatcher in the shared server configuration
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User Processes

- Run on the client machine
- Are spawned when a tool or an application is invoked
  - SQL*Plus, Server Manager, Oracle Enterprise Manager, Developer/2000
  - Custom applications
- Include the User Program Interface (UPI)
- Generate calls to the Oracle server
UPDATE table
SET user = 'SHIPERT'
WHERE id = 12345
Oracle Architecture
Transaction Example - Update

- **SGA**
  - Database Buffer Cache
  - Redo Log Buffer

- **Database Files**
  - Redo Log Files

- **Redo Log Files**

- **User Process**

- **Dedicated Server**

- **Kernel Threads**
  - CKPT
  - SMON
  - PMON
  - DBWR
  - LGWR

- **Rollback Segment**

- **Segment 3**
Oracle Architecture
Transaction Example - Update
Oracle Architecture
Transaction Example - Update

- SGA
  - Shared Pool
  - Database Buffer Cache
  - Redo Log Buffer

- Rollback Segment

- Dedicated Server

- User Process

- CKPT
- SMON
- PMON

- Database Files
- Redo Log Files

- DBWR
- LGWR

PMON: Process Monitor
SMON: System Monitor
CKPT: Checkpoint
DBWR: Database Writer
LGWR: Log Writer
Oracle Architecture
Transaction Example - Update

- SGA
  - Shared Pool
  - Database Buffer Cache
  - Rollback Segment
  - Redo Log Buffer
- Dedicated Server
- User Process
- CKPT
- SMON
- PMON
- DBWR
- LGWR
- Database Files
- Redo Log Files
Oracle Architecture
Transaction Example - Update
Oracle Architecture
Transaction Example - Update

1 ROW UPDATED
Oracle Architecture
Transaction Example - Update

SGA
- Shared Pool
- Database Buffer Cache
- Redo Log Buffer

Dedicated Server
- User Process

Commit Successful

Database Files
Redo Log Files

CKPT
SMON
PMON

Rollback Segment

DBWR
LGWR
Oracle Architecture
Transaction Example - Update

SGA

- Shared Pool
- Database Buffer Cache
- Redo Log Buffer

Components:
- CKPT
- SMON
- PMON

- Rollback Segment

Database Files

- DBWR
- LGWR

- Redo Log Files