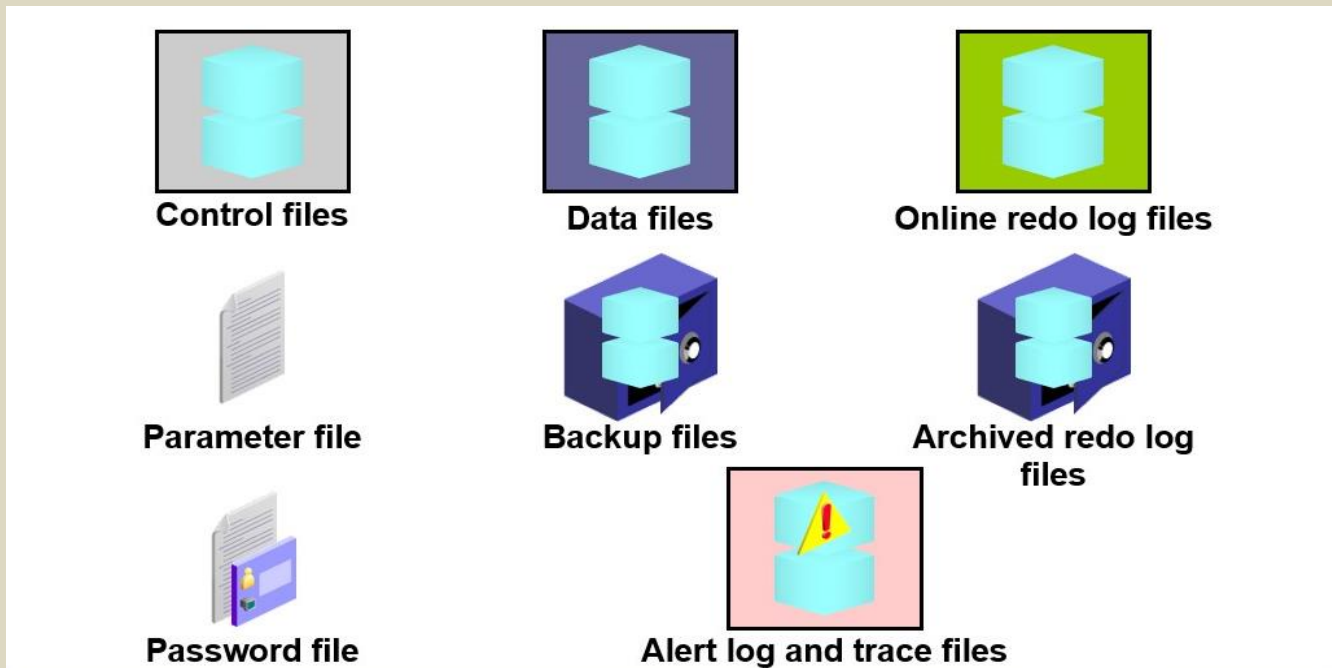


## ORACLE DATABASE STORAGE ARCHITECTURE



### Database Storage Architecture

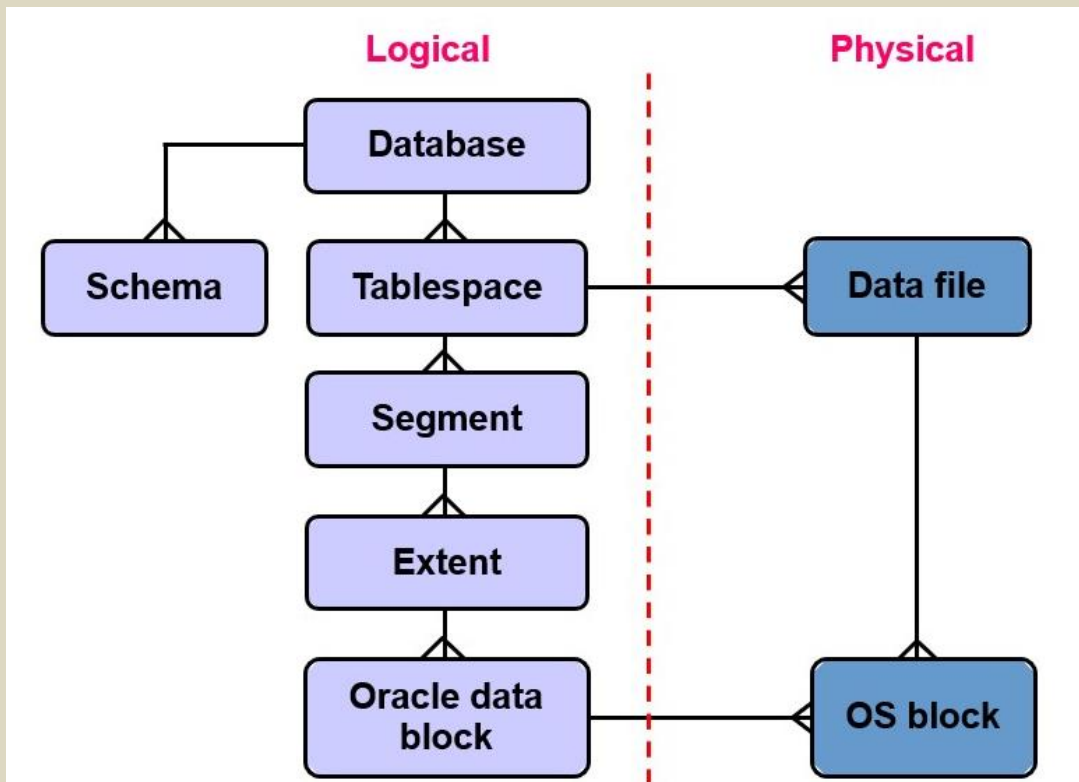
The files that constitute an Oracle database are organized into the following:

- **Control files:** Contain data about the database itself (that is, physical database structure information). These files are critical to the database. Without them, you cannot open data files to access the data in the database.
- **Data files:** Contain the user or application data of the database, as well as metadata and the data dictionary
- **Online redo log files:** Allow for instance recovery of the database. If the database server crashes and does not lose any data files, the instance can recover the database with the information in these files.

The following additional files are important to the successful running of the database:

- **Parameter file:** Is used to define how the instance is configured when it starts up
- **Password file:** Allows sysdba, sysoper, and sysasm to connect remotely to the database and perform administrative tasks
- **Backup files:** Are used for database recovery. You typically restore a backup file when a media failure or user error has damaged or deleted the original file.
- **Archived redo log files:** Contain an ongoing history of the data changes (redo) that are generated by the instance. Using these files and a backup of the database, you can recover a lost data file. That is, archive logs enable the recovery of restored data files.
- **Trace files:** Each server and background process can write to an associated trace file. When an internal error is detected by a process, the process dumps information about the error to its trace file. Some of the information written to a trace file is intended for the database administrator, whereas other information is for Oracle Support Services.
- **Alert log file:** These are special trace entries. The alert log of a database is a chronological log of messages and errors. Each instance has one alert log file. Oracle recommends that you review this periodically.

## SYSTEM and SYSAUX Tablespaces



### Logical and Physical Database Structures

The database has logical structures and physical structures.

### Tablespaces

A database is divided into logical storage units called *tablespaces*, which group related logical structures together. For example, tablespaces commonly group all of an application's objects to simplify some administrative operations. You may have a tablespace for application data and an additional one for application indexes.

### Databases, Tablespaces, and Data Files

The relationship among databases, tablespaces, and data files is illustrated in the slide. Each database is logically divided into one or more tablespaces. One or more data files are explicitly created for each tablespace to physically store the data of all logical structures in a tablespace. If it is a TEMPORARY tablespace instead of a data file, the tablespace has a temporary file.

### Schemas

A *schema* is a collection of database objects that are owned by a database user. Schema objects are the logical structures that directly refer to the database's data. Schema objects include such structures as tables, views, sequences, stored procedures, synonyms, indexes, clusters, and database links. In general, schema objects include everything that your application creates in the database.

### Data Blocks

At the finest level of granularity, an Oracle database's data is stored in *data blocks*. One data block corresponds to a specific number of bytes of physical database space on the disk. A data block size is specified for each tablespace when it is created. A database uses and allocates free database space in Oracle data blocks.

# ORACLE DATABASE STORAGE ARCHITECTURE

## Extents

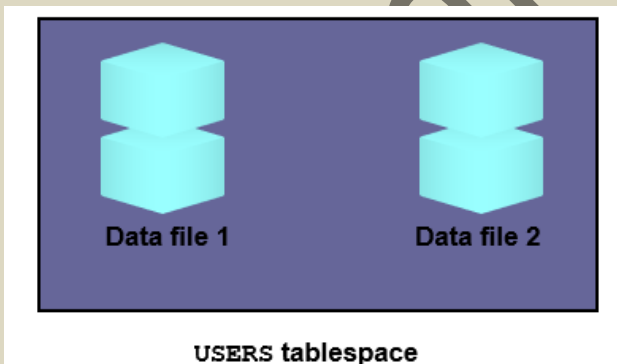
The next level of logical database space is an *extent*. An extent is a specific number of contiguous data blocks (obtained in a single allocation) that are used to store a specific type of information.

## Segments

The level of logical database storage above an extent is called a *segment*. A segment is a set of extents that are allocated for a certain logical structure. Different types of segments include:

- **Data segments:** Each nonclustered, non-index-organized table has a data segment, with the exception of external tables, global temporary tables, and partitioned tables in which each table has one or more segments. All of the table's data is stored in the extents of its data segment. For a partitioned table, each partition has a data segment. Each cluster has a data segment. The data of every table in the cluster is stored in the cluster's data segment.
- **Index segments:** Each index has an index segment that stores all of its data. For a partitioned index, each partition has an index segment.
- **Undo segments:** One UNDO tablespace is created for each database instance. This tablespace contains numerous undo segments to temporarily store undo information. The information in an undo segment is used to generate read-consistent database information and, during database recovery, to roll back uncommitted transactions for users.
- **Temporary segments:** Temporary segments are created by the Oracle database when a SQL statement needs a temporary work area to complete execution. When the statement finishes execution, the temporary segment's extents are returned to the instance for future use. Specify either a default temporary tablespace for every user, or a default temporary tablespace that is used database-wide.

The Oracle database dynamically allocates space. When the existing extents of a segment are full, additional extents are added. Because extents are allocated as needed, the extents of a segment may or may not be contiguous on the disk.



## Tablespaces and Data Files

A database is divided into *tablespaces*, which are logical storage units that can be used to group related logical structures. Each database is logically divided into one or more tablespaces. One or more data files are explicitly created for each tablespace to physically store the data of all logical structures in a tablespace.

**Note:** You can also create bigfile tablespaces, which have only one file that is often very large. The file may be any size up to the maximum that the row ID architecture permits. The maximum size is the block size for the tablespace multiplied by  $2^{36}$ , or 128 TB for a 32 KB block size. Traditional smallfile tablespaces (which are the default) usually contain multiple data files, but the files cannot be as large. For more information about bigfile tablespaces, see the *Oracle Database Administrator's Guide*.

## SYSTEM and SYSAUX Tablespaces

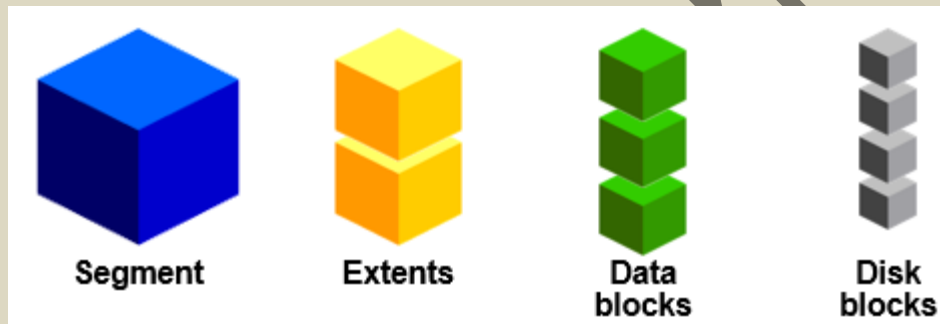
### SYSTEM and SYSAUX Tablespaces

Each Oracle database must contain a SYSTEM tablespace and a SYSAUX tablespace, which are automatically created when the database is created. The system default is to create a smallfile tablespace. You can also create bigfile tablespaces, which enable the Oracle database to manage ultralarge files (up to 8 exabytes in size).

A tablespace can be online (accessible) or offline (not accessible). The SYSTEM tablespace is always online when the database is open. It stores tables that support the core functionality of the database, such as the data dictionary tables.

The SYSAUX tablespace is an auxiliary tablespace to the SYSTEM tablespace. The SYSAUX tablespace stores many database components, and it must be online for the correct functioning of all database components.

**Note:** The SYSAUX tablespace may be offlined to do tablespace recovery, whereas this is not possible for the SYSTEM tablespace. Neither of them may be made read-only.



### Segments, Extents, and Blocks

Database objects such as tables and indexes are stored as segments in tablespaces. Each segment contains one or more extents. An extent consists of contiguous data blocks, which means that each extent can exist only in one data file. Data blocks are the smallest unit of I/O in the database.

When the database requests a set of data blocks from the operating system (OS), the OS maps this to an actual file system or disk block on the storage device. Because of this, you do not need to know the physical address of any of the data in your database. This also means that a data file can be striped or mirrored on several disks.

The size of the data block can be set at the time of database creation. The default size of 8 KB is adequate for most databases. If your database supports a data warehouse application that has large tables and indexes, a larger block size may be beneficial.

If your database supports a transactional application in which reads and writes are random, specifying a smaller block size may be beneficial. The maximum block size depends on your OS. The minimum Oracle block size is 2 KB; it should rarely (if ever) be used.

You can have tablespaces with a nonstandard block size. For details, see the *Oracle Database Administrator's Guide*.