Oracle Database Architecture

Welcome to the first module of this course Database Management System 2! For this lesson, we will review the Architecture of Oracle Database.

It is important to understand the 3 major parts of Oracle Architecture which id consist of: Memory Structure, Process Structure and Storage Structure

Architecture

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, even if it is not currently active; Information needed during program execution, for example, the current state of a query from which rows are being fetched; Information such as lock data that is shared and communicated among processes; and Cached data, such as data blocks and redo records, that also exists on disk. All of these scenarios are parts of Oracle Architecture.

After completing this lesson, the student should be able to:

- List the major architectural components of Oracle.
- Explain the memory structures.
- Describe the background processes.
- Compare the logical and physical storage structures.
- Describe ASM storage components.

What are Oracle Database Management System, Database and Database Server?

1. The Oracle **(RDBMS)** or also known as Relational Database Management System provides an open, comprehensive, integrated approach to information management.
   - The Oracle relational database management system (RDBMS) reliably manages a large amount of data in a multiuser environment so that many users can concurrently access the same data. This is accomplished while delivering high performance. At the same time, it prevents unauthorized access and provides efficient solutions for failure recovery.

2. An **Oracle database** is a collection of data treated as a unit. The purpose of a database is to store and retrieve related information.
3. A **database server** is the key to solving the problems of information management.

Process of Connecting to the Database Instance:

1. **Connection:** Communication between a user process and an instance.
   - A *connection* is a communication pathway between a user process and an Oracle Database instance. A communication pathway is established using available interprocess communication mechanisms (on a computer that runs both the user process and Oracle Database) or network software (when different computers run the database application and Oracle Database, and communicate through a network).

2. **Session:** Specific connection of a user to an instance through a user process.
   - A *session* represents the state of a current user login to the database instance. For example, when a user starts SQL*Plus, the user must provide a valid username and password, and then a session is established for that user. A

session lasts from the time a user connects until the user disconnects or exits the database application.
- Multiple sessions can be created and exist concurrently for a single Oracle database user using the same username. For example, a user with the username/password of ORACLE/ORACLE can connect to the same Oracle Database instance several times.

System Global Area (SGA)

- Group of shared memory structures, known as SGA components, that contain data and control information for one Oracle Database instance. The SGA is shared by all server and background processes. Examples of data stored in the SGA include cached data blocks and shared SQL areas.

System Global Area is composed of the following:

1. Shared Pool contains:
    - Library Cache
        - Shared SQL Area
    - Data Dictionary Cache
    - Control Structure
2. Data Buffer Cache
    - Is part of the SGA that holds copies of data blocks that are read from data files.
    - Is shared by all concurrent users
3. 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.
4. Large Pool

- Provides large memory allocations for: Session memory for the shared server and the Oracle XA I/O server processes
- Oracle Database backup and restore operations

5. Java 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
   - Store buffered queue messages
   - Provide memory for Oracle Streams processes

Program Global Area

The Program Global Area (PGA) is a private memory region containing data and control information for a server process.

Two Types of Process Architecture

1. User process

   - Is the application or tool that connects to the Oracle Database Processes
   - The term *user process* is used to refer to the user's application.

2. Server process:

   - Connects to the Oracle instance and is started when a user establishes a session
   - Server processes created on behalf of each user's application can perform one or more of the following:
     - Parse and run SQL statements issued through the application
     - Read necessary data blocks from data files on disk into the shared database buffers of the SGA (if the blocks are not already present in the SGA)

- Return results in such a way that the application can process the information

3. Background processes:
   - To maximize performance and accommodate many users, a multiprocess Oracle Database system uses some additional Oracle Database processes called *background processes*.
     - Are started when an Oracle instance is started.
       - Daemon / Application processes
       - Networking listeners
       - Grid infrastructure daemons

Process Structure is composed of:

1. Database Writer Process (DBWn)
   - Writes modified (dirty) buffers in the database buffer cache asynchronously while performing otheprocessing to advance the checkpoint.
2. Log Writer Process (LGWR)
   - Writes the redo log buffer to a redo log file on disk :
     - 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.
4. Checkpoint Process (CKPT)
   - Records checkpoint information in Control file on each data file header.
5. System Monitor Process (SMON)
   - Performs recovery at instance startup.
   - Cleans up unused temporary segments
6. 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

6. 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 transaction.
7. Archiver Processes (ARCn)
   - 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

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.

Tablespace and Data Files

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 Relational Database Management System is a relation of two or more dimensional table.
- Database is used to store data and information.
- Oracle Architecture is composed of 3 major Components:
  - Instance which establish the connection and initiate a session in Oracle Server.
  - Process Structure holds all the transaction made by the Database Administrator. Process Structure is composed of the following processes: Database Writer, Log Writer, Checkpoint, System Monitor , Process Monitor, Recoverer and Archiver Processes.
  - All of these processes hold a specific function with regards to managing all the transaction made by the DBA.

Lesson Summary:

- Oracle Relational Database Management System is a relation of two or more dimensional table.
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Glossary

- **Archiver Processes (ARCn) -** Copy redo log files to a designated storage device after a log switch has occurred
- **Background processes** – are started when an oracle instance is started.
- **Checkpoint Process (CKPT) -** Records checkpoint information in Control file on each data file header.
- **Connection –** also known as ommunication between a user process and an instance.
- **Database Writer Process (DBWn) -** Writes modified (dirty) buffers in the database buffer cache asynchronously while performing otheprocessing to advance the checkpoint.
- **Database server** – is the key to solving the problems of information management.
- **Data blocks** are mapped to disk blocks.
- **Data Buffer Cache –** part of the SGA that holds copies of data blocks that are read from data file.
- Extents are collections of data blocks.
- **Java Pool –** provide memory for Oracle Streams processes
- **Large Pool –** provide large memoryallocations for sessions memory for the shared server and the Oracle XA I/O server processes.
- **Log Writer Process (LGWR) -** Writes the redo log buffer to a redo log file on disk
- **Oracle database -** is a collection of data treated as a unit. The purpose of a database is to store and retrieve related information.
- **Process Monitor Process (PMON) -** Performs process recovery when a user process fails
- **Recoverer Process -** Used with the distributed database configuration.
- **Redo Log Buffer** – contains redo entries that have information to redo changes made by operations such as DML and DDL.
- **RDBMS -** or also known as Relational Database Management System provides an open, comprehensive, integrated approach to information management.

- Segments are collections of extents.
- **Session -** specific connection of a user to an instance through a user process.
- **Server process** - Connects to the Oracle instance and is started when a user establishes a session
- **System Monitor Process (SMON)** - Performs recovery at instance startup.
- **User process** – is the application or tool that connects to the Oracle Database processes.

References

Textbook:

- Oracle Database 11g 2nd Edition K Gopalakrishnan (2012)

References:

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- Connoly, Thomas & Begg, Carolyn (2010). Database Systems : A practical approach to design, implementation and management
- Sciore, Edward (2009). Database Design and Implementation
- Bulusu, Lakshman (2008). Oracle PL/SQL : Expert Techniques for Developers and Database Administrators
- Loshin, David (2008). Master Data Management

Other Suggested Readings (e.g. periodicals, articles, websites, IT applications/software, etc.):

- www.oracle.com
- www.apex.oracle.com
- SQL Tutorial. In ws3schools, Retrieved from http://www.w3schools.com/sql/default.asp

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