Memory Management and Memory Structures

Oracle Database Memory Management

Memory management - focus is to maintain optimal sizes for memory structures.
- Memory is managed based on memory-related **initialization parameters**.
- These values are stored in the init.ora file for each database.

Three basic options for memory management are as follows:
- **Automatic memory management**:
    o DBA specifies the target size for instance memory.
    o The database instance automatically tunes to the target memory size.
    o Database redistributes memory as needed between the SGA and the instance PGA.

- **Automatic shared memory management**:
    o This management mode is partially automated.
    o DBA specifies the target size for the SGA.
    o DBA can optionally set an aggregate target size for the PGA or managing PGA work areas individually.

- **Manual memory management**:
    o Instead of setting the total memory size, the DBA sets many initialization parameters to manage components of the SGA and instance PGA individually.

If you create a database with Database Configuration Assistant (DBCA) and choose the basic installation option, then automatic memory management is the default.

The memory structures include three areas of memory:
- System Global Area (SGA) – this is allocated when an Oracle Instance starts up.
- Program Global Area (PGA) – this is allocated when a Server Process starts up.

- User Global Area (UGA) – this is allocated when a user connects to create a session.

System Global Area

The **SGA** is a read/write memory area that stores information shared by all database processes and by all users of the database (sometimes it is called the **Shared Global Area**).
  - This information includes both organizational data and control information used by the Oracle Server.
  - The SGA is allocated in memory and virtual memory.
  - The size of the SGA can be established by a DBA by assigning a value to the parameter **SGA_MAX_SIZE** in the parameter file—this is an optional parameter.

The SGA is allocated when an Oracle instance (database) is started up based on values specified in the initialization parameter file (either PFILE or SPFILE).

The SGA has the following mandatory memory structures:
- Database Buffer Cache
- Redo Log Buffer
- Java Pool
- Streams Pool
- Shared Pool – includes two components:
  - Library Cache
  - Data Dictionary Cache
- Other structures (for example, lock and latch management, statistical data)

Additional optional memory structures in the SGA include:
- Large Pool

The **SHOW SGA** SQL command will show you the SGA memory allocations.
- This is a recent clip of the SGA for the DBORCL database at SIUE.

- In order to execute SHOW SGA you must be connected with the special privilege **SYSDBA** (which is only available to user accounts that are members of the DBA Linux group).

```
SQL> connect / as sysdba
Connected.
SQL> show sga

Total System Global Area 1610612736 bytes
Fixed Size                    2084296 bytes
Variable Size              1006633528 bytes
Database Buffers            587202560 bytes
Redo Buffers                14692352 bytes
```

Early versions of Oracle used a **Static SGA**. This meant that if modifications to memory management were required, the database had to be shutdown, modifications were made to the **init.ora** parameter file, and then the database had to be restarted.

Oracle 11g uses a **Dynamic SGA**.   Memory configurations for the system global area can be made without shutting down the database instance. The DBA can resize the Database Buffer Cache and Shared Pool dynamically.

Several initialization parameters are set that affect the amount of random access memory dedicated to the SGA of an Oracle Instance. These are:

- **SGA_MAX_SIZE**: This optional parameter is used to set a limit on the amount of **virtual memory** allocated to the SGA – a typical setting might be **1 GB**; however, if the value for SGA_MAX_SIZE in the initialization parameter file or server parameter file is less than the sum the memory allocated for all components, either explicitly in the parameter file or by default, at the time the instance is initialized, then the database ignores the setting for SGA_MAX_SIZE. For optimal performance, the entire SGA should fit in real memory to eliminate paging to/from disk by the operating system.
- **DB_CACHE_SIZE**: This optional parameter is used to tune the amount memory allocated to the Database Buffer Cache in standard database blocks. Block sizes vary among operating systems. The

DBORCL database uses **8 KB** blocks. The total blocks in the cache defaults to **48 MB** on LINUX/UNIX and **52 MB** on Windows operating systems.

- **LOG_BUFFER**: This optional parameter specifies the number of bytes allocated for the Redo Log Buffer.
- **SHARED_POOL_SIZE**: This optional parameter specifies the number of bytes of memory allocated to shared SQL and PL/SQL. The default is **16 MB**. If the operating system is based on a **64 bit** configuration, then the default size is **64 MB**.
- **LARGE_POOL_SIZE**: This is an optional memory object – the size of the Large Pool defaults to zero. If the init.ora parameter**PARALLEL_AUTOMATIC_TUNING** is set to **TRUE**, then the default size is automatically calculated.
- **JAVA_POOL_SIZE**: This is another optional memory object. The default is **24 MB** of memory.

The size of the SGA cannot exceed the parameter **SGA_MAX_SIZE** minus the combination of the size of the additional parameters, **DB_CACHE_SIZE**,**LOG_BUFFER**, **SHARED_POOL_SIZE**, **LARGE_POOL_SIZE**, and **JAVA_POOL_SIZE**.

Memory is allocated to the SGA as contiguous virtual memory in units termed granules. Granule size depends on the estimated total size of the SGA, which as was noted above, depends on the SGA_MAX_SIZE parameter. Granules are sized as follows:

- If the SGA is less than **1 GB** in total, each granule is **4 MB**.
- If the SGA is greater than **1 GB** in total, each granule is **16 MB**.

Granules are assigned to the Database Buffer Cache, Shared Pool, Java Pool, and other memory structures, and these memory components can dynamically grow and shrink. Using contiguous memory improves system performance. The actual number of granules assigned to one of these memory components can be determined by querying the database view named **V$BUFFER_POOL**.

Granules are allocated when the Oracle server starts a database instance in order to provide memory addressing space to meet the SGA_MAX_SIZE parameter. The minimum is 3 granules: one each for the fixed SGA, Database Buffer Cache, and Shared Pool. In practice, you'll find the SGA

is allocated much more memory than this. The SELECT statement shown below shows a current_size of 1,152 granules.

```
SELECT name, block_size, current_size, prev_size,
prev_buffers
FROM v$buffer_pool;


NAME                      BLOCK_SIZE CURRENT_SIZE   PREV_SIZE
PREV_BUFFERS
-------------------- ---------- ------------ ----------
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DEFAULT                        8192          560         576
        71244
```

For additional information on the dynamic SGA sizing, enroll in Oracle's *Oracle11g Database Performance Tuning* course.

Program Global Area (PGA)

A PGA is:
* a **nonshared** memory region that contains data and control information exclusively for use by an Oracle process.
* A PGA is created by Oracle Database when an Oracle process is started.
* One PGA exists for each **Server Process** and each **Background Process**. It stores data and control information for a single **Server Process** or a single**Background Process**.
* It is allocated when a process is created and the memory is scavenged by the operating system when the process terminates. This is **NOT** a shared part of memory – one PGA to each process only.
* The collection of individual PGAs is the **total instance PGA**, or **instance PGA**.
* Database initialization parameters set the size of the instance PGA, not individual PGAs.

The **Program Global Area** is also termed the **Process Global Area (PGA)** and is a part of memory allocated that is outside of the **Oracle Instance**.

PGA

Sort Area	Hash Area	Bitmap Merge Area	— SQL Work Areas
Session Memory	Persistent Area	Runtime Area	— Private SQL Area