Managing Tablespaces

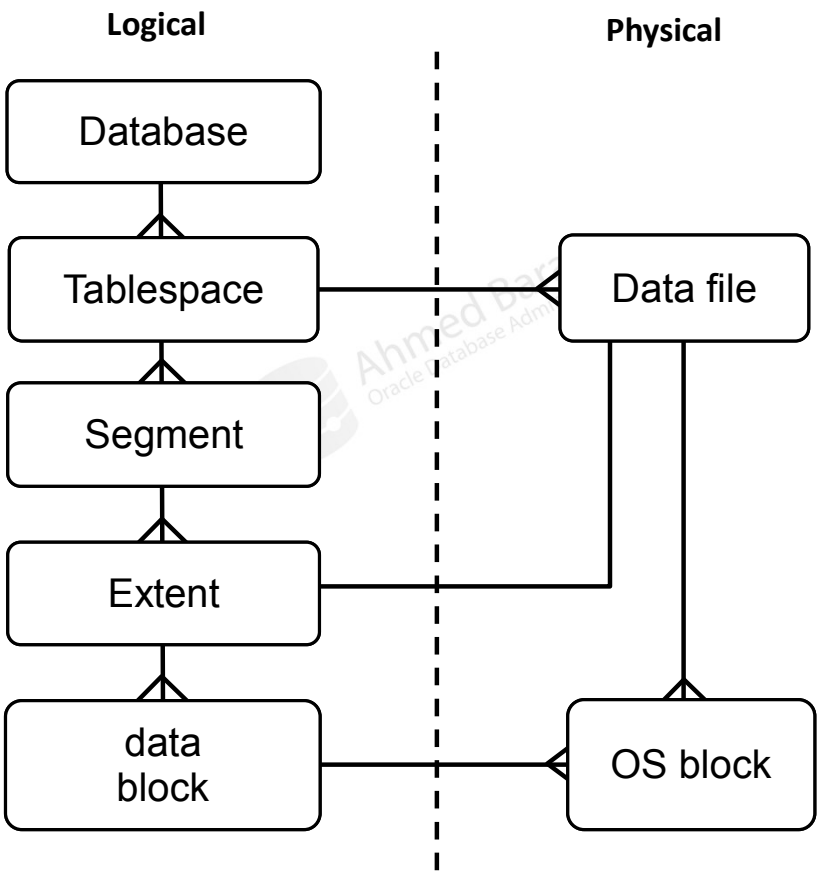
By Ahmed Baraka

Objectives

In this lecture, you will learn how to perform the following:

- Describe tablespace types
- Create permanent tablespaces
- Describe and enable Oracle-managed Files (OMF)
- Obtain information about tablespaces
- Enlarge tablespaces
- Drop tablespaces
- Create or move tables into tablespaces
- Describe and create Bigfile tablespaces
- Alter Tablespace availability
- Make tablespaces read-only or read-write
- Assign specific quota on tablespaces to users

Logical and Physical Database Structures



About Tablespaces

- A logical group of datafiles
- Tablespace types:
  - **SYSTEM**: basic to the functioning of the database server
  - **SYSAUX**: schemas used by various database components and features
  - **Undo**: contains undo records used for recovery and read consistency
  - **Temporary**: transient data that persists only for the duration of the session, such as session sort operations that do not fit into the memory
  - **Permanent (User)**: hosts application data
- Classification based on extent management:
  - **Dictionary managed** tablespaces (*deprecated*)
  - **Locally managed** tablespaces

Creating Permanent Tablespaces

- A simplified syntax:

```
CREATE TABLESPACE <tablespace-name>
[DATAFILE ['datafile fullpath'] [SIZE <size>] [REUSE]
 [AUTOEXTEND OFF | ON [NEXT <size>] [MAXSIZE UNLIMITED | <size>] ]
[EXTENT MANAGEMENT LOCAL [AUTOALLOCATE | UNIFORM SIZE <size>]]
[SEGMENT SPACE MANAGEMENT AUTO | MANUAL]
```

  - Default datafile size: 100M
  - **AUTOEXTEND** default: **ON** for OMF and **OFF** for user-managed
  - Default **NEXT**: the original datafile size or 100M whichever is smaller
- The provides syntax defines: datafile attributes, extent management attributes, and space management attributes.
- **CREATE TABLESPACE** system privilege is required

Maximum Possible Datafile Sizes for Data Block Sizes

Data Block Size	Maximum Datafile Size
2K	8G
4K	16G
8K	32G
16K	64G
32K	128G

Specifying Datafile Attribute Examples

```
CREATE TABLESPACE lmtbs DATAFILE '/u02/oracle/data/payrolltbs01.dbf'
SIZE 50M AUTOEXTEND ON NEXT 10M MAXSIZE 32G;
```

```
CREATE TABLESPACE lmtbs DATAFILE '/u02/oracle/data/statictbs01.dbf'
SIZE 10G AUTOEXTEND OFF;
```

Specifying Extent Management Options

- A simplified syntax:

Option	Description
AUTOALLOCATE	Extent sizes are automatically determined by the database
UNIFORM SIZE <size>	extents are created with uniform size (default 1 M)

- A tablespace with minimum extent size of 64K:

```
CREATE TABLESPACE lmtbsb DATAFILE '/u02/oracle/data/lmtbsb01.dbf'
SIZE 50M EXTENT MANAGEMENT LOCAL AUTOALLOCATE;
```

- A tablespace with uniform 128K extents:

```
CREATE TABLESPACE lmtbsb DATAFILE '/u02/oracle/data/lmtbsb01.dbf'
SIZE 50M EXTENT MANAGEMENT LOCAL UNIFORM SIZE 128K;
```

Specifying Segment Space Management

```
CREATE TABLESPACE <tbs-name>
..
[SEGMENT SPACE MANAGEMENT AUTO | MANUAL]
```

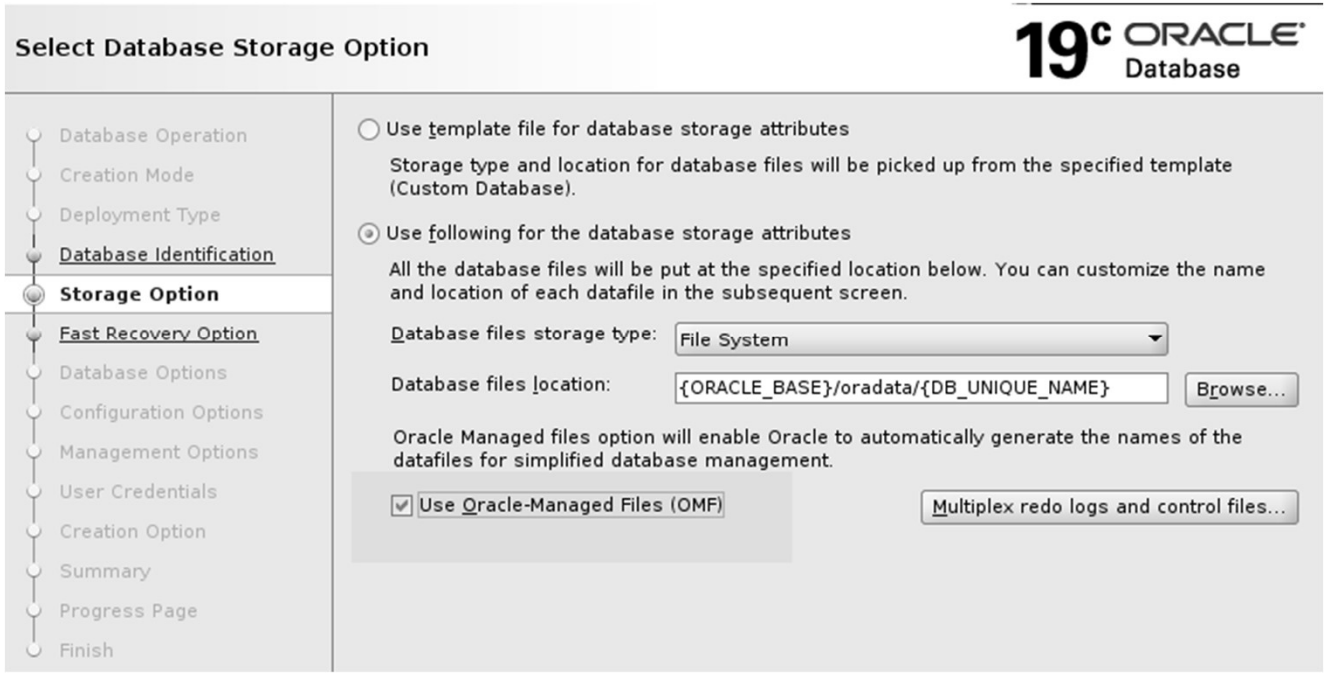
- Options:
  - **Automatic**: uses *bitmaps* to manage free space in the segment (this is called automatic segment space management or **ASSM**)
  - **Manual**: uses linked lists called "*freelists*" to manage free space in the segment
- Automatic is the default and more efficient

About Oracle-Managed Files (OMF)

- A set of options that controls the default locations for specific database files like: tablespace datafiles, redo log files, archived log files,..etc.
- We can have a mixture of OMF and non-OMF database files
- File names are automatically set
- Default datafile size: 100M, auto-extesible

Parameter	Description
`DB_CREATE_FILE_DEST`	Defines the location of the default file system directory for data files and temporary files (SYSTEM and SESSION modifiable)
`DB_CREATE_ONLINE_LOG_DEST_n`	Defines the location for redo log files and control file creation
`DB_RECOVERY_FILE_DEST`	Default location for the fast recovery area (FRA)

Enabling OMF in dbca



Creating Permanent Tablespace with OMF

- Enable OMF:

```
ALTER SYSTEM SET DB_CREATE_FILE_DEST = '/u01/app/oracle/oradata';
ALTER SESSION SET DB_CREATE_FILE_DEST = '/u01/app/oracle/oradata';
```

- Create tablespaces:

```
CREATE TABLESPACE hrtbs ;
CREATE TABLESPACE hrtbs SIZE 1G;
```


- For CDB, datafiles are created in the following directory path format:

```
<OMF>/<CDB DB name>/<pdb GUID>/datafile/<datafile name>.dbf
<OMF>/<$ORACLE_SID>/datafile/<datafile name>.dbf
```

Obtaining Information About Tablespace and Datafiles

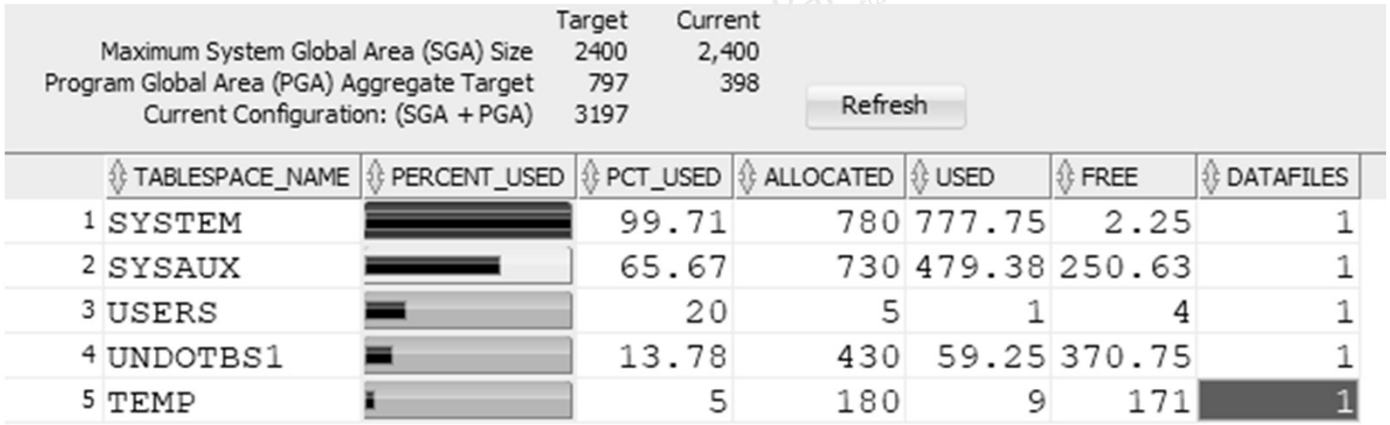
Clause	Description
`DBA_TABLESPACES`	Describes all tablespaces in the database.
`V$TABLESPACE`	Displays tablespace information from the control file.
`DBA_DATA_FILES`	Describes all the data files.
`V$DATAFILE`	Displays datafile information from the control file.
`DBA_TEMP_FILES`	Describes all temporary files (tempfiles) in the database.
`V$TEMPFILE`	Displays temp file information.

Obtaining Information About Tablespace Used and Free Space

```
SELECT F.TABLESPACE_NAME "Tablespace Name"
      ,F.TOTALSPACE "Size MB"
      , (F.TOTALSPACE - U.TOTALUSEDSPACE) "Free MB"
      ,ROUND (100 * ( (F.TOTALSPACE - U.TOTALUSEDSPACE) / F.TOTALSPACE)) || '%' "Free %"
      ,T.MAX_S "Max Size"
FROM   (SELECT   TABLESPACE_NAME, ROUND (SUM (BYTES) / (1024 * 1024)) TOTALSPACE
        FROM     DBA_DATA_FILES
        GROUP BY TABLESPACE_NAME) F
      ,(SELECT   TABLESPACE_NAME, ROUND (SUM (BYTES) / (1024 * 1024)) TOTALUSEDSPACE
        FROM     DBA_SEGMENTS
        GROUP BY TABLESPACE_NAME) U
      ,( SELECT TABLESPACE_NAME, ROUND (MAX_SIZE / (1024 * 1024)) MAX_S
        FROM     DBA_TABLESPACES) T
WHERE  F.TABLESPACE_NAME = U.TABLESPACE_NAME(+)
  AND  F.TABLESPACE_NAME = T.TABLESPACE_NAME;
```

Obtaining Information About Tablespaces Space Usage in SQL Developer

- Right-click on the connection node > select **Manage Database**
  - The free space is calculated based on the current tablespace **`SIZE`** and not the **`MAXSIZE`**



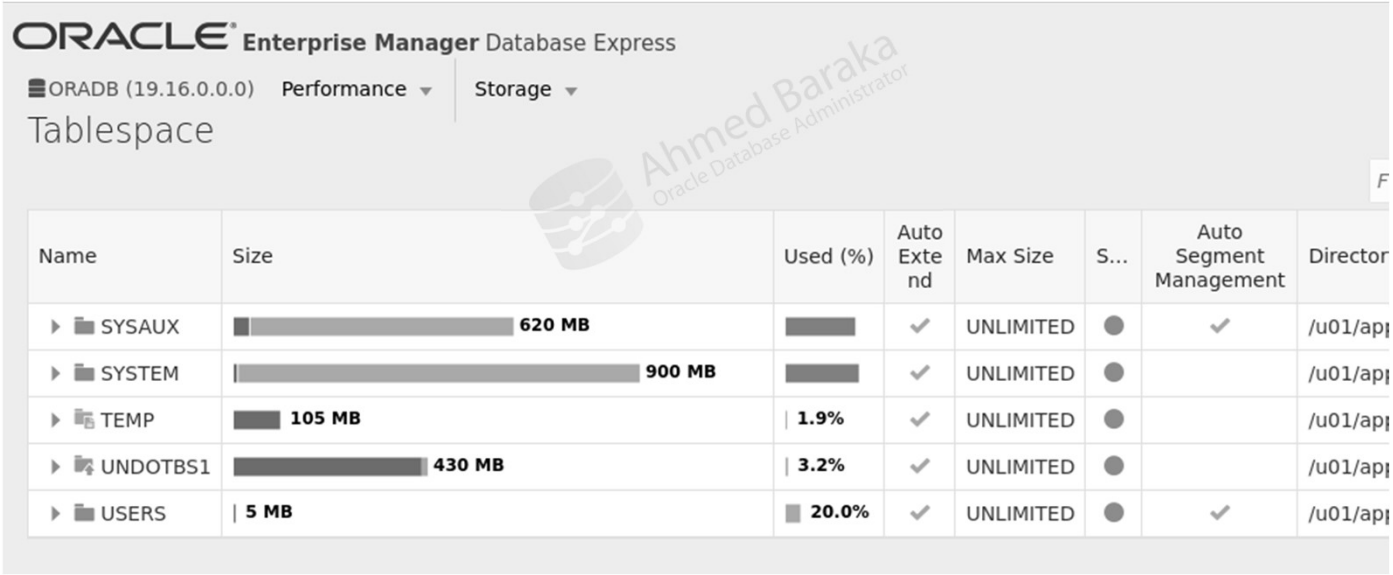
	Target	Current
Maximum System Global Area (SGA) Size	2400	2,400
Program Global Area (PGA) Aggregate Target	797	398
Current Configuration: (SGA + PGA)	3197	

Refresh

	TABLESPACE_NAME	PERCENT_USED	PCT_USED	ALLOCATED	USED	FREE	DATAFILES
1	SYSTEM		99.71	780	777.75	2.25	1
2	SYSAUX		65.67	730	479.38	250.63	1
3	USERS		20	5	1	4	1
4	UNDOTBS1		13.78	430	59.25	370.75	1
5	TEMP		5	180	9	171	1

Obtaining Information About Tablespaces in EM Express

- In the Home page > Performance > Performance Hub > Storage > Tablespace



Enlarging the Database

- Creating a new tablespace
- Adding a data file to an existing tablespace:

```
ALTER TABLESPACE hrbsb ADD DATAFILE;

ALTER TABLESPACE hrbsb ADD DATAFILE
'/u02/oracle/data/payrolltbs02.dbf'
SIZE 50M AUTOEXTEND ON NEXT 10M MAXSIZE 32G;
```

- Increasing the size of a data file

```
ALTER DATABASE DATAFILE 15 RESIZE 10240M;
```

- Enable the dynamic growth of a data file

Dropping Tablespaces

- Drop a tablespace, if the tablespace and its contents are no longer required:

```
DROP TABLESPACE <tbs name> [INCLUDING CONTENTS [AND DATAFILES ]]
```

- **DROP TABLESPACE** system privilege is required

Creating Tables in Tablespaces

- By default, tables are created in the owner's default tablespace
- Tables can be created in specific tablespaces (assuming the user has the required privileges on the target tablespace):

```
CREATE TABLE EMPLOYEES ( ... ) TABLESPACE HRTBS;
```

- An existing table can be moved to a different tablespace:
  - The *new* table might take less space than the original table

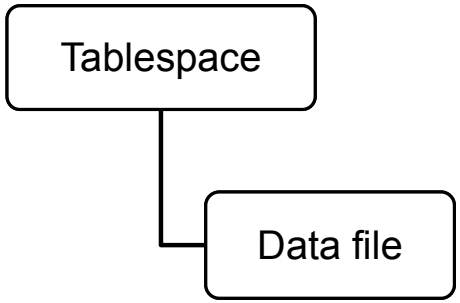
```
ALTER TABLE EMPLOYEES MOVE TABLESPACE HRTBS;
```

- To know which tablespace is table is saved in:

```
SELECT TABLESPACE_NAME FROM USER_TABLES WHERE TABLE_NAME='EMPLOYEES';
```

About Bigfile Tablespaces

- A permanent tablespace that is linked to a single datafile (usually very large).
  - For example: A bigfile tablespace with 8K blocks can contain a 32-terabyte data file



- Benefits:
  - Reduce number of datafiles for a database
  - Simplify managing so many datafiles
- The underlying filesystem should be able to accommodate the file size
  - Supported by logical volume managers that support stripping, like ASM
- The other tablespace type is called **small tablespace**.

Creating a Bigfile Tablespace

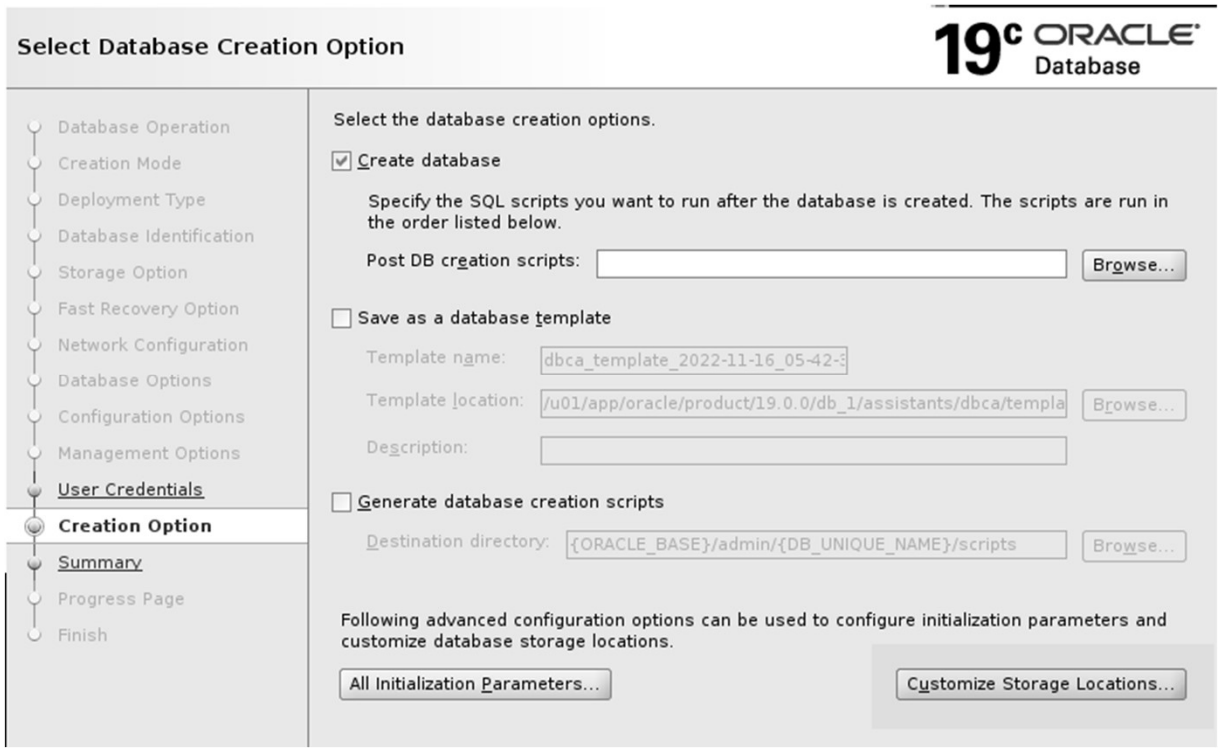
- Use the corresponding keyword:

```
CREATE [BIGFILE | SMALLFILE] TABLESPACE <tbs name> ...;
```

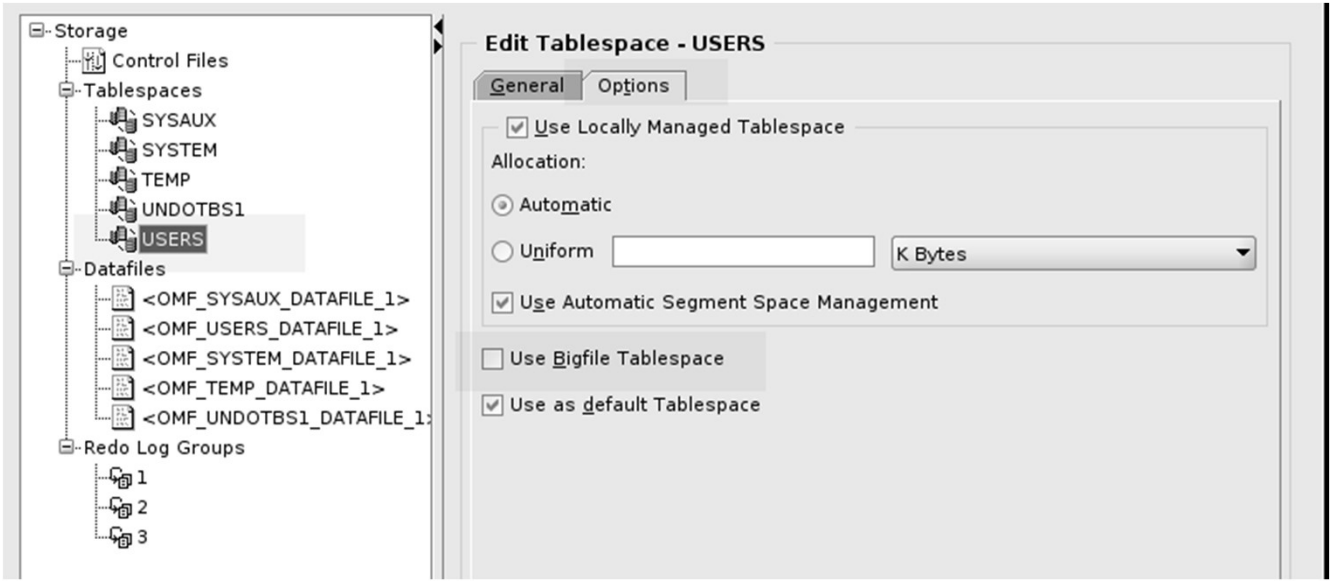
- The default tablespace type is set at database creation
- The **AUTOEXTEND** is by default turned off but you can enable it
- Can be identified by the column **BIGFILE** in the data dictionary views: ***_TABLESPACES** and **V$TABLESPACE**
- Example:

```
CREATE BIGFILE TABLESPACE bigtbs
DATAFILE '/u02/oracle/data/bigtbs01.dbf' SIZE 500G;
```

Supporting Bigfile Tablespaces During Database Creation



Supporting Bigfile Tablespaces During Database Creation



Specifying the Default Tablespace Type

- When creating the database manually:

```
CREATE DATABASE ... SET DEFAULT [ BIGFILE | SMALLFILE ] TABLESPACE
```

- To change it after database creation:

```
ALTER DATABASE SET DEFAULT BIGFILE TABLESPACE;
```

- Determine the current default tablespace type for the database:

```
SELECT PROPERTY_VALUE
FROM DATABASE_PROPERTIES
WHERE PROPERTY_NAME = 'DEFAULT_TBS_TYPE';
```

Using Bigfile Tablespaces Guide

- Consider it when:
  - The database size is in multi-TB
  - The underlying volume manager supports stripping, like Oracle ASM

Altering Tablespace Availability

- When a tablespace is taken offline, it becomes unavailable for general use
- We might need to make a tablespace offline:
  - To rename or relocate tablespace data file
  - To perform an offline tablespace backup
- You cannot take the following tablespaces offline:
  - **`SYSTEM`**
  - The undo tablespace
  - Temporary tablespaces

Altering Tablespace Availability

- To take a tablespace offline:
  - The database must be open

```
ALTER TABLESPACE <tbs-name> OFFLINE [NORMAL | TEMPORARY | IMMEDIATE]
```

Clause	Description
NORMAL	The database takes a checkpoint for all data files of the tablespace (**clean**)
TEMPORARY	The database takes offline the data files that are not already offline. The tablespace may require recovery before you can bring it back online.
IMMEDIATE	No checkpoint is taken on any data file. Media recovery for the tablespace is required before the tablespace can be brought online

- To take a tablespace online:

```
ALTER TABLESPACE <tbs-name> ONLINE;
```

Making Tablespaces Read-Only or Read-Write

- To make a tablespace read-only:

```
ALTER TABLESPACE mytbs READ ONLY;
```

- To make a tablespace writable:

```
ALTER TABLESPACE mytbs READ WRITE;
```

- To check if a tablespace is set to read-only operations, query the **`STATUS`** column in the view **`DBA_TABLESPACES`**

Assigning Specific Quota on Tablespaces to Users

- The tablespace quota defines how much space a user may take
- Can be set at the time of creating the users:

```
CREATE USER scott IDENTIFIED BY password
DEFAULT TABLESPACE data_ts
QUOTA 100M ON data_ts
QUOTA 10M ON index_ts ...
```


- Can be altered for existing users:

```
ALTER USER user1 QUOTA UNLIMITED ON data_tbs;
```

- Quota is needed even for default tablespace.
- If the quota is exceeded, the following error is returned:

```
ORA-1536 space quota exceeded for tables
```

About the `UNLIMITED TABLESPACE` Privilege

- To permit a user to use an unlimited amount of any tablespace in the database
  - The privilege overrides all explicit tablespace quotas for the user
  - We cannot selectively revoke tablespace access from a user
- It is better to use the **`QUOTA UNLIMITED`** option.

Managing Tablespace Guidelines

- Put application data and indexes in separate tablespaces
- Put static or read-mostly data in a separate tablespace
- Do not create user objects in the **`SYSTEM`** or **`SYSAUX`** tablespaces
- The underlying storage should support redundancy and fault-tolerance
- You must always monitor the tablespace space usage

Note: Some advanced tablespace settings have not been discussed in this lecture.

Summary

In this lecture, you should have learnt how to perform the following:

- Describe tablespace types
- Create permanent tablespaces
- Describe and enable Oracle-managed Files (OMF)
- Obtain information about tablespaces
- Enlarge tablespaces
- Drop tablespaces
- Create or move tables into tablespaces
- Describe and create Bigfile tablespaces
- Alter Tablespace availability
- Make tablespaces read-only or read-write
- Assign specific quota on tablespaces to users