Unit objectives

After completing this unit, you should be able to:

• Describe Db2
• List 4 types of SQL
• List SQL statements
• Understand Db2 Programming Language APIs
• Understand Db2 Structures
• Understand Active and Archive Logging
• List 4 Db2 bufferpool sizes
Relational Data Base Technology

A relational database allows you to easily find specific information.

It also allows you to sort based on any field and generate reports that contain only certain fields from each record. Relational databases use tables to store information.

The standard fields and records are represented as columns (fields) and rows (records) in a table.

Relational databases are created, updated and read using a special computer language, structured query language (SQL), that is the standard for database SQL is the foundation for all of the popular database applications available today.
Relational Data Base Technology

Edgar Frank "Ted" Codd invented the relational model for database management and the theoretical basis for relational databases while working for IBM.

While all relational databases follow Codd's theoretical basis, implementation differences exist between the various relational databases. As a result porting from one relational database platform to another relational database platform frequently requires some SQL adjustments.

The good news is that if you understand any specific relational database, then you can use that knowledge to quickly learn other relational database systems.
Db2 Concepts: Structured Query Language (SQL)

**Database Administrator (DBA)**
- **DDL** - Data Definition Language (Structures)
- **DCL** - Data Control Language (Security)

**Application Developer**
- **DML** - Data Manipulation Language
- **TCL** - Transactional Control Language
Db2 Concepts: Structured Query Language (SQL)

**DDL** - Data Definition Language
It is used to create and modify the structure of database objects in database.

Examples: **CREATE, ALTER, DROP** statements

**DCL** - Data Control Language
It is used to create roles, permissions, and referential integrity as well it is used to control access to database by securing it.

Examples: **GRANT, REVOKE** statements
Db2 Concepts: Structured Query Language (SQL)

**DML** - Data Manipulation Language.
It is used to retrieve, store, modify, delete, insert and update data in database.

Examples: **SELECT, UPDATE, INSERT** statements

**TCL** - Transactional Control Language.
It is used to manage different transactions occurring within a database.

Examples: **COMMIT, ROLLBACK** statements
### Db2 Application Programming

**Languages**
- COBOL
- Java
- C/C++
- REXX
- Assembler
- PL/I

**Application Program Interface (API)**

<table>
<thead>
<tr>
<th>EXEC SQL</th>
<th>select</th>
<th>insert</th>
<th>update</th>
</tr>
</thead>
<tbody>
<tr>
<td>DML</td>
<td>create</td>
<td>drop</td>
<td>alter</td>
</tr>
<tr>
<td>DDL</td>
<td>grant</td>
<td>revoke</td>
<td></td>
</tr>
<tr>
<td>DCL</td>
<td>commit</td>
<td>rollback</td>
<td></td>
</tr>
</tbody>
</table>
Db2 - Application Programming

Diagram:
- Modified Source
  - Compile
    - Object Module
      - Linkedit
        - Load Module
          - Source Program
            - Precompile
              - Include Member
                - DC1GEN
                  - DBRM
                    - Bind
                      - Package
                        - Bind
                          - Plan
                            - RUN
Db2 - Application Programming

Java application

DriverManager or DataSource

JDBC driver*

DRDA

Database server

*Java byte code executed under JVM
Db2 for z/OS Interfaces

Db2 tool set (3270 based)
  SPUFI
  DCLGEN
  Bind/Rebind
  Command Processor
  Utilities
  Defaults
  Administration
  Performance Expert
Control Center (GUI)
IDz (IDE) DB2 Workbench (GUI)
Data Studio (GUI)
Db2 for z/OS Disk Storage Allocation (volume)

z/OS controls many disk devices with unique volume labels

A Db2 created STOGROUP is assigned to use specific volume labels

z/OS Db2 DDL - CREATE STOGROUP name ADD VOLUME(......

z/OS Db2 DDL – ALTER STOGROUP name ADD|DELETE VOLUME(....

SYSDEFLT STOGROUP exists (best practice - never use it)

Each Database name is assigned to a STOGROUP
create database.tablespace is allocated on a volume from assigned STOGROUP

If DBA (SYSADM) creates databases without specifying STOGROUP, then database.tablespace will use SYSDEFLT (which may have little disk space)
zOS Db2 One Table per Tablespace (Best Practice)

While it is common to create many tables in a single LUW tablespace, Db2 for z/OS best practice is only one table per tablespace.

Yes – this means DDL needs to include:
CREATE TABLESPACE
   for every
CREATE TABLE

Negative performance impact is the result of multiple tables in a single tablespace in Db2 for z/OS environment.
Db2 for z/OS Tablespace Data Set Name

When a tablespace is created, a **VSAM** Linear Data Set is defined with the following data set name format:

\[\text{vcat.DSNDBC.dbname.tsname.y0001.z001} \quad (\text{Cluster name})\]
\[\text{vcat.DSNDBD.dbname.tsname.y0001.z001} \quad (\text{Data component of cluster})\]
\[\text{y0001.z001} \quad (\text{instance#. dataset #})\]
\[\text{tsname} \quad (\text{tablespace name})\]
\[\text{dbname} \quad (\text{database name})\]
\[\text{vcat} \quad (\text{typically an ‘alias’ in the master catalog})\]
Db2 for z/OS Data Structures

Storage group

Database

Table Space

Table

Index Space

Index

Views
Db2 for z/OS Data Structures

SMS managed storage (ACS routine)

volume label (s)

vcat.DSNDBC.dbname.tsname.**
  (table_name)

vcat.DSNDBC.dbname.ixsname.**
  (index_name)

Create Stogroup name

Create Database name

Create Tablespace name

Create Table name

Create Index name

Db2 Catalog (metadata)
1. Create Storage Group
   a. disk volumes specified
   b. catalog alias name (VCATNAME) specified
2. Create Database
   a. storage group specified
   b. buffer pool specified
3. Create Tablespace
   a. database name specified
   b. buffer pool specified
   c. primary and secondary disk space quantity specified
4. Create Table
   a. fields and respective data types specified
   b. database.tablespace specified to contain table
CREATE STOGROUP \textcolor{red}{ACCTDISK} VOLUMES (VPARC1) VCAT ACCOUNTS;

CREATE DATABASE ACCOUNTS STOGROUP \textcolor{red}{ACCTDISK} BUFFERPOOL BP0;
CREATE TABLESPACE **TS01** IN **ACCOUNTS**
USING STOGROUP ACCTDISK PRIQTY 20 SECQTY 20 ERASE NO
LOCKSIZE PAGE LOCKMAX SYSTEM
BUFFERPOOL BP0 CLOSE NO COMPRESS YES;

COMMIT;

CREATE TABLE ZIBM001.TBL01
  (ACCTNO CHAR(8) NOT NULL,
   LIMIT DECIMAL(9,2),
   BALANCE DECIMAL(9,2),
   SURNAME CHAR(20) NOT NULL,
   FIRSTN CHAR(15) NOT NULL,
   ADDRESS1 CHAR(25),
   ADDRESS2 CHAR(20),
   ADDRESS3 CHAR(15),
   RESERVED CHAR(7),
   COMMENTS CHAR(50),
   PRIMARY KEY(ACCTNO))
IN **ACCOUNTS**.**TS01**;
CREATE UNIQUE INDEX ZIBM001.XTBL01
  ON ZIBM001.TBL01 (ACCTNO   ASC)
  USING STOGROUP ACCTDISK PRIQTY 12 ERASE NO
  BUFFERPOOL BP0 CLOSE NO;
GRANT DBADM ON DATABASE ACCOUNTS TO PUBLIC;
GRANT USE OF STOGROUP ACCTDISK TO PUBLIC;
GRANT STATS ON DATABASE ACCOUNTS TO PUBLIC;
GRANT USE OF TABLESPACE ACCOUNTS.TS01 TO PUBLIC;
GRANT DELETE, INSERT, SELECT, UPDATE ON TABLE ZIBM001.TBL01 TO PUBLIC;
Db2 – DBA and Systems Programmer View

- System Parameters and Db2 ZPARMs
- JCL PROCLIB
- Boot Strap Data Set (BSDS)
- Active and Archive Logs
- Buffer Pools
- Distributed Data Facility (DDF)
- Db2 Directory (DSNDB01)
- Db2 Default Databases (DSNDB04)
- Db2 Catalog (DSNDB06)
PARMLIB (IEFSSNxx)
  DBCG,DSN3INI,'DSN3EP,-DBCG,S,DBC'

MVS command to start DB2 environment
-DBCG START DB2

DSNC10.NEW.SDSNSAMP(DSNTIJUZ)
DSNZPARM – aka ZPARMs global parameter values
JCL PROCLIB

**ssnmMSTR** - DB2 Master Facility

**ssnmDBM1** - DB2 Data Base Manager Facility

**ssnmDIST** - DB2 Distributed Data Facility

**ssnmIRLM** - DB2 Lock Manager Facility

**ssnmWLMx** - DB2 Work Load Manager Facility

where **ssnm** (subsystem name) is selected during installation process.

```
//DBCGMSTR  PROC
//IEFPROC    EXEC  PGM=DSNYASCP,PARM='ZPARM(DSNZPARM)'
//STEPLIB    DD    DISP=SHR,DSN=DSNC10.DB9G.SDSNEXIT
//           DD    DISP=SHR,DSN=DSNC10.SDSNLOAD
//BDS1       DD    DISP=SHR,DSN=DSNC10.DBCG.BSDS01
//BDS2       DD    DISP=SHR,DSN=DSNC10.DBCG.BSDS02
```
Boot Strap Data Set (BSDS)

The bootstrap data set (BSDS) is a VSAM key-sequenced data set (KSDS) that contains information critical to Db2. Specifically, the BSDS contains an inventory of all active and archive log data sets known to Db2. Db2 uses this information to track the active and archive log data sets.

Db2 also uses this information to locate log records to satisfy log read requests during normal Db2 system activity and during restart and recovery processing.
Active log data sets record significant events and data changes.

Active log data sets are periodically offloaded to the archive log.

Therefore, the storage requirements for your active log data sets depend on how often Db2 data is changed at your site and how often Db2 offloads those changes to the archive log.
Buffer pools are areas of virtual storage in which DB2 temporarily stores pages of table spaces or indexes.

When an application program accesses a row of a table, DB2 retrieves the page containing that row and places the page in a buffer.

If the needed data is already in a buffer, the application program does not have to wait for it to be retrieved from disk, significantly reducing the cost of retrieving the page.

Buffer pools require monitoring and tuning.

The size of buffer pools is critical to the performance characteristics of an application or group of applications that access data in those buffer pools.
80 virtual buffer pools

50 4K page buffer pools
  BP0–BP49

10 8K page buffer pools
  BP8K0–BP8K9

10 16K page buffer pools
  BP16K0–BP16K9

10 32K page buffer pools
  BP32K0–BP32K9

-DBCG DISPLAY BUFFERPOOL(BP0)
DSNB401I -DB9G BUFFERPOOL NAME BP0, BUFFERPOOL ID 0, USE COUNT 10
DSNB402I -DB9G BUFFER POOL SIZE = 20000 BUFFERS AUTOSIZE = NO
  ALLOCATED = 20000 TO BE DELETED = 0
  IN-USE/UPDATED = 0 BUFFERS ACTIVE = 120

-DBCG DISPLAY BUFFERPOOL(BP1)
DSNB401I -DB9G BUFFERPOOL NAME BP1, BUFFERPOOL ID 1, USE COUNT 0
DSNB402I -DB9G BUFFER POOL SIZE = 0 BUFFERS AUTOSIZE = NO
  ALLOCATED = 0 TO BE DELETED = 0
  IN-USE/UPDATED = 0 BUFFERS ACTIVE = 0
-DBCG DISPLAY DDF

DSNL080I -DBCG DSNLTDDDF DISPLAY DDF REPORT FOLLOWS:
DSNL082I LOCATION LUNAME
DSNL083I DALLASC USASDV02.DBCGLU1
DSNL084I TCPPORT=5040 SECPORT=0 RESPORT=5041
DSNL085I IPADDR=:192.86.32.67
DSNL086I SQL DOMAIN=S0W1.DAL-EBIS.IHOST.COM
Starting Db2 for z/OS

-DB9G START DB2

S DB9GMSTR
$HASP373 DB9GMSTR STARTED
DSNY024I -DB9G DSNYASCP MSTR INITIALIZATION IS STARTING
DSNZ002I -DB9G DSNZINIT SUBSYSTEM DB9G SYSTEM PARAMETERS LOAD MODULE
NAME IS DB9GPARM

S DB9GIRLM
$HASP373 DB9GIRLM STARTED
DXR117I DJ9G001 INITIALIZATION COMPLETE
DSNY001I -DB9G SUBSYSTEM STARTING
DSNJ127I -DB9G SYSTEM TIMESTAMP FOR BSDS= 10.055 08:31:11.86
DSNJ001I -DB9G DSNJW007 CURRENT COPY 1 ACTIVE LOG
DATA SET IS DSN910.DB9G.LOGCOPY1.DS01,
STARTRBA=0003C1E00000,ENDRBA=0003C3FBFFFF
DSNJ099I -DB9G LOG RECORDING TO COMMENCE WITH
STARTRBA=0003C23CD000

S DB9GDBM1
$HASP373 DB9GDBM1 STARTED
DSNY024I -DB9G DSNYASCP DBM1 INITIALIZATION IS STARTING

S DB9GDIST
$HASP373 DB9GDIST STARTED
DSNY024I -DB9G DSNYASCP DIST INITIALIZATION IS STARTING
DSNR001I -DB9G RESTART INITIATED
## Db2 for z/OS in EXECUTION

SDSF STATUS DISPLAY ALL CLASSES

PREFIX=DB*  DEST=(ALL)  OWNER=*  

<table>
<thead>
<tr>
<th>NP</th>
<th>JOBNAME</th>
<th>JobID</th>
<th>Owner</th>
<th>Prty</th>
<th>Queue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DB9GDIST</td>
<td>STC01095</td>
<td>STCOPER</td>
<td>15</td>
<td>EXECUTION</td>
</tr>
<tr>
<td></td>
<td>DB9GDBM1</td>
<td>STC01094</td>
<td>STCOPER</td>
<td>15</td>
<td>EXECUTION</td>
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<tr>
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<td>DB9GIRLM</td>
<td>STC01093</td>
<td>STCOPER</td>
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<td>DB9GMSTR</td>
<td>STC01092</td>
<td>STCOPER</td>
<td>15</td>
<td>EXECUTION</td>
</tr>
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</table>
Db2 Professional Manuals and Documentation

Db2 12 for z/OS Product Documentation

IBM DB2 12 for z/OS Technical Overview
Unit summary

Having completed this unit, you should be able to:

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- List 4 types of SQL
- List SQL statements
- Understand Db2 Programming Language APIs
- Understand Db2 Structures
- Understand Active and Archive Logging
- List 4 Db2 bufferpool sizes