DATABASE ADMINISTRATION

TI. Database Server Architecture

C2: Oracle Storage Structures

Plan

- 2. Operating Oracle Database Server Internals
  - 2.1 Structures of Oracle Instance
    - Server Processes, Background Processes, Internal Memory
  - 2.2 Oracle Instance life cycle
    - Starting and stopping stages, Oracle Instance Data Query Processing
  - **2.3 Oracle Database Storage Structures**
    - **Data Files, Tablespaces, Blocks and extents, Data Segments**
    - **Database creation process**
  - 2.4 Table storage
    - Table space allocation, Table segments, Clusters, Partitions
  - 2.5 Index storage
    - Index organization, Index space allocation, IO-Tables, Index Partitions

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2.3 Oracle Storage Model

- **Data Files** - using OS file system management;
- **Tablespaces** - covering one more datafiles to allocate storage for:
  - space of (business and data dictionary) tables and indexes;
  - *undo* data;
  - *temporary* data.
- **Data Blocks** - as storage and I/O memory pages;
- **Extents** - adjacent data blocks sets to be allocated to data objects (initial allocation and further space extension for tables and indexes);
- **Segments** - physical "print" (on disk) of data objects defined to database dictionary: object segment (table or index segment) will pile/heap all extends allocate to a data object.

Logical and physical storage structures
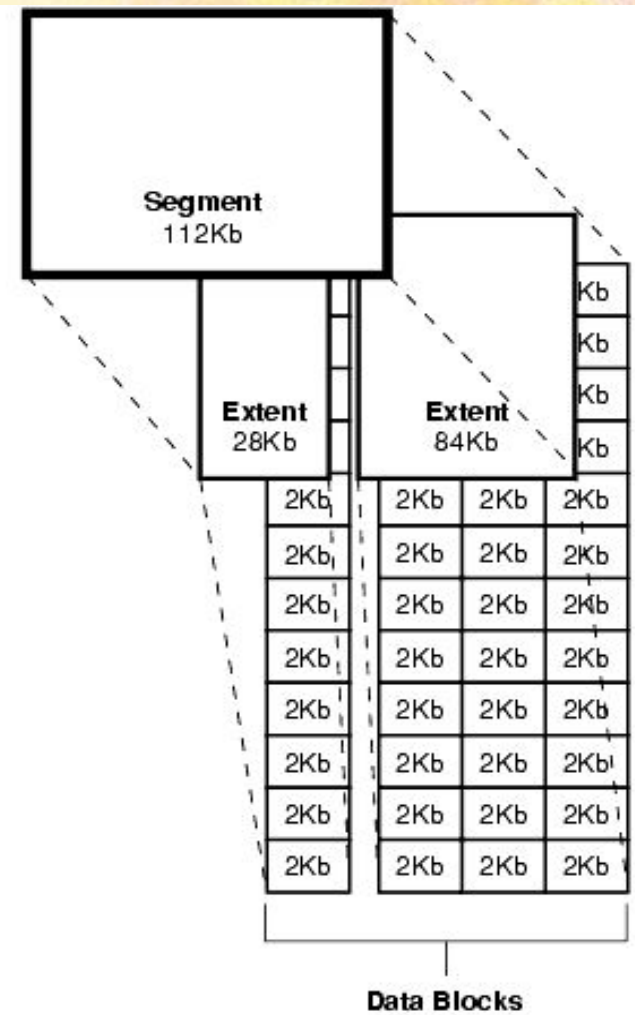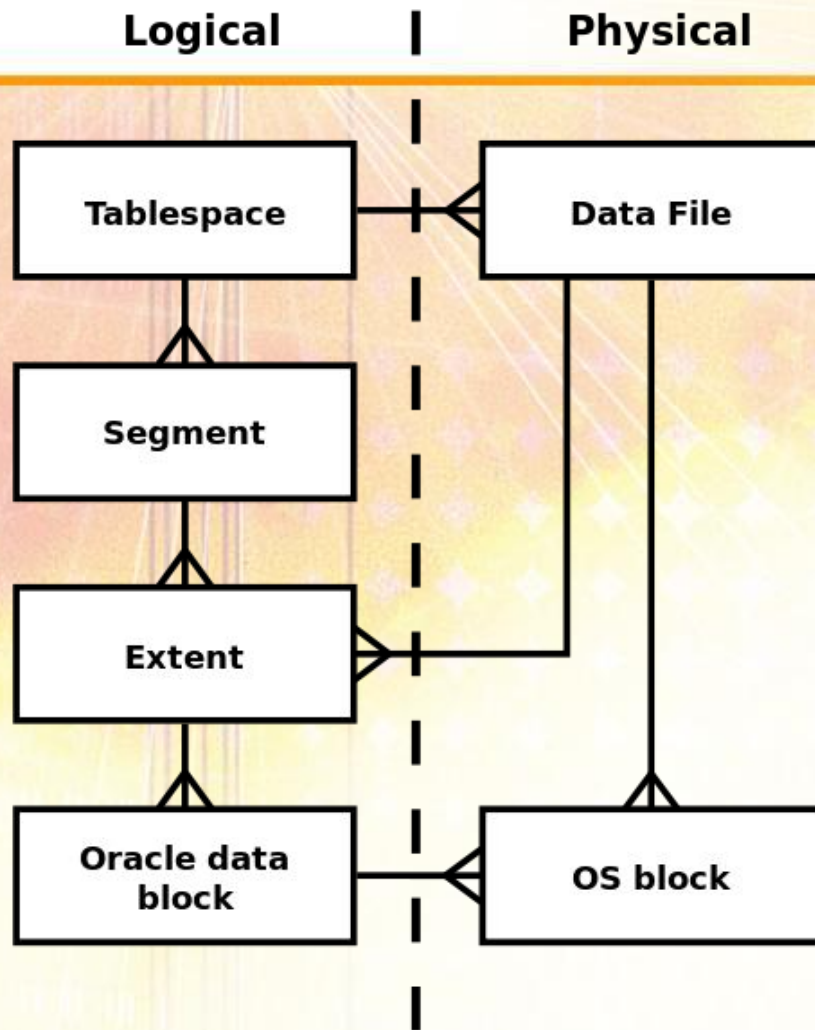
Oracle Data Blocks
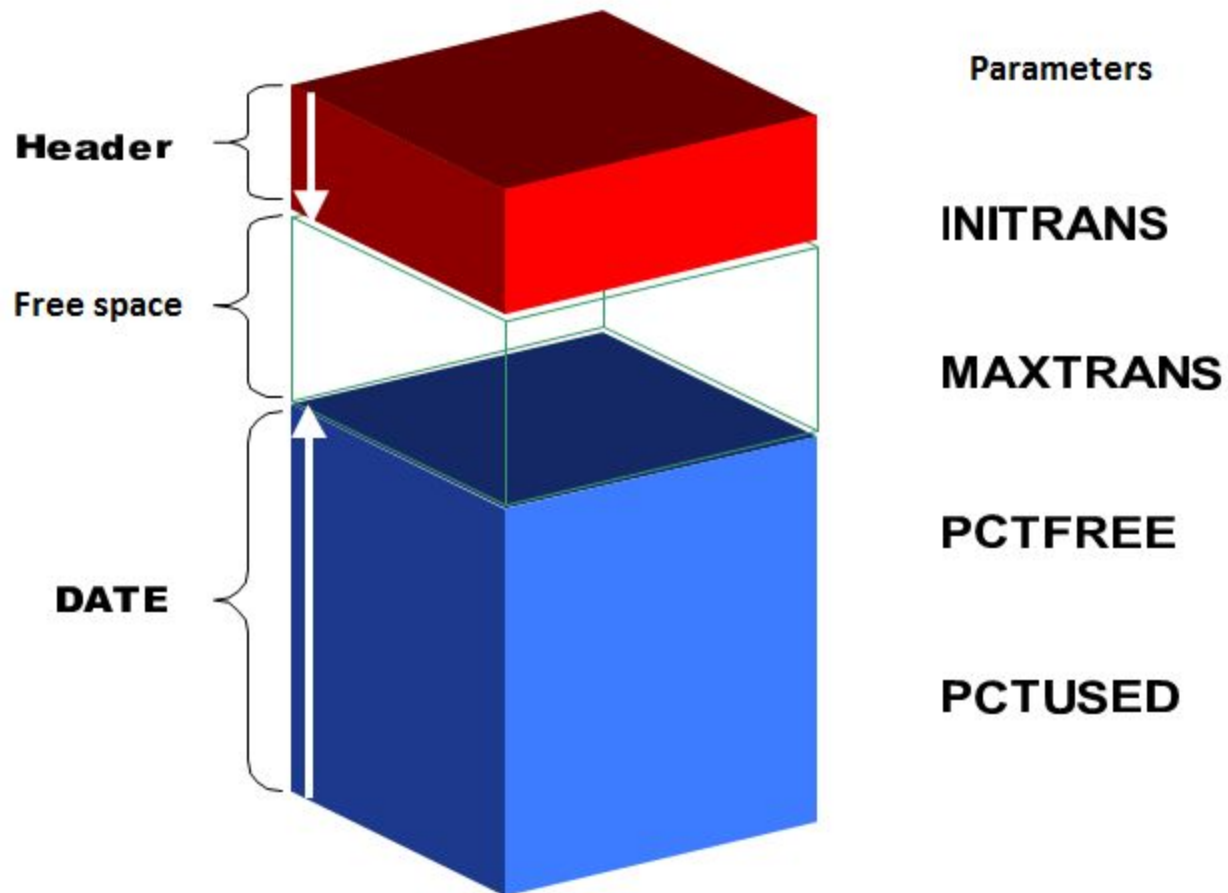
Oracle Database Creation Process
[Tool: DB Configuration Assistant]

- Creation process stages:
  - 1. DB Planning.
  - 2. Instance Creation.
  - 3. Instance Start-up.
  - 4. CREATE DATABASE command execution:
    - to create default tablespaces: SYSTEM, UNDO, TEMP and USERS.
  - 5. Data dictionary creation and PL/SQL environment initialization
    - with *catalog.sql* and *catproc.sql* scripts.
  - 6. UNDO segments creation.
  - 7. Additionally creation of other support structures.
- Process outcome:
  - OS Services and internal memory structures.
  - data files, control files, log files;
  - SYS schema owning database dictionary and PL/SQL environment libs;
  - admin default users: sys şi system.

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CREATE TABLESPACE Command

CREATE TABLESPACE
DATAFILE file_specification
[, file_specification
[AUTOEXTEND OFF]
or [AUTOEXTEND ON [NEXT number K or M]
[MAXSIZE UNLIMITED or MAXSIZE number K or M]]
[MINIMUM EXTENT number K or M]
[EXTENT MANAGEMENT LOCAL | DICTIONARY]
[SEGMENT SPACE MANAGEMENT AUTO | MANUAL]
[DEFAULT STORAGE ([INTIAL integer K|M] [NEXT integer K|M]
[MINEXTENTS integer] [MAXEXTENTS integer|UNLIMITED] [PCTINCREASE integer])]]
[ONLINE or OFFLINE]
[PERMANENT or TEMPORARY]

CREATE TABLESPACE DATA01
DATAFILE 'd:\oracle\u01data\disk4\data01.dbf' **SIZE** 2M
        'd:\oracle\u01data\disk4\data01.dbf' SIZE 2M
MINIMUM EXTENT 500K
DEFAULT STORAGE (INITIAL 500K NEXT 500K MAXEXTENTS 500 PCTINCREASE 0)

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TABLESPACES
Storage space management for data

- Tablespaces' space comes from (physical and permanent) storage devices (disks):
  - db storage space is allocated as datafiles specifically formatted into data blocks (data pages).

- Tablespace structures:
  - allow flexible storage management;
  - enable logical data structures' separation taking into consideration data nature and data destinations: as tables, indexes, undo data, temporary data;
  - allow to make the usual maintenance (data) operations (e.g. backup and recovery operations) avoiding blocking the database entirely.

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OFA: Optimal Flexible Architecture

- Base principles:
    - flexible and orderly OS directory structure;
    - separating objects with different data dature;
    - separating objects with different transactional behaviour;
    - separating database components by multiplexing using multiple physical storage disks.

SYSTEM
DATA
INDEXES
TOOLS
UNDO
TEMP

OFA Option: Oracle Managed Files [OMF]

- OMF refers to auto-management of OS paths for data files and redo-log files using these parameters:
  - DB_CREATE_FILE_DEST;
  - DB_CREATE_ONLINE_LOG_DEST_n – as redo-log group sequential number.
- Using OMF option CREATE TABLESPACE, CREATE DATABASE, ALTER DATABASE, ALTER TABLESPACE will mention only the STORAGE parameters and not the specific file-paths clauses.

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OFA Option: Locally Managed Tablespaces [LMT]
CREATE TABLESPACE with EXTENT MANAGEMENT LOCAL

- LMT refers to auto-management of free and allocated space distribution within tablespaces (the control-info concerning free and allocated extents) by using the specific CREATE TABLESPACE clause:
  - EXTENT MANAGEMENT LOCAL in opposition with
    - EXTENT MANAGEMENT DICTIONARY.

```
CREATE DATABASE ... EXTENT MANAGEMENT LOCAL ... ;


CREATE TABLESPACE userdata DATAFILE
    '%ORACLE_BASE%\oradata\u01\data03.DBF' SIZE 5M
    EXTENT MANAGEMENT LOCAL
    UNIFORM SIZE 250k;
```

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OFA Option: Auto Segment Space Management [ASSM] STORAGE with SEGMENT SPACE MANAGEMENT AUTO

- ASSM refers to to auto-management of free and allocated space distribution within data segment (the control-info concerning space usage of each data blocks) by using the specific CREATE TABLESPACE clause:
  - SEGMENT SPACE MANAGEMENT AUTO in opposition with
    - SEGMENT SPACE MANAGEMENT MANUAL.

```
CREATE TABLESPACE userdata DATAFILE
    '%ORACLE_BASE%\oradata\u01\data03.DBF' SIZE 5M
    EXTENT MANAGEMENT LOCAL UNIFORM SIZE 250k
    SEGMENT SPACE MANAGEMENT AUTO;
```

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TABLESPACE STORAGE PARAMETERS
[STORAGE Clause]

- **DEFAULT STORAGE – with LMT/ASSM (default uniform extent size: 1M)**
  - **INITIAL integer K|M**
  - **MINEXTENTS integer**
  - **MAXEXTENTS integer|UNLIMITED**

- DEFAULT STORAGE – no LMT/ASSM (no default extent size)
  - INTIAL integer K|M
  - NEXT integer K|M
  - MINEXTENTS integer
  - MAXEXTENTS integer|UNLIMITED
  - PCTINCREASE integer

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ALTER-ing TABLESPACE accessible state:

- ALTER TABLESPACE command options to change tablespace state:
  - entirely:
    - **OFFLINE**
      - NORMAL
      - IMMEDIATE
      - TEMPORARY
    - **ONLINE**
      - READONLY
      - READWRITE
  - partially at DATAFILE level.
    - OFFLINE [FOR DROP] - ALTER TABLESPACE ... DROP DATAFILE
    - ONLINE

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Practice C2_P1

Script	Topics
C2_P1.1.DB_CREATION.sql	CREATE DATABASE Commands: initial db structures
C2_P1.2.TABLESPACES.sql	Allocate storage space to database. Implement OFA.

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2.4 Storing SQL Tables
# Table storage structures

- Data Storage Types/Data Segment Types for SQL Data in tables and indexes:
    - Table Data Storage:
        - TABLE segments (conventional data storage);
        - CLUSTER segments;
        - TABLE PARTITION segments;
        - INDEX segments;
        - EXTERNAL file storage.
    - Index Data Storage:
        - INDEX segments;
        - INDEX PARTITION segments.

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HEAP Table Structures
(Conventional Table Segments)

■ **Heap-type tables** assume a random row storage determined by the Oracle default strategy to identify available blocks (free block lists) for INSERTs.

■ **Space allocation and usage** within TABLE segments is determined by:

   ■ STORAGE clause from CREATE TABLE (or CREATE TABLESPACE);

   ■ PCTUSED, PCTFREE of CREATE TABLE statement.

```
CREATE TABLE table
(column datatype [,column datatype ] …)
   [TABLESPACE tablespace]
   [PCTFREE integer][PCTUSED integer]
   [INITRANS integer][MAXTRANS integer]
   [STORAGE  storage-clause]
   [LOGGING | NOLOGGING] [CACHE | NOCACHE]
```

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Internal Organization of Table Data Blocks

Header

Column Size

Column Value

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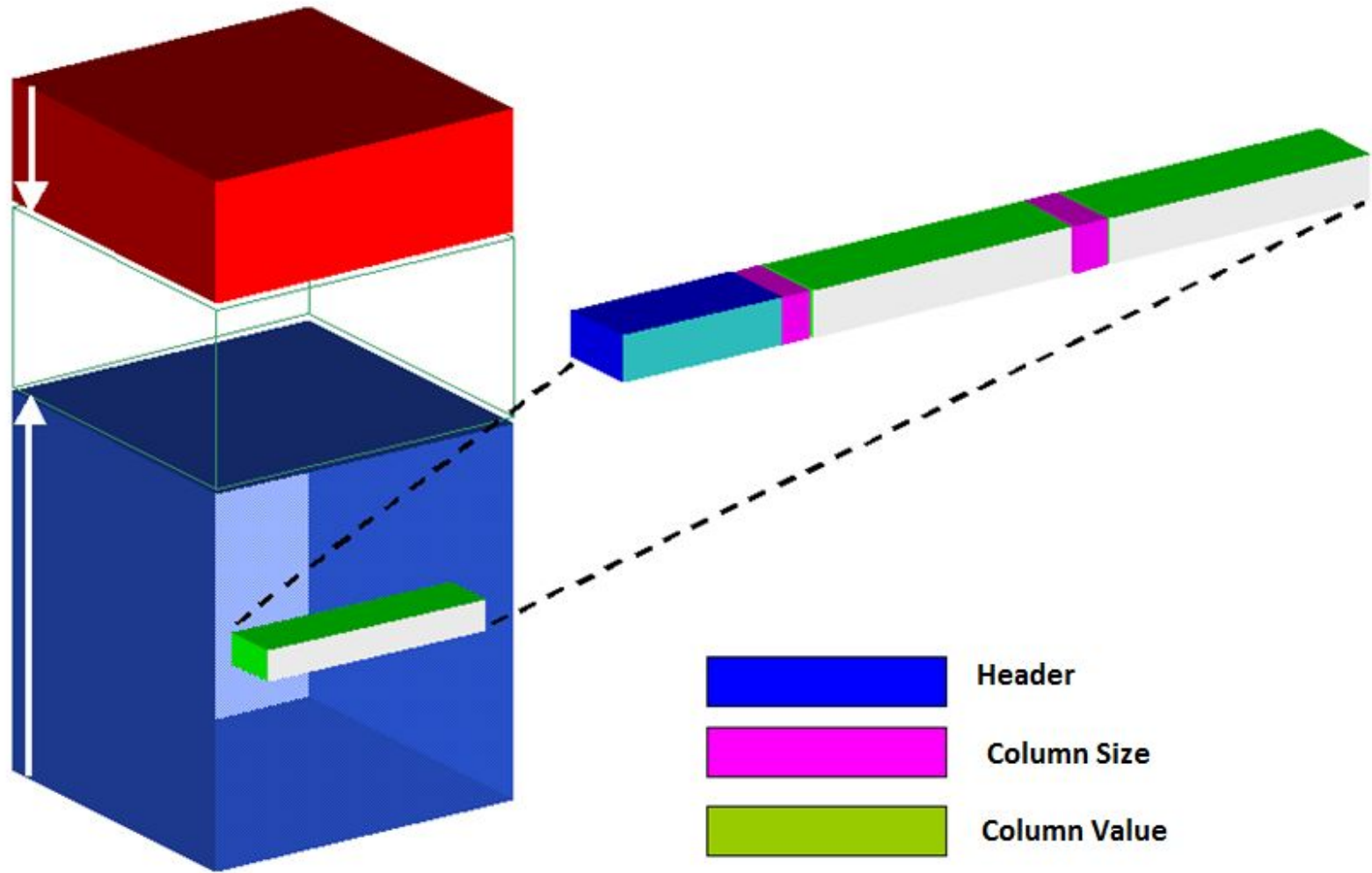
HIGH WATER MARK Factor
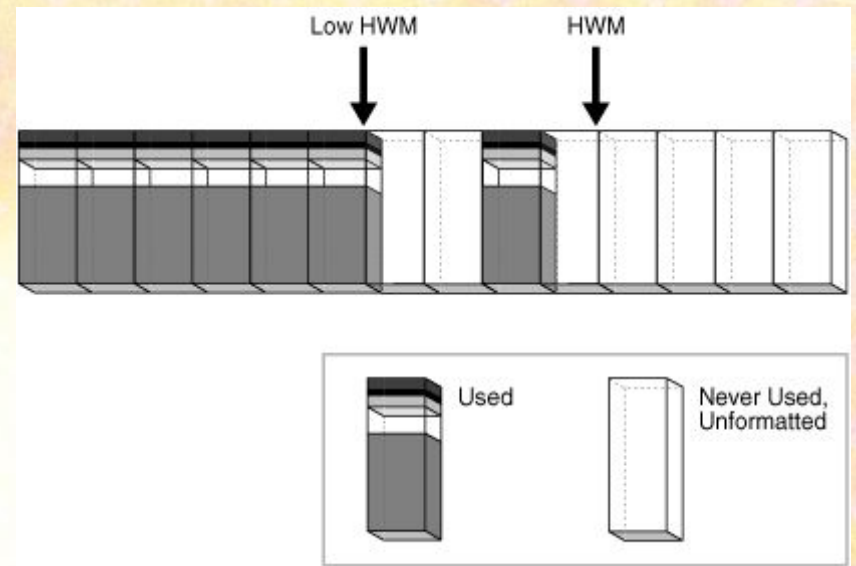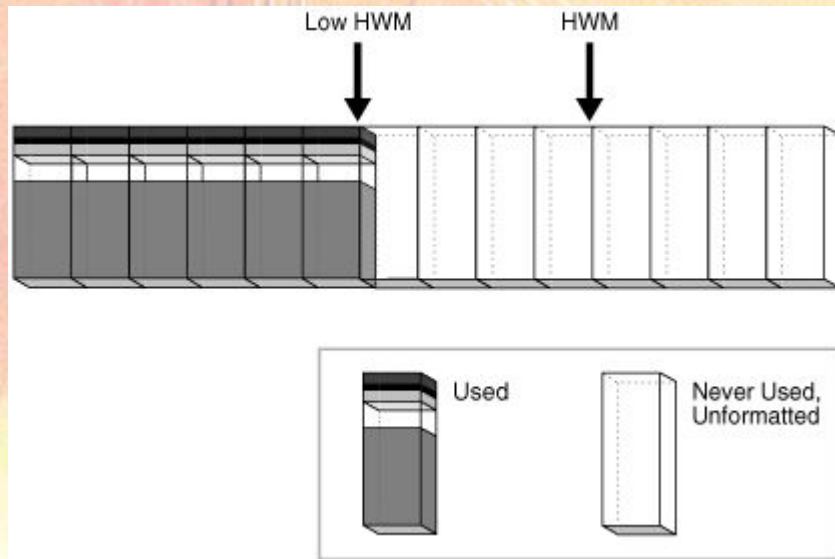
Physical Identification Mechanism of Table Rows: ROWID

- ROWID pseudo-column - hexadecimal structure:
  - Data Object Number;
  - Relativ File Number;
  - Block Number (within data file);
  - Row Number – row-slot sequential number from row catalog of block header.
- SELECT statement to get and decode ROWID:

```
SELECT  nrfact, ROWID,
    DBMS_ROWID.ROWID_OBJECT(ROWID) AS OBJECT,
    DBMS_ROWID.ROWID_RELATIVE_FNO(ROWID) AS "RELATIVE FILE",
    DBMS_ROWID.ROWID_BLOCK_NUMBER(ROWID) AS BLOCK
FROM FACTURI;
```

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Dictionary Views On Tables

DBA_TABLES

OWNER
TABLE_NAME
PCT_FREE
PCT_USED
INITIAL_EXTENT
NEXT_EXTENT
MIN_EXTENTS
MAX_EXTENTS
PCT_INCREASE
CACHE
BLOCKS
EMPTY_BLOCKS
CHAIN_CNT

DBA_OBJECTS

OWNER
OBJECT_NAME
OBJECT_ID
DATA_OBJECT_ID
CREATED

DBA_SEGMENTS

OWNER
SEGMENT_NAME
TABLESPACE_NAME
HEADER_FILE
HEADER_BLOCK

DBA_EXTENTS

OWNER
SEGMENT_NAME
EXTENT_ID
FILE_ID
BLOCK_ID
BLOCKS

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Practice C2_P2

Script	Topics
C2_P2.1.Base_Schema_CREATE_TABLE_OFA.sql	Recreate tables for OFA
C2_P2.2.Base_Schema_OFA_Stats.sql	Table buffer strategies

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References

Titles
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Lahdenmaki, Tapio, Leach, Michael, *Relational database index design and optimizers: DB2, Oracle, SQL server et al*, John Wiley & Sons, 2005
Bob Bryla, Kevin Loney *Oracle Database 11g DBA Handbook*, (Oracle Press), McGraw-Hill Osborne Media, 2008

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