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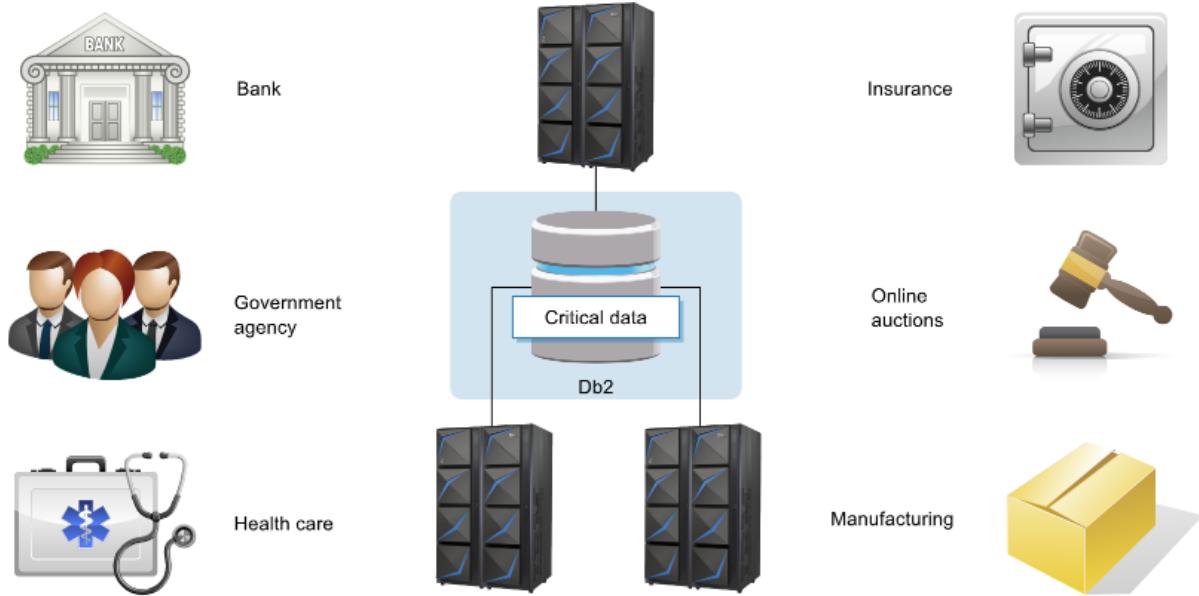
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Overview of DB2

Reality of Digital Data

It is estimated that the amount of digital data increases at a rate of 60% each year. With 80% of the world's data processed by mainframes, organizations need to ensure that their data is stored securely and that it can be accessed reliably and quickly.



Organizations such as banks, health care, insurance and government departments need to be able to share their data between sites and applications and have it available 24 hours a day.

Introducing DB2

Many of the organisations mentioned above have turned to DB2 to manage their data. Today's DB2 can be run on a variety of platforms, but the majority of information in these notes will focus on DB2 for z/OS, which combines a robust relational database (DB2) with the dependability of the mainframe (z/OS).

Within this structure, data can be made extremely secure, while providing the organisation with continuous availability of data and a scalable solution for future data growth.

Some examples of data issues faced by organisations:

- **Banks** - May be dealing with new financial reforms requiring it to store additional records and produce new reports.
- **Health Care** - May have recently acquired a previous competitor, whose data systems are in a different format and are more geographically spread.
- **Government Agency** - May be looking to reduce energy costs and improve operational efficiency, the availability of data and access times to it.
- **Online Auctions** - May be consolidating the IT systems that are currently running different operating systems on various hardware platforms.

Advantages of DB2 for z/OS

DB2 by itself provides you with a data structure that:

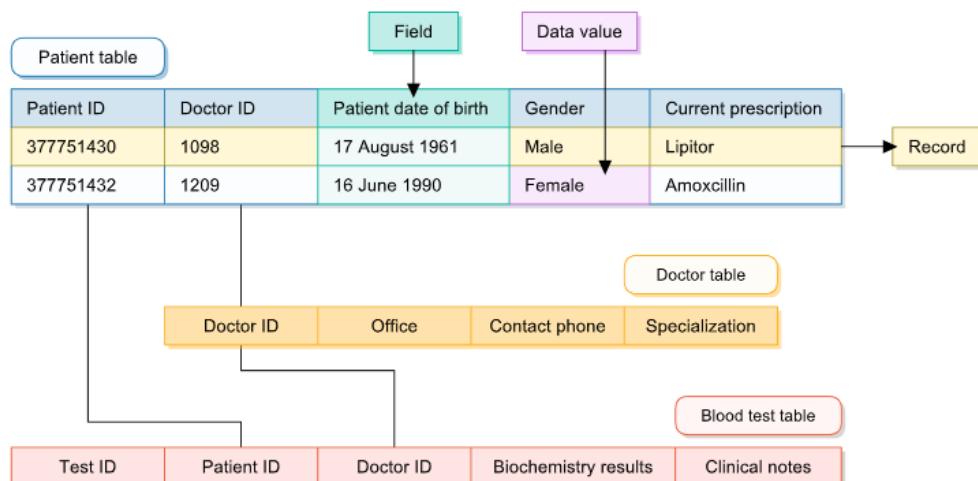


- Is easy to understand. Data from DB2 databases is presented to users in table-like format. This is one of the more familiar ways of displaying data, used in, for example, telephone books and transport timetables.
- Allows design flexibility. A table of data is relatively easy to design. All you need to know are the key components of your database, such as Name, Address and Telephone number.
- Provides ease of access. The user is shielded from the internal workings of Db2. Therefore, the user does not need to know the physical relationships of the database they are accessing.

DB2 - A Relational Database

Db2 itself is a relational database, which is basically a collection of related data that is stored in multiple tables that can be reassembled to form meaningful user data.

The example displayed here shows a simple relational database structure for a healthcare organization. Three tables are displayed that contain doctor, patient, and blood test results. In reality there would be anywhere between ten and a thousand tables for this type of organization. The columns of each table form field names, while a row of data values forms a specific record.



Accessing DB2 Data

The data stored in Db2 is accessed using SQL, which is a computer language specifically designed to communicate with relational databases. SQL is both simple and powerful, since a single SQL statement can generate an entire report, which would take numerous lines of conventional programming code.

As an example, if you wanted to list all doctors and sort them by the office they work in, you would need to access the Doctor table using the following SQL statement:

```
SELECT * FROM DOCTOR  
ORDER BY OFFICE;
```

SQL statements can be invoked from a number of sources if the appropriate interface software to Db2 has been installed. Common z/OS environment interfaces include:

- **TSO** - Allows you to interact with DB2 using the TSO attachment facility, the call attachment facility (CAF), and the Resource Recovery Services (RRS) attachment facility.
- **Batch** - Batch jobs accessing DB2 data use the same attachment facilities as those mentioned for TSO.
- **CICS** - The CICS Transaction Server provides access to DB2 through the CICS attachment facility.
- **IMS** - This is a hierarchical database and information management system that can access DB2 data using the IMS attachment facility.
- **WebSphere** - A suite of WebSphere products have been designed to be able to access DB2 data using the Resource Recovery Services (RRS) attachment facility.

You can also start Db2 sessions from other environments on clients such as Microsoft Windows or UNIX by using interfaces like ODBC, JDBC, and SQLJ.

DB2 - Users

If a problem occurs with Db2, it may be your responsibility to identify the person it is escalated to, so it is important to understand the functions performed by IT personnel who interact with DB2.

- **Application Developer** - This person is responsible for all phases of development and maintenance associated with the development of DB2 related applications.
- **Database Administrator** - This person is responsible for the logical and physical design of databases, and implementation of those databases to support the business applications. They may also be involved in monitoring DB2 space usage and database performance.
- **DB2 Systems Programmer** - This person is usually responsible for the installation, upgrade and migration of the DB2 subsystem and related software. They may also be responsible for performance monitoring and tuning as well as reporting and resolving software issues.
- **Computer Operator** - This person monitors the overall computing system, including DB2. They may be responsible for starting and stopping the database or subsystem and responding to system messages produced by this product.

DB2 - User Groups

If you are working with DB2, then there are a considerable range of options available to keep up to date with DB2 developments and interact with people.

User groups, and their websites and resources, can benefit you by expanding your resource pool and provide you with exposure to technical personnel with common areas of interest.

The International DB2 Users Group is one such organization, whose website contains information on conferences, blogs, and webcasts.

Many individual states have formed their own DB2 user groups, making it easier to attend meetings and meet people face to face.

DB2 - Publications

There are a number of sources that provide DB2 users with publications such as technical user guides, useful tips, case studies, and general articles on various DB2 products and utilities.

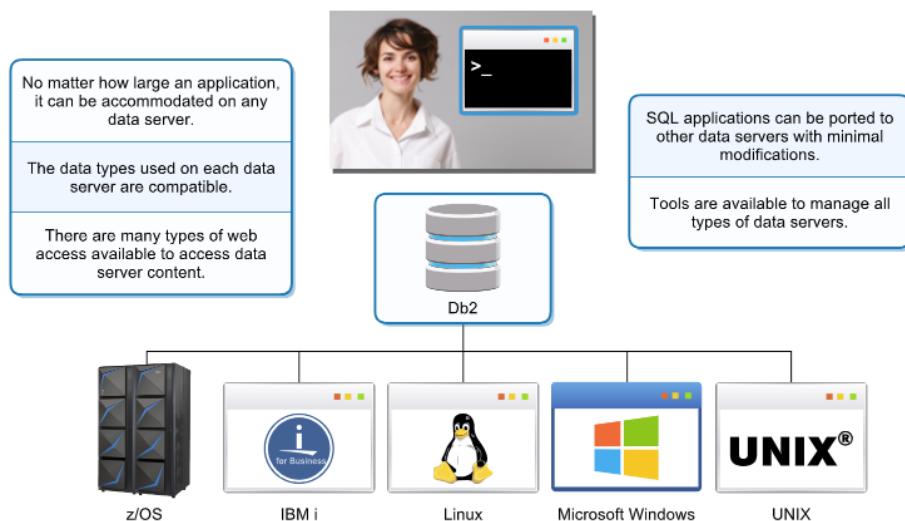
IBM's online Knowledge Center is always a great place to start when looking for in-depth information, while IBM's DB2 product page contains links to articles and blogs on DB2 products.

The DB2 Environment

DB2 - Components

As mentioned previously, DB2, or the DB2 data server as it is more commonly known, and its associated products can be implemented and run on a number of different operating systems including: z/OS, IBM i, Linux, UNIX, and Microsoft Windows. This is useful if an organization consists of a mixture of these systems.

While each version shown here is tweaked to support the individual capabilities of that system, SQL is virtually the same in each environment, allowing data sharing to occur between data servers and application code with minimal modifications.



DB2 - Capabilities

Db2 data servers support a large number of different clients and languages, and with additional support can integrate data from other sources.

Data sources	Languages	Clients
IMS	APL2	AIX
Informix	Assembler	Eclipse
Oracle	C	HP-UX
Microsoft® SQL Server, Excel	C++	Linux
Sybase	C#	Solaris
JDBC	COBOL	Windows
Databases that support the JDBC API	Fortran	Web browsers
OLE DB	Java	
Teradata	.NET	
EMC Documentum	Perl	
	PHP	
	PL/I	
	Python	
	REXX	
	Ruby on Rails	
	SQL procedural language	
	Visual Basic .NET	

DB2 - Tools

There is a long list of tools that may be implemented by your organization to support aspects of DB2 for z/OS performance, administration, backup and recovery, automation, and replication and application management. DB2 for z/OS includes a comprehensive toolset, but many additional tools are optionally available from IBM as well as from third-party software vendors.

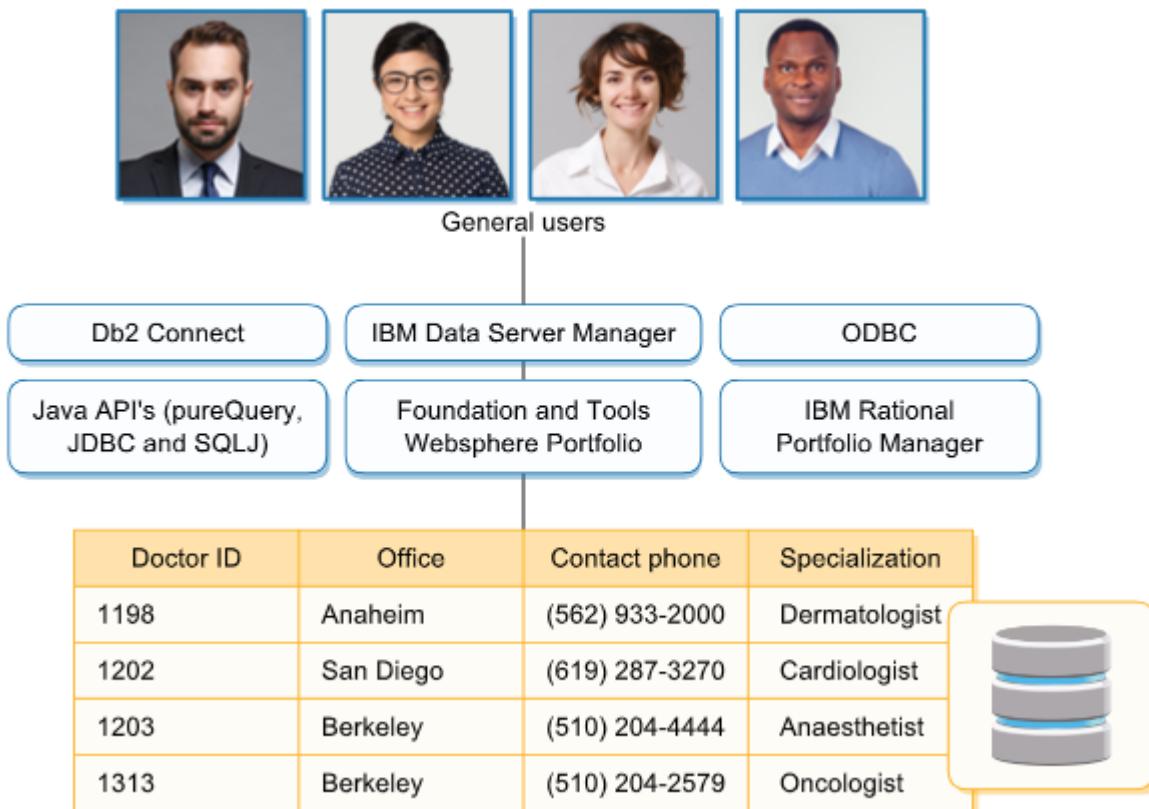
The tools mentioned below are provided by IBM.

- **DB2 Utilities Solution Pack for z/OS V4.2**
 - This solution provides you with the framework to better execute and manage DB2 utilities, ensuring improved performance optimisation and resource utilisation. The DB2 Automation Tool for z/OS can be set up to work with the Data Server Manager.
- **DB2 Performance Solution Pack for z/OS V1.5**
 - This solution enables you to quickly identify, diagnose, solve and prevent performance problems in your DB2 for the z/OS environment.
- **DB2 Administration Solution Pack for z/OS V3.1.0**
 - This solution manages the complexity, growth, change and cloning of DB2 for the z/OS objects and schema throughout the application lifecycle.

Many of the DB2 for z/OS tools display data using a graphical user interface or ISPF and allow you to perform a number of DB2 tasks interactively.

Middleware

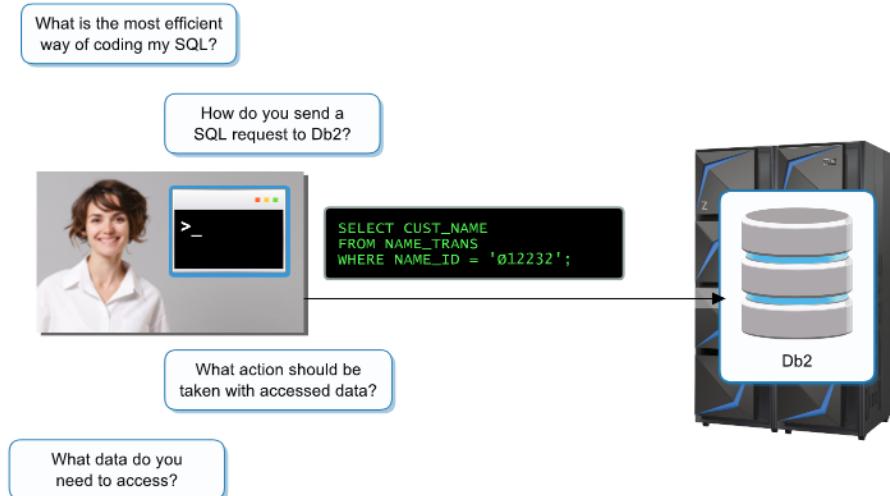
Today's on-demand environment requires powerful and efficient middleware products and APIs to define and manage application development and facilitate communication between clients and the Db2 content.



Accessing DB2 Data

Structured Query Language (SQL)

In the scenario shown here, an application programmer has coded some structured query statements to access specific DB2 data. SQL consists of over 100 different statements that can be used to insert, query, update, delete, and authorize access to DB2 data.



Embedding SQL in an Application Program

SQL statements can be inserted into source application programs. This type of invocation is referred to as an embedded statement.

In the COBOL example shown here, the keywords EXEC SQL are required to invoke SQL statements and END-EXEC indicates the end of the SQL stream.

- For C and C++ programs, each SQL statement must begin with EXEC SQL and end with a semicolon (;).
- For REXX, each SQL statement must begin with EXECSQL (in either upper-, lower-, or mixed-case) and be followed by either an SQL statement (enclosed in single or double quotation marks) or a REXX variable that contains an SQL statement.
- For Java, embedded SQL is executed within SQLJ executable clauses which begin with #sql and end with a semicolon.

```
EXEC SQL DECLARE LRNR.DEPARTMENT TABLE
( DEPTNO          CHAR(3) NOT NULL,
  DEPTNAME        VARCHAR(29) NOT NULL,
  MGRNO           CHAR(6),
  ADMRDEPT        CHAR(3) NOT NULL,
  LOCATION         CHAR(16)
) END-EXEC.
*****
* COBOL DECLARATION FOR TABLE LRNR.DEPARTMENT
*****
01 DCLDEPARTMENT.
  10 DEPTNO          PIC X(3).
  10 DEPTNAME        PIC S9(4) USAGE COMP.
  49 DEPTNAME-LEN    PIC X(29).
  49 DEPTNAME-TEXT   PIC X(6).
  10 MGRNO           PIC X(3).
  10 ADMRDEPT        PIC X(16).
  10 LOCATION         PIC X(16).
```

Dynamic Preparation of SQL

Rather than using static SQL statements as in the previous example, you can dynamically build SQL statements based on input provided to the application.

```
PROCEDURE DIVISION.  
  MOVE "INSERT INTO TEST_RES VALUES (?,?,?)" TO RESBUF  
  EXEC SQL  
    PREPARE REC1 FROM :RESBUF  
  END-EXEC  
  ...  
  ...  
  EXEC SQL  
    EXECUTE REC1 USING :tstid,:tstcode,:tstres  
  END-EXEC.
```

The example here shows that PREPARE and EXECUTE statements have been used to create an executable SQL statement from a string and then execute it.

- All non-Java languages use this code or the EXECUTE IMMEDIATE statement.
- While Java uses Statement, PreparedStatement, and CallableStatement classes to perform the same function.

Preparing the Source Program

In traditional programming languages, whether there are static or dynamic SQL statements in your source program, they both need to be processed before the program is compiled.

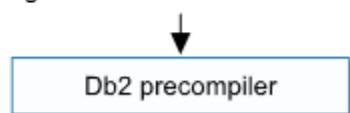
With **Static SQL** statements, the DB2 precompiler or coprocessor checks the syntax of the SQL statements and if acceptable will convert them into host language statements that are used to access DB2 data.

Dynamic SQL statements are handled differently in that they are not precompiled but are instead passed to DB2 as a character string by the program. These statements are then processed at run time.

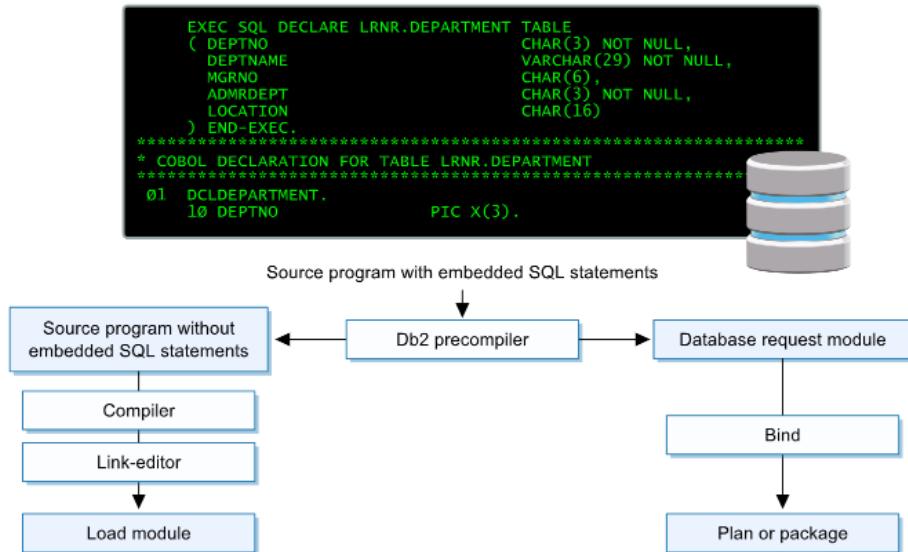
```
EXEC SQL DECLARE LRNR.DEPARTMENT TABLE  
( DEPTNO          CHAR(3) NOT NULL,  
  DEPTNAME        VARCHAR(29) NOT NULL,  
  MGRNO           CHAR(6),  
  ADMRDEPT        CHAR(3) NOT NULL,  
  LOCATION         CHAR(16)  
 ) END-EXEC.  
*****  
* COBOL DECLARATION FOR TABLE LRNR.DEPARTMENT  
*****  
01 DCLDEPARTMENT.  
10 DEPTNO          PIC X(3).
```



Source program with embedded SQL statements



The DB2 precompiler stage produces a Database Request Module (DBRM) that contains the SQL statements and host variable information from the source program. This information is used when the BIND command is invoked, and will create a plan or package that contains control structures and processing options.

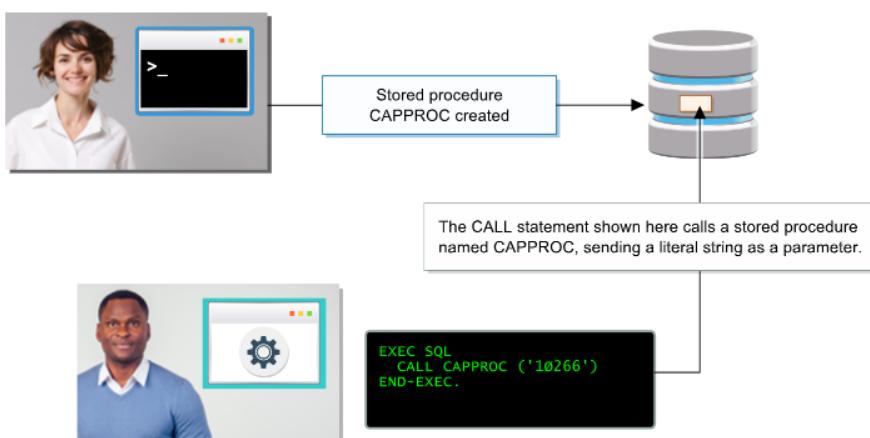


Finally an executable load module needs to be created from your source program using a link-edit procedure. The DB2 application is now ready to run.

Stored SQL Procedures

Where an application program containing SQL statements performs a common function, it can be placed as a stored procedure on the database server. The stored procedure is then invoked from an application program using the CALL statement. The benefits of having a stored procedure are the following:

- There is less network traffic as the procedure is stored in close proximity to the data.
- Less duplication of code as it is only written once, which means that any changes will also only need to be made to one set of code.
- Security can be enhanced by assigning database privileges to the stored procedure rather than to users.



Interactively Invoking SQL

SQL statements can be sent to DB2 directly from a workstation. In the example shown here, a TSO facility called **SPUFI (SQL Processor Using File Input)** allows you to execute SQL statements from an input file, without needing to embed them in an application program.

The screenshot shows the SPUFI interface with the following text:

```
==>          SSID: DB11
Enter the input data set name:      (Can be sequential or PDS member)
1 DATA SET NAME ... ==> 'BAY1.SPUFI.INPUT' (Enter if not contained in the input data set)
2 VOLUME SERIAL ... ==>          (Enter if not contained in the input data set)
3 DATA SET PASSWORD ==>          (Enter if password is required)

Enter the output data set name:     (Must be sequential data set)
4 DATA SET NAME ... ==> 'BAY1.SPUFI.OUTPUT'

Specify processing options:
5 CHANGE DEFAULTS ==> YES
6 EDIT INPUT ..... ==> YES
7 Execute ..... ==> YES
8 AUTOCOMMIT ..... ==> YES
9 BROWSE OUTPUT ... ==> YES
(Y/N - Browse output data set?)

For remote SQL processing:
10 CONNECT LOCATION ==>

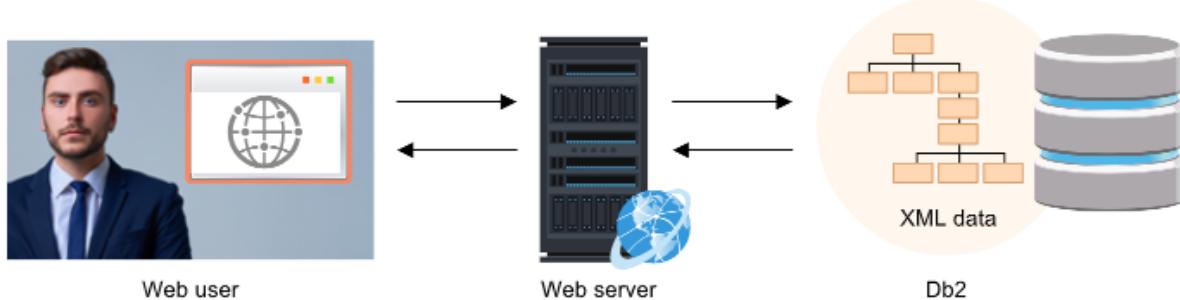
PRESS: ENTER to process END to exit           HELP for more information
```

Two callout boxes provide additional information:

- The first box, pointing to the input data set entry, states: "The input data set or PDS member contains either existing SQL statements or is empty, allowing you to enter your own statements."
- The second box, pointing to the output data set entry, states: "The result from processing the SQL statements is placed in the output data set, which is automatically opened in browse mode following the processing. (Y/N - Browse output data set?)"

XML Data

XML data can also be stored in a DB2 table and is accessed, with a few exceptions, using the same SQL statements. This XML data can be used by organizations for document processing and providing information through its Web services.



DB2 uses a feature called **pureXML** to manage XML data stored in DB2 tables.

JSON

Today's rapidly changing application environments have seen the emergence of JavaScript Object Notation (JSON) as a key technology to achieving an organization's mobile, social, big data analytics, and cloud data needs.

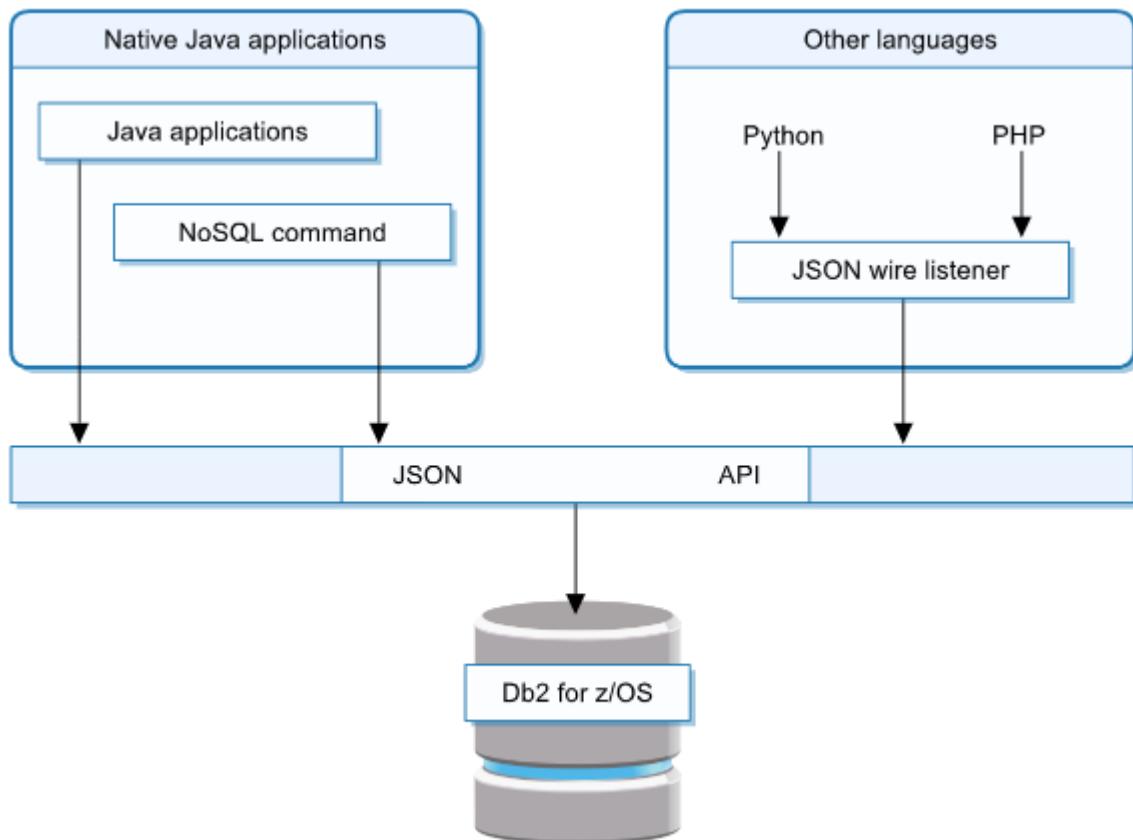
New web applications often use JSON for storing and exchanging information. With DB2 V10 for z/OS, document storage support for JSON was added, relying on DB2 NoSQL JSON APIs.

DB2 V11 for z/OS added two additional SQL interfaces, User Defined Functions:

- One to convert JSON to BSON
- The other is to convert BSON to JSON.

These allow SQL to be used to perform basic manipulation of JSON data. Db2 V12 for z/OS improves support for web and mobile applications with two ways of working with JSON: the Java driver for the JSON API or via SQL extensions.

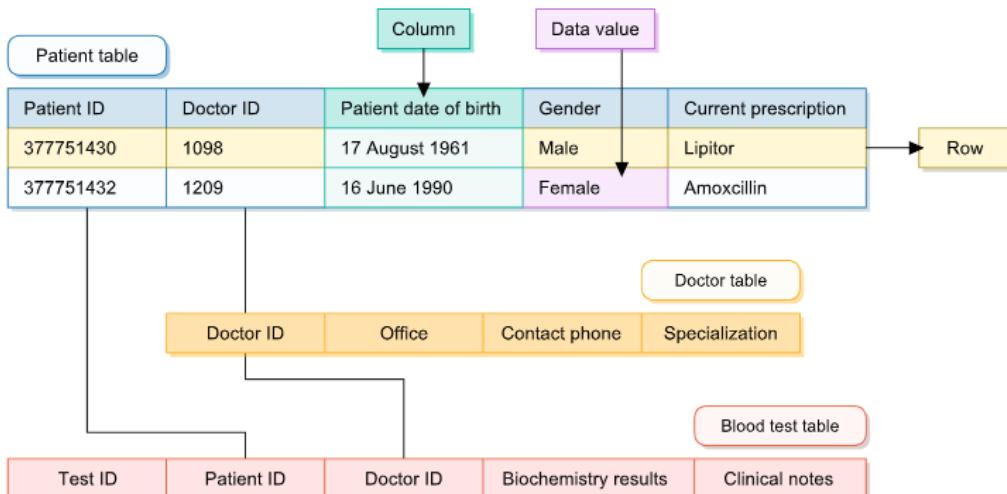
The example shown here identifies various methods in which JSON documents can be queried and managed.



DB2 Data Components

Tables

One of the most basic structures within DB2 is the table, which contains data your organization needs to store. A primary key is used when you need to create a referential integrity relationship with a foreign key in another table. If creating a primary key, it must have a corresponding index created, the process of which you will see shortly.



There are several types of tables that can be created from the commonly used base table, result tables, sample tables, temporary tables, history tables, auxiliary tables, and others.

Table Spaces

All tables within DB2 are stored in table spaces, which is a storage structure that consists of **VSAM data** sets. Table spaces can be created by issuing a **CREATE TABLESPACE** command or by DB2 automatically when a table is created.

Types of table space that DB2 can work with include:

- Partition-by-growth universal table spaces (PBG UTS)
- Partition-by-range universal table spaces (PBR UTS)
- Segmented non-UTS table spaces (deprecated)
- Partitioned non-UTS table spaces (deprecated)
- Simple table spaces (deprecated)
- Large object table spaces
- XML table spaces

Note: As of DB2 12 for z/OS, non-UTS table spaces for base tables are deprecated and are likely to be unsupported in the future.



There are many types of table spaces that can be defined with the type you use being dependent on the type of data being stored and the amount of space available.

Table space			
Doctor table			
Doctor ID	Office	Contact phone	Specialization
1198	Anaheim	(562) 933-2000	Dermatologist
1202	San Diego	(619) 287-3270	Cardiologist
1203	Berkeley	(510) 204-4444	Anaesthetist

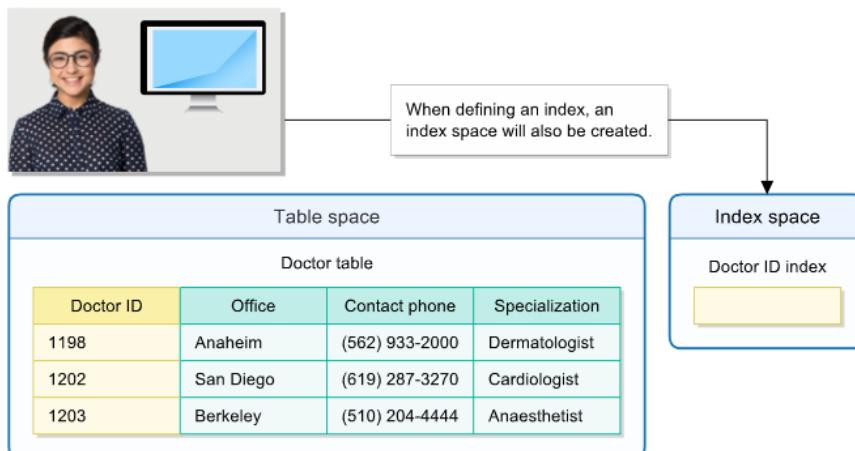
Indexes

Just like an index for a book, DB2 indexes are used to quickly locate information without having to read all the content. In the example from the previous section, an index could be created for the Doctor ID column to locate a specific doctor's record.

The main benefit derived from using an index is performance, because not all data in the table needs to be accessed during a request.

Index Spaces

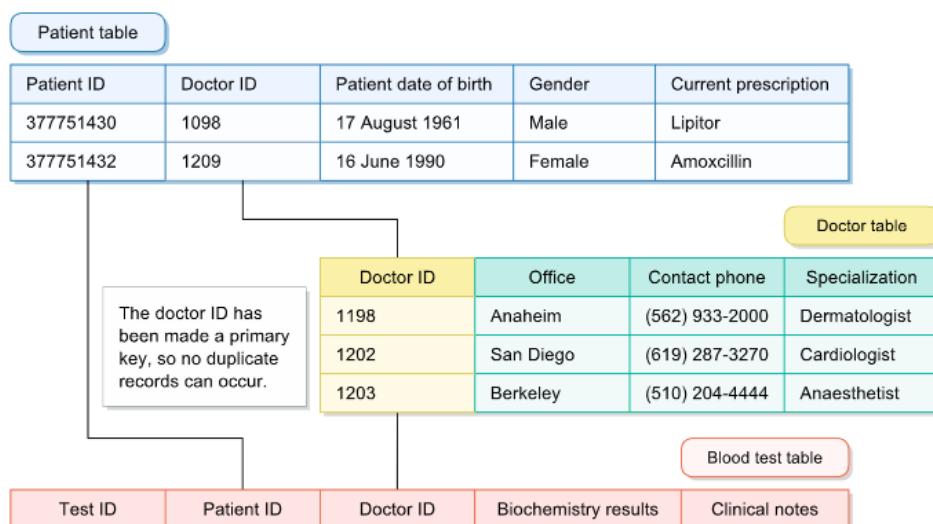
Just as tables have their own table space defined, so do indexes. A separate index space is created for every index.



Keys

Tables can, and often do, contain columns that are defined as keys. These keys are used to ensure that each record in the table is unique, for example, that there are no duplicate doctor IDs, and that data from one table cannot be removed if it has related data in another table.

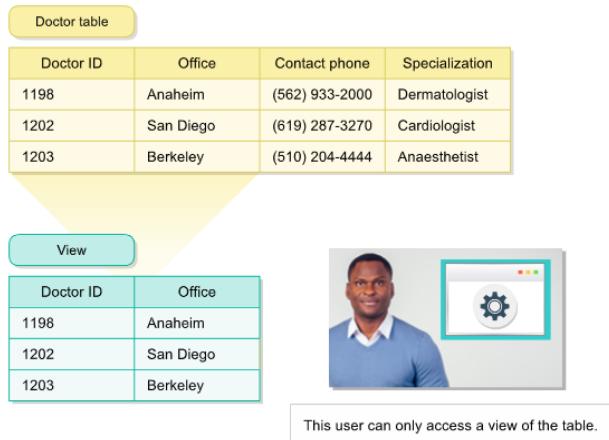
You will often see a primary key defined for a table, which is a unique key that is not allowed to contain null values. An index can be created for this type of key and is called a primary index. DB2 also supports a number of other keys including unique keys, parent keys, foreign keys, and composite keys.



Views

There may be occasions where specific data from several tables is often requested, or users are not authorized to view certain data in a table. In these scenarios, views can be created which are subsets of existing data.

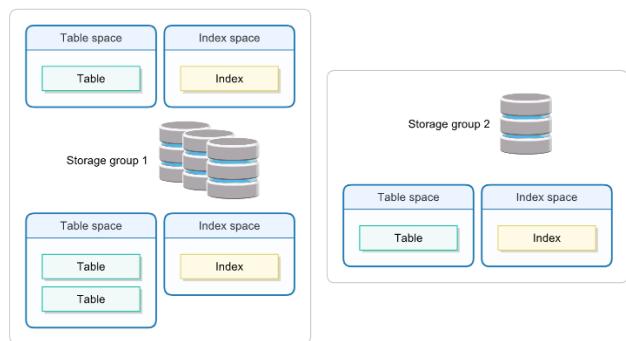
When a request for a new view is issued, only the definition supporting that view is stored. The data used to make up the view is already in existing tables, so creating separate data in views would result in much data duplication..



Storage Groups

A storage group is a defined area on disk used to store tables and indexes. When these components are created you can specify the storage group whose space is to be utilized.

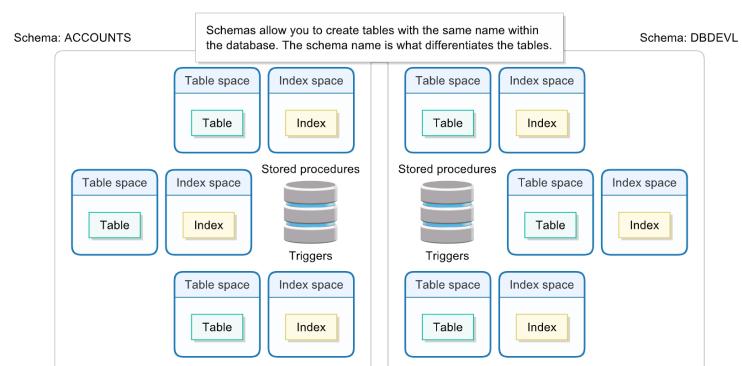
Note: These storage groups are not the same as the ones used by DFSMS.



Schemas

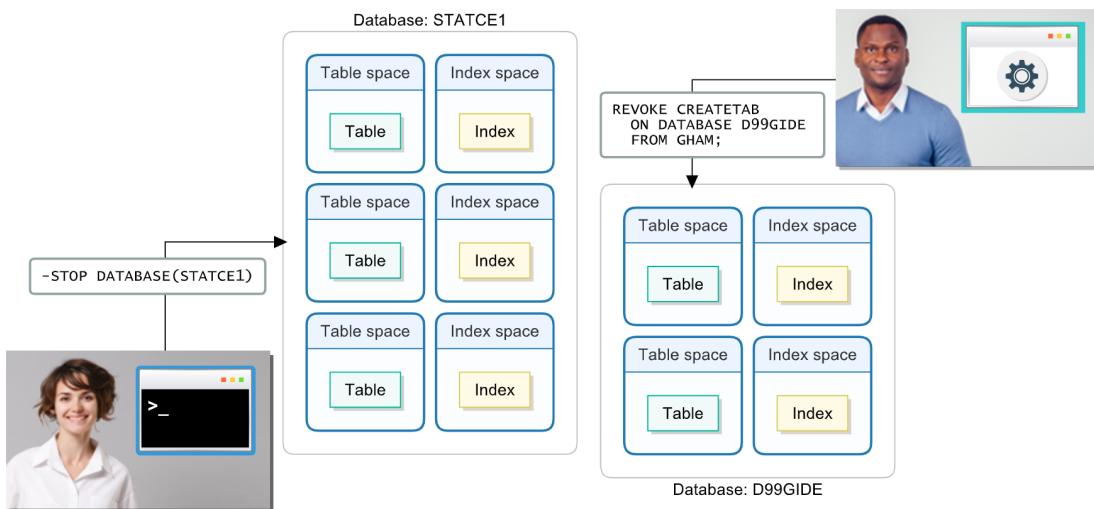
A schema is used to group a set of objects within the Db2 database together using a high-level qualifier name. For example, if a schema called Accounts is created and there are two tables in the database, Cust and Invoice, that are linked to the schema, then the fully qualified names of the tables are Accounts.Cust and Accounts.Invoice.

Schemas can also consist of indexes, table spaces (note that the schema for a table space is actually the database it belongs to), functions, stored procedures, and triggers. Whenever any of these elements is created, it is automatically assigned a high-level qualifier schema name.



Databases

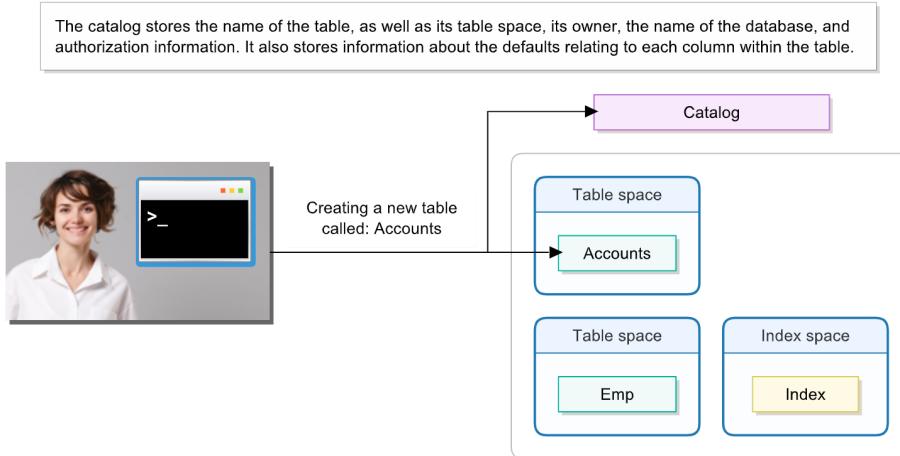
All of the data components you have looked at so far are linked together to form a database. Linking them like this enables you to control an entire application by entering commands to the database entity. For example, you may need to prevent access to all data relating to that database because there is a problem, or you may want to grant access to a user that needs to use the information in that database.



DB2 System Components

DB2 - Catalog

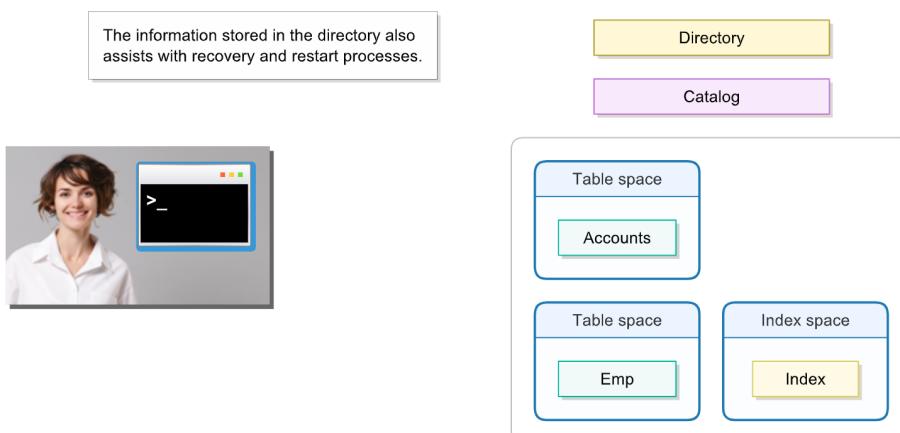
DB2 keeps track of objects such as tables, table spaces, indexes, index spaces, views, and storage groups within the DB2 database using a catalog. The catalog itself is a set of tables that contains details of when the objects just mentioned are created, modified, or deleted.



Because the catalog is a set of tables, it can be accessed using SQL.

DB2 - Directory

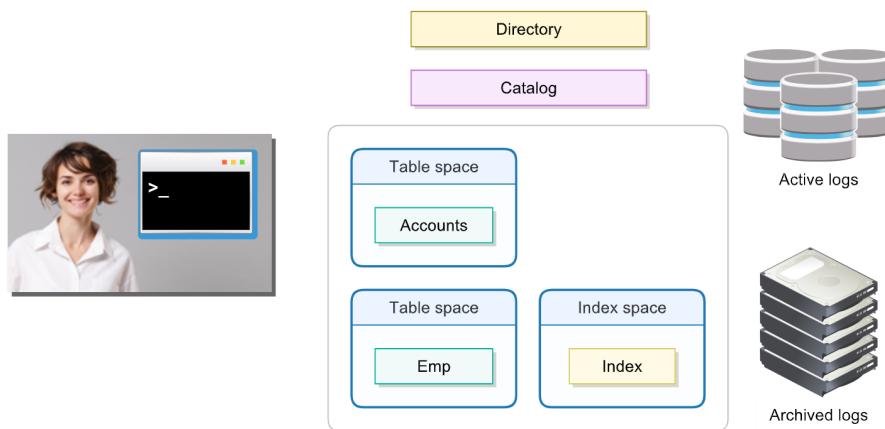
The DB2 directory consists of a number of directory tables stored in database DSNDB01. These tables contain system related information that is designed to be used internally by DB2, but a system administrator with appropriate authority can access data from them using SQL.



For example, details of active or stopped utility jobs can be obtained from the directory.

DB2 - Logs

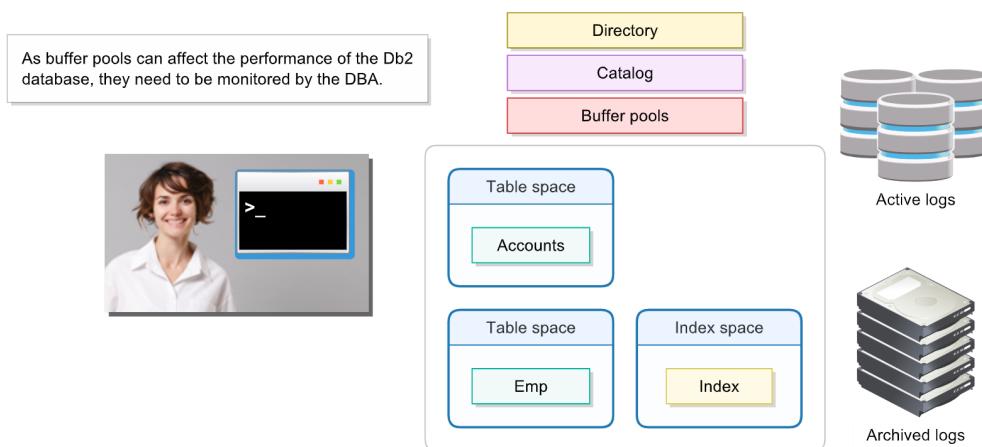
Like most products, DB2 stores information relating to data changes and major events in a log. During normal operation, an active log copy will have a number of data sets available for storing this data, and when one of these active log data sets becomes full, it is automatically backed up to tape or disk and is referred to as an archived log.



The logs can be browsed to help analyze problems and are also used in recovery scenarios to roll changes backward or forwards to a point where the database was known to be consistent.

DB2 - Buffer Pools

When an application program needs to use Db2 table or index data, that data is accessed and stored in a temporary area called a buffer pool. Access to data in this buffer pool is much quicker than if the application program had to request it again from the table or index on DASD.



The data in the buffer pool can be read or modified and is copied back to the table or index following the completion of processing.

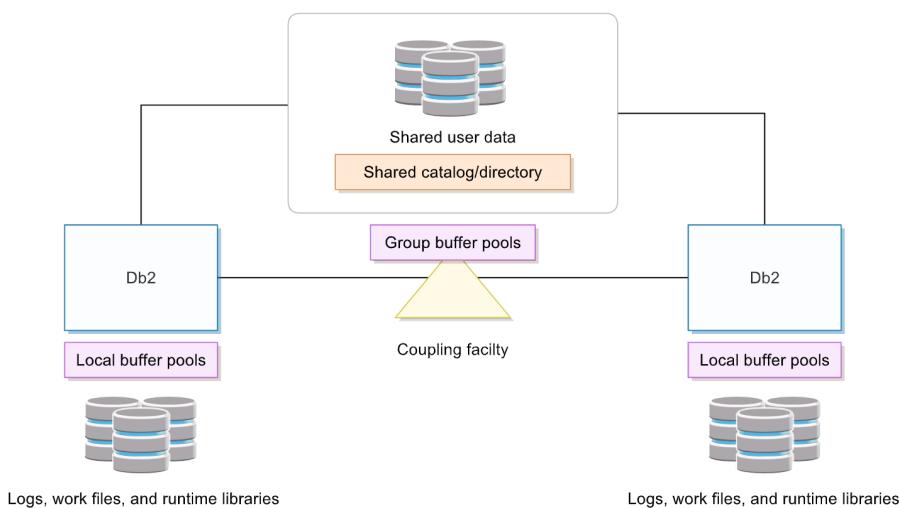
Databases

Several related databases can be populated and used to provide support for DB2. For example:

- Data Definition Control Support Database - This database contains information that is used to prevent certain data definition language statements from being submitted.
- Resource Limit Facility - This consists of one or more tables that define the amount of processor resources that can be used by certain types of SQL statements.
- Work File Database - If SQL statements require additional space for processing, this database can be used.
- Communications Database - This database is used to communicate with remote database management systems.

DB2 and the Parallel Sysplex

If an organization connects z/OS systems using a Parallel Sysplex then it will probably want to configure DB2 so that it can share data across the network.



The graphic displayed here shows how such a configuration can look and the data that is shared.

Introduction to SQL

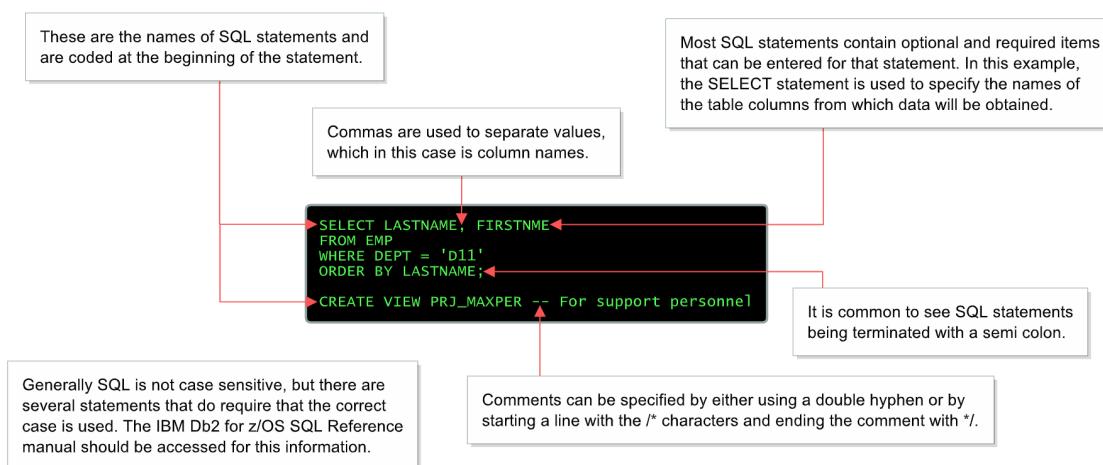
SQL is used to obtain and manipulate data that is stored in DB2 tables. SQL consists of over 100 different statements that can be used to insert, query, update, delete, and authorize access to DB2 data.

Invoking SQL

SQL statements can be inserted into source application programs and invoked when they are executed or they can be run interactively using a TSO product such as SPUFI. The examples displayed in this section are created using this method.

SQL Syntax

When coding SQL you need to adhere to the syntax rules, otherwise your code will not execute.



SELECT Statement

One of the most commonly used SQL statements is **SELECT**. This statement is used to query a table and produce results that are in a table format. The simple example here selects and displays all entries from the ADDR01.TABLE table.

The screenshot shows the output of a SPUFI session. The command entered was:

```
BROWSE USER01234.RESULT
COMMAND INPUT ==>
SELECT *
FROM ADDR01.TABLE;
```

A callout box highlights the SQL statement: "SQL statement that was entered".

The resulting table data is shown:

LASTNAME	FIRSTNAME	ADDRESS	PHONE	GENDER
ADDISON	PAUL	123 RUSHDALE STREET, COOTAMUNDRA	4819	M
BAKER	GAIL	456 SMITH STREET, EASTWOOD	5767	F
DAVIS	MICHELLE	12 TINTERN AVENUE, ASHFIELD		F
D'SILVA	MARK	25 HIGH STREET, SEAFORD		M
FISHER	PHILLIP	2/144 POWER STREET, HAWTHORN	5558	M
MACKINTOSH	HARRY	154 SYDNEY DRIVE, SWAN VIEW	2236	M
PETERSON	BRETT	16 CHARLIES PLACE, TOOOWOOMBA	7673	M
RICHARDSON	PETER	97 STURT HIGHWAY, GLENELG	4231	M
SMITH	EYVONNE	17/125 GRANGE ROAD, SOUTH YARRA	6582	F
SMITH	GREG	49 EVANS ROAD, PENRITH	7164	M

General invocation messages at the bottom indicate:

```
DSNE610I NUMBER OF ROWS DISPLAYED IS 10.
DSNE610I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0.
```

Using the table from the previous example, if certain columns of data only needed to be retrieved, then just those column names can be specified as shown in this example.

```
BROWSE USER01234.RESULT -----  
COMMAND INPUT ==>  
-----+-----+-----+-----+-----+-----+  
SELECT LASTNAME, PHONE ← Only the LASTNAME and PHONE columns  
FROM ADDR01.TABLE; have been selected to be displayed.  
-----+-----+-----+-----+-----+  
LASTNAME    PHONE  
ADDISON     4819  
BAKER       5767  
DAVIS       6529  
D'SILVA     2376  
FISHER      5538 ← Only the specified data is displayed.  
MACKINTOSH  2236  
PETERSON    7673  
RICHARDSON  4231  
SMITH        6582  
SMITH        7164  
-----+-----+-----+-----+-----+  
DSNE610I NUMBER OF ROWS DISPLAYED IS 10.  
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0.  
-----+-----+-----+-----+-----+
```

Clause Statements

When the data you require needs to be further qualified, several types of clauses can be used with the SELECT statement.

- The **WHERE** clause allows you to select data from rows that meet certain conditions. In this example, all columns will be displayed for those rows which contain the value F in the column named GENDER.
- The **ORDER BY** clause allows you to sort the rows you have selected in a particular order. For example, if you wanted a listing of all rows in your EMP.TABLE table, sorted by the department they work in, then the SQL statement shown below can be used.
- Once specific data has been requested from a table you may want to group the records together. In the example below, the OFFICE and the average of all the SALARY values is selected and then those rows will be **GROUPED BY** the office.
- The **HAVING** clause is used in conjunction with the GROUP BY clause to further refine the data to be displayed. In this example, the MAX function is used to return the name of each TESTID and maximum cost of that test. The HAVING clause will only display those TESTIDS that have a maximum cost greater than 500.
- The amount of data displayed by your SELECT request can be limited by using the **FETCH FIRST** clause. This is useful if you are working with large tables and do not require all the data or are performing testing and need only a subset of data. In this example, only the first 20 rows of the table are selected.

```
SELECT * FROM ADDR01.TABLE  
WHERE GENDER = 'F';
```

```
SELECT * FROM EMP.TABLE  
ORDER BY DEPT;
```

```
SELECT OFFICE, AVG(SALARY) FROM DOC.TABLE  
GROUP BY OFFICE;
```

```
SELECT TESTID, MAX(COST) FROM TEST.TABLE  
GROUP BY TESTID  
HAVING MAX(COST) > 500;
```

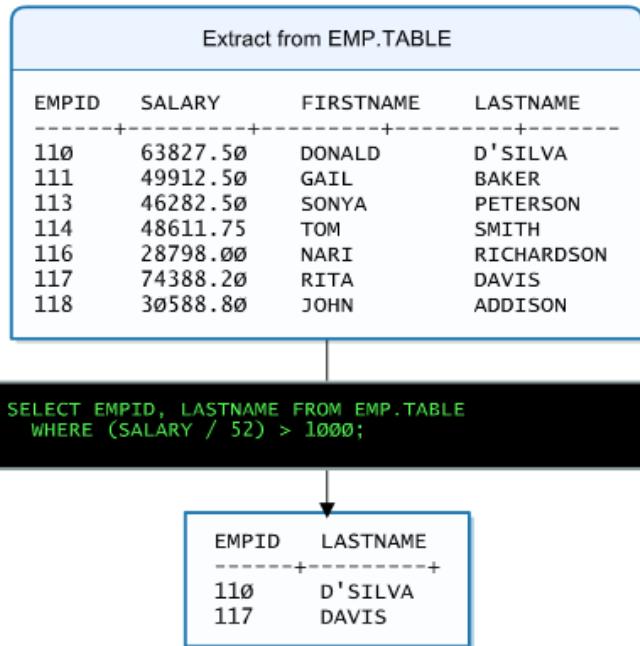
```
SELECT * FROM EMP.TABLE  
FETCH FIRST 20 ROWS ONLY;
```

Arithmetic Operators

There will be times when you need to select rows from a table based on a mathematical calculation.

For example, you may need to select all the employees in the organization that get paid more than \$1000 a week.

Arithmetic operators such as plus (+), minus (-), multiply (*), and divide (/) can be used with any column name, whether or not they are specified to be displayed in the SELECT statement, provided that the column's data type is numeric.



Comparison Operators

There have been several examples already shown in this section where values are compared to produce a subset of the original table data. SQL supports a number of different types of comparison operators that can be used.

```
SELECT * FROM BUSINESS.TABLE
WHERE CUSTNAME = 'GH LIMITED';
```

```
SELECT ORDER, COST, MARKUP FROM SALES.TABLE
WHERE MARKUP > 100;
```

```
SELECT INGRED, SHOP, COST FROM RECIPE.TABLE
WHERE COST <= 20;
```

The following comparison operators can be used:

=	Equal to
<>	Not equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to

Predicates

Another item that can be added to a SQL statement is a predicate. A predicate is used against a row or group and returns a value of true, false, or unknown. Where the result is true, that data is selected for the result table.

- **Scenario 1** - You need to select employees from a table who have a salary between 30,000 and 40,000.

```
SELECT EMPNAME, WAGE, DEPT FROM EMP.TABLE  
WHERE SALARY BETWEEN 30000 AND 40000;
```

- **Scenario 2** - You only require names to be selected from a lastname column in an address table.

```
SELECT DISTINCT LASTNAME FROM ADDR01.TABLE;
```

- **Scenario 3** - You need to display all patients that live in a specific area where at least one of those patients has returned a specific test result.

```
SELECT PATID, AREA, TESTRES FROM CUST.TABLE A  
WHERE EXISTS (SELECT * FROM CUST TABLE  
WHERE A.AREA=AREA AND TESTREST='K108');
```

- **Scenario 4** - You need to compare results from a SELECT statement with one or more values.

```
SELECT CUSTNAME, CUSTID, FROM ORDER.TABLE  
WHERE CUSTID IN ('1079', '1220', '1378')  
ORDER BY CUSTNAME;
```

- **Scenario 5** - You need to display all clients that live in a suburb with SOUTH in its name.

```
SELECT * FROM CLIENT.TABLE  
WHERE BURB LIKE '%SOUTH%';
```

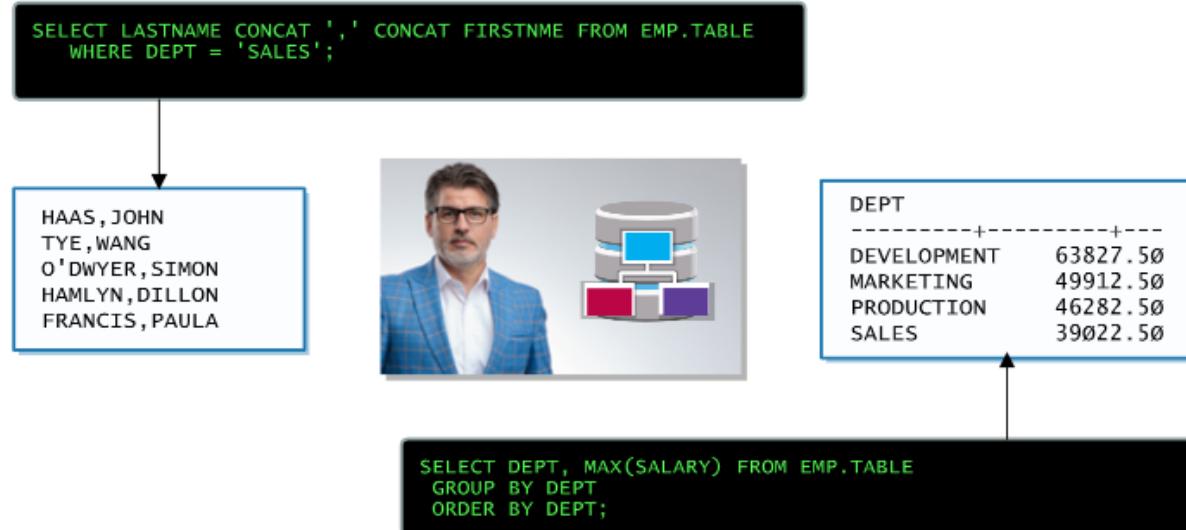
- **Scenario 6** - You need to display certain users that have not completed a test.

```
SELECT USEDID, SCORE FROM RESULTS.TABLE  
WHERE USERID > 200  
AND SCORE IS NULL  
ORDER BY USERID;
```

Functions

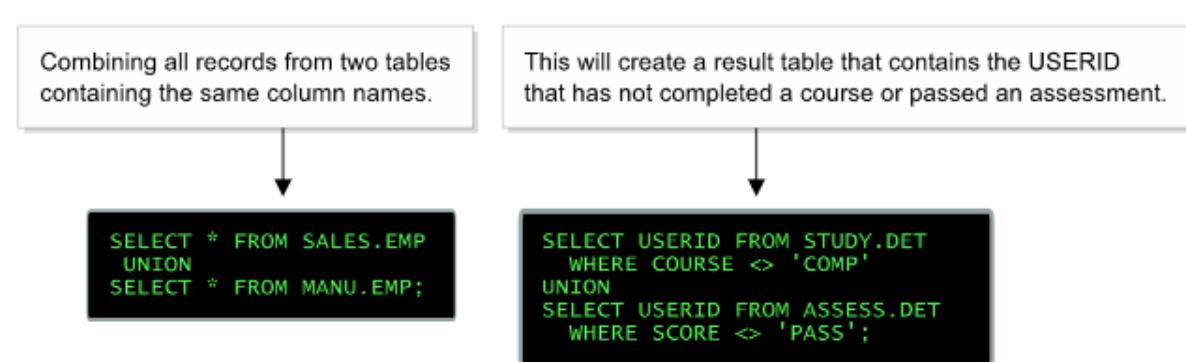
There are a number of built-in and user-defined functions that you can also use to further modify the data captured through your SELECT statement.

The CONCAT function shown at the top of this graphic is concatenating character strings, while MAX and MIN can be used to return the maximum and minimum value from a set of values. In this example the MAX function is being used to display the largest salary within each department.



Merging Data

The majority of examples shown so far have dealt with a SELECT statement creating data in a result table. The merging of data with that from a separate SELECT statement is possible using the UNION keyword.



Creating and Modifying Table Data

Creating Tables

The CREATE TABLE statement is used to create the structure into which data is added. A number of data value types can be assigned to columns you define within the table.

```
CREATE TABLE STAFF.DAT
(STAFFID CHAR(4) NOT NULL,
FIRSTNAME VARCHAR(15) NOT NULL,
LASTNAME VARCHAR(25) NOT NULL,
SALARY DECIMAL(8,2),
DEPTCODE CHAR(3),
GENDER CHAR(1) NOT NULL,
PRIMARY KEY (STAFFID));
```

- In this example, the CREATE TABLE statement is being used to define a new table called STAFF.DAT
- FIRSTNAME and LASTNAME - These are the names of the columns to be created within the table.
- CHAR(4) and VARCHAR(15) - A number of different data types can be assigned to column data. For example, CHAR represents a fixed length character string which is followed by the length, while VARCHAR is used for a variable length character string up to the maximum number of characters specified.
- DECIMAL(8,2) - The DECIMAL data type is used for a column that displays decimal numbers. The first integer is the precision of the number. That is, the total number of digits, which can range from 1 to 31. The second integer is the scale of the number. That is, the number of digits to the right of the decimal point, which can range from 0 to the precision of the number.
- NOT NULL - This is used to prevent the column from containing a null value.
- PRIMARY KEY - This code is used to define a primary key for the table.

Inserting Data

There are several ways of inserting data into a table. You can add a single row of data by specifying values to be inserted into columns, or populate an entire table by inserting all or selected rows from another table.

```
INSERT INTO RESULT.TAB
VALUES ('002', 'SALES', '109', 'SA', 'UNICORN');
```

This will create a new row within the RESULT.TAB table and add the specified values to the existing columns.

```
INSERT INTO EMP.DAT (DEPTNO, DEPTNAME, MGRNO, SALARY)
VALUES ('020', 'PRODUCTION', '7099', '52000');
```

This will create a new row in the EMP.DAT table but only add the values to the corresponding column names specified in the first line.

```
INSERT INTO SALES.EMP
SELECT * FROM MARKET.EMP;
```

This will insert all the data from the MARKET.EMP table into the SALES.EMP table.

```
INSERT INTO ORDER.TAB
SELECT * FROM OSORDER.TAB
WHERE LANG = 'ENGLISH';
```

This will only select the records from the OSORDER.TAB table that contain ENGLISH in the LANG column, and then insert them into the ORDER.TAB table.

Deleting Data

Just as rows can be added, they can also be removed using the DELETE statement. A search argument can be provided to remove specific rows or they can be deleted relative to where the cursor is positioned.

- **Example 1** - This will remove all data from the TSCORES.DAT table.
- **Example 2** - This statement is used to remove a specific record from the table, that being the record for employee 022.
- **Example 3** - This statement is used to remove multiple records from the ACTIVITY.TAB table, those being where the DEPTNAME column contains the value MARKETING.
- **Example 4** - In this example, a previous statement has declared C1 as the cursor. This DELETE statement will delete the row on which the cursor C1 is currently positioned.

```
DELETE FROM TSCORES.DAT;
```

```
DELETE FROM ORG.EMP  
WHERE EMPNO = '022';
```

```
DELETE FROM ACTIVITY.TAB  
WHERE DEPTNAME = 'MARKETING';
```

```
DELETE FROM PLANT.DET  
WHERE CURRENT OF C1;
```

Updating Existing Data

When existing table data needs to be modified, the UPDATE statement can be used. This statement can update data on one or multiple rows and can be used in conjunction with search criteria.

```
UPDATE USORG.EMP  
SET MANAGER = 'YOUNG'  
WHERE DEPTNO = '005';
```

This will update only those records in table USORG.EMP where the DEPTNO column contains the 005 value. In those records, the value in the MANAGER column will be changed to YOUNG.

```
UPDATE TAX.EMP  
SET SALARY = 1.05 * SALARY;
```

This will update all records in table TAX.EMP, changing the value in the SALARY column to reflect a 5% increase.

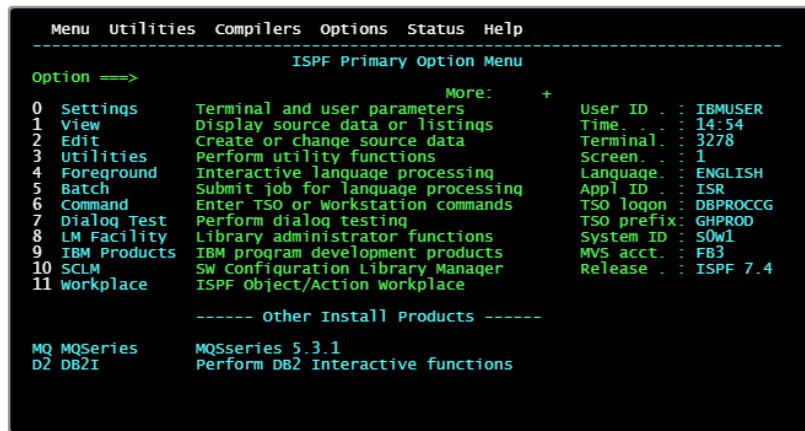
SQL and SPUFI

Accessing DB2 Data - SPUFI

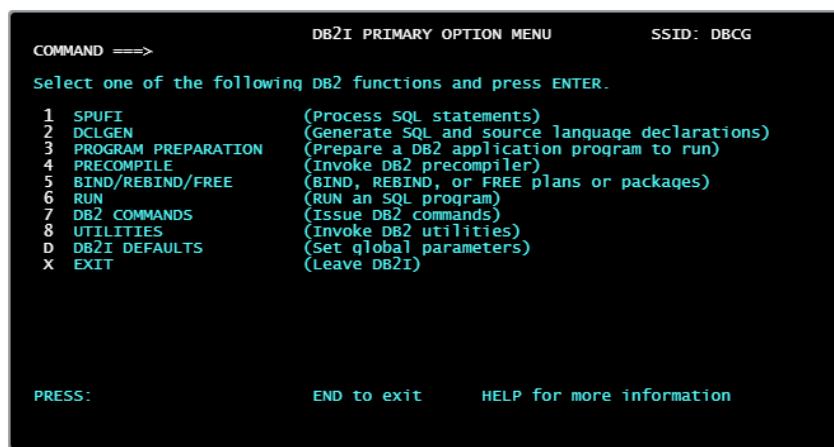
As one begins coding SQL you will need to test it against DB2 data. A quick method of performing this is to use the SQL Processor Using File Input (SPUFI) facility, which is available through TSO/ISPF.

Accessing SPUFI

Because SPUFI is run through TSO/ISPF, you will need to have been assigned access to this product by your security administrator who will provide you with a logon ID and password. After logging on, an ISPF Primary Option panel similar to the one shown here will be displayed.



In this example you can see option D2 at the bottom of the screen, which is used to access the SPUFI facility on this system. Note that your site's systems programmer may use other panel option selection codes, or that you may need to scroll down (PF8) in your version of this panel to locate the correct option

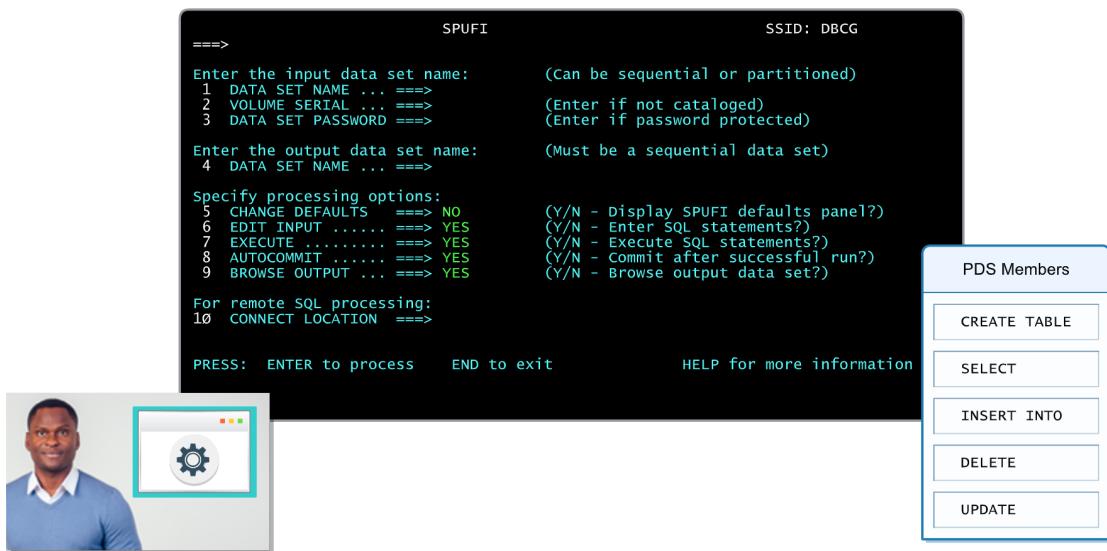


You can see that a number of interactive DB2 functions can be accessed from the resulting DB2I Primary Option Menu. The DB2 subsystem which will perform those functions is identified in the top right of this, and subsequent menu panels. In this case, it is DB11.

- The identity of the subsystem is just one of the variables which may be set via the panel option: D DB2I DEFAULTS.

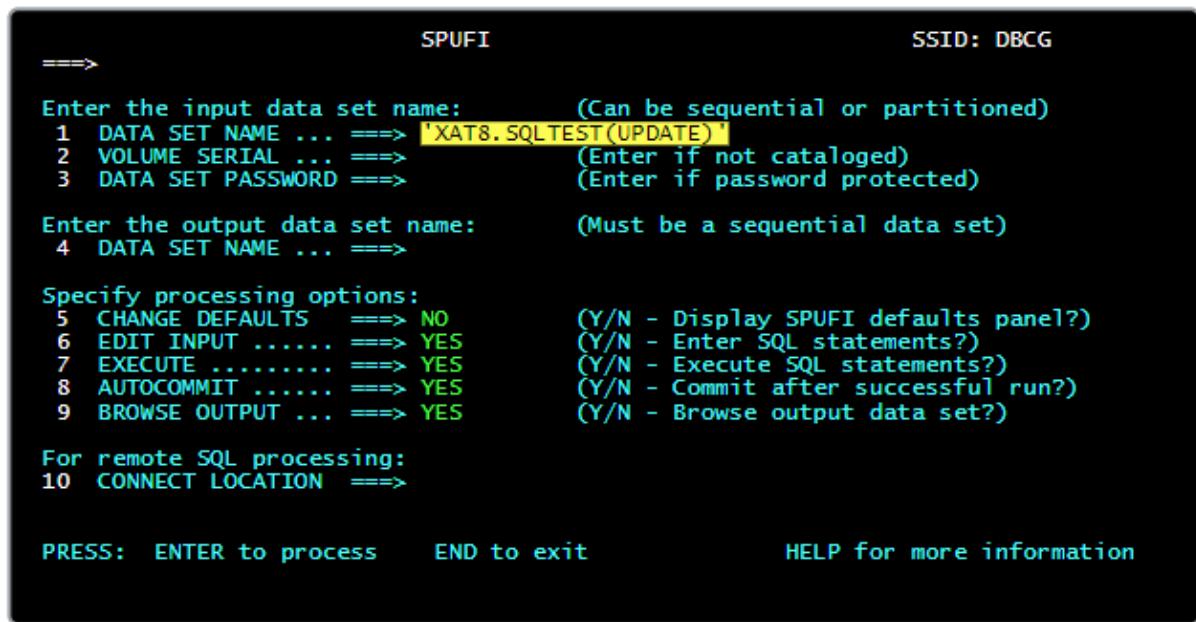
SPUFI Panel - Overview

The SPUFI panel allows you to provide details on the input, output, and general SPUFI defaults to be used when invoking your SQL statements against DB2 table data and indexes.



Firstly, you should create a data set to store the SQL statements you need to test. This can be a sequential data set, but if you need to test different types of statements you may want to create a partitioned data set so that unique code can be stored in different members.

SPUFI Panel - Input



You will enter some SQL statements later but for now, you will code your SQL statements into a data set called XAT8.SQLTEST in a member called UPDATE.

This data set name and member needs to be coded within single quotes in the input data set name field. If the name is spelled incorrectly or you forget to include the single quotes, an error message will be displayed when SPUFI attempts to execute the SQL.

SPUFI Panel - Results

The result from your executed SQL statements will be stored in a sequential data set specified in option 4. If the data set name you provide is an existing one, data in it will be overwritten each time you use it. If the data set name does not exist, it will be created automatically for you.

```
SPUFI SSID: DBCG  
====>  
Enter the input data set name: (Can be sequential or partitioned)  
1 DATA SET NAME ... ==> 'XAT8.SQLTEST(UPDATE)'  
2 VOLUME SERIAL ... ==> (Enter if not catalogued)  
3 DATA SET PASSWORD ==> (Enter if password protected)  
  
Enter the output data set name: (Must be a sequential data set)  
4 DATA SET NAME ... ==> RESULT ← If your logon ID is XAT8 then the data set referenced here would be XAT8.RESULT  
  
Specify processing options:  
5 CHANGE DEFAULTS ==> NO (Y/N - Display SPUFI defaults panel?)  
6 EDIT INPUT ..... ==> YES (Y/N - Enter SQL statements?)  
7 EXECUTE ..... ==> YES (Y/N - Execute SQL statements?)  
8 AUTOCOMMIT ..... ==> YES (Y/N - Commit after successful run?)  
9 BROWSE OUTPUT ... ==> YES (Y/N - Browse output data set?)  
  
For remote SQL processing:  
10 CONNECT LOCATION ==>  
  
PRESS: ENTER to process END to exit HELP for more information
```

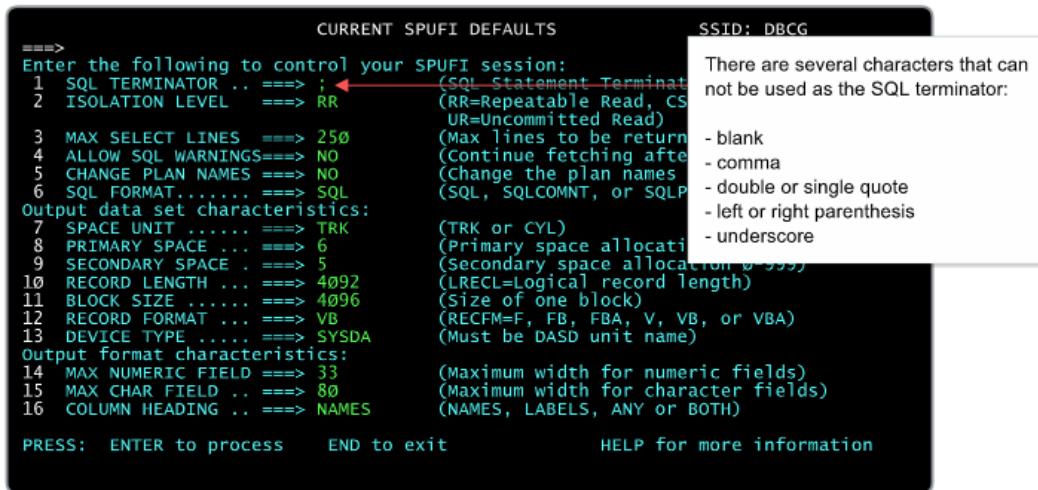
If you forget to insert the single quotes around the data set name, the data set referenced will contain your logon ID as the high-level qualifier.

SPUFI Defaults

There may be cases where the default processing values used by SPUFI need to be changed before your SQL statements are processed. By setting the value for option 5 to Y or YES, the SPUFI default panel will be displayed before executing your SQL statements.

```
SPUFI SSID: DBCG  
====>  
Enter the input data set name: (Can be sequential or partitioned)  
1 DATA SET NAME ... ==> 'XAT8.SQLTEST(UPDATE)'  
2 VOLUME SERIAL ... ==> (Enter if not catalogued)  
3 DATA SET PASSWORD ==> (Enter if password protected)  
  
Enter the output data set name: (Must be a sequential data set)  
4 DATA SET NAME ... ==> RESULT  
  
Specify processing options:  
5 CHANGE DEFAULTS ==> NO (Y/N - Display SPUFI defaults panel?)  
6 EDIT INPUT ..... ==> YES (Y/N - Enter SQL statements?)  
7 EXECUTE ..... ==> YES (Y/N - Execute SQL statements?)  
8 AUTOCOMMIT ..... ==> YES (Y/N - Commit after successful run?)  
9 BROWSE OUTPUT ... ==> YES (Y/N - Browse output data set?)  
  
For remote SQL processing:  
10 CONNECT LOCATION ==>  
  
PRESS: ENTER to process END to exit HELP for more information
```

The pages that follow contain details on the defaults you can overtype and update on the CURRENT SPUFI DEFAULTS panel.



- **SQL Terminator** - As mentioned in the sections above, the default SQL statement terminator is a semicolon. If your SQL statement does not contain this character as part of its data processing, then SPUFI will not know when to terminate the statement.
- **Isolation Level** - SQL Statements can be executed at various isolation levels to prevent them from affecting other applications that are running.
- **Max Select Lines** - If you are using your SQL SELECT statements for testing purposes, you may want to limit the amount of data that is returned from it. The MAX SELECT LINES field can contain a number from 1 to 99999999 and will prevent any more lines than the number specified from being selected.
- **Allow SQL Warnings** - This field is used to specify the action to take should an SQL warning occur. If YES is specified, then SPUFI is allowed to continue processing the SQL statement. If NO is specified, then SPUFI will stop processing the SQL statement.
- **Change Plan Names** - Specifying YES will display another panel that allows you to change the plan name to be used by SPUFI
- **SQL Format** - This option is used to instruct SPUFI on how to pre-process SQL statements. The SQL value is the most commonly specified option except when using SQL procedural language. The SQLCOMNT and SQLPL values are often used for SQL procedural language processing.

If the output produced from your SQL is to be used for other purposes such as being fed as input into another program, you may need to change some of the output data set characteristics or output format characteristics. Normally once all defaults have been defined in this panel, you will not need to access it every time you process your SQL, so the CHANGE DEFAULTS option from the previous panel can be set to NO.

The F3 key can be used to exit from this panel and return to the main SPUFI panel, or if you have made any required changes, the Enter key can be pressed to continue processing of your SQL statements.

SPUFI Panel - Editing Input

In this scenario there were no changes made to the defaults, and a message informing you of that fact is displayed at the top of the SPUFI panel.

```
SPUFI SSID: DBCG
==>
DSNE800A NO DEFAULT VALUES WERE CHANGED, PRESS ENTER TO CONTINUE
Enter the input data set name: (Can be sequential or partitioned)
1 DATA SET NAME ... ==> 'XAT8.SQLTEST(UPDATE)'
2 VOLUME SERIAL ... ==> (Enter if not cataloged)
3 DATA SET PASSWORD ==> (Enter if password protected)

Enter the output data set name: (Must be a sequential data set)
4 DATA SET NAME ... ==> RESULT

Specify processing options:
5 CHANGE DEFAULTS ==> * (Y/N - Display SPUFI defaults panel?)
6 EDIT INPUT ..... ==> YES (Y/N - Enter SQL statements?)
7 EXECUTE ..... ==> YES (Y/N - Execute SQL statements?)
8 AUTOCOMMIT ..... ==> YES (Y/N - Commit after successful run?)
9 BROWSE OUTPUT .... ==> YES (Y/N - Browse output data set?)

For remote SQL processing:
10 CONNECT LOCATION ==>

PRESS: ENTER to process END to exit HELP for more information
```

The CHANGE DEFAULTS field is also changed to * to indicate that it has been processed and that when the Enter key is pressed the defaults panel will not be displayed.

There are two methods of entering your SQL statements through SPUFI:

- You can create your input data set or data set member and using ISPF, code all your required statements prior to invoking them through SPUFI.
- Another method is to type YES into the EDIT INPUT field so that when SPUFI is invoked, the input data set will be opened using ISPF Edit and you can type in the statements required for that invocation.

The SQL statements required can be entered in the data area of this screen, either into an empty line or by overtyping existing text. When all statements have been entered, the PF3 key or END command can be used to save the data and return to the SPUFI panel.

SPUFI Panel - Processing

The message at the top of the SPUFI panel indicates that the editing has been performed on the input data set. Normally you will want to begin processing the SQL statements that you have entered in your input data set, so the EXECUTE field should be set to Y or YES before pressing the Enter key.

```
          SPUFI                               SSID: DBCG
==>
DSNE808A EDIT SESSION HAS COMPLETED. PRESS ENTER TO CONTINUE
Enter the input data set name:           (Can be sequential or partitioned)
 1 DATA SET NAME ... ==> 'XAT8.SQLTEST(UPDATE)'
 2 VOLUME SERIAL ... ==>               (Enter if not cataloged)
 3 DATA SET PASSWORD ==>              (Enter if password protected)

Enter the output data set name:          (Must be a sequential data set)
 4 DATA SET NAME ... ==> RESULT

Specify processing options:
 5 CHANGE DEFAULTS ==> *             (Y/N - Display SPUFI defaults panel?)
 6 EDIT INPUT ..... ==> *            (Y/N - Enter SQL statements?)
 7 EXECUTE ..... ==> YES            (Y/N - Execute SQL statements?)
 8 AUTOCOMMIT ..... ==> YES         (Y/N - Commit after successful run?)
 9 BROWSE OUTPUT ... ==> YES        (Y/N - Browse output data set?)

For remote SQL processing:
10 CONNECT LOCATION ==>

PRESS: ENTER to process    END to exit      HELP for more information
```

If this field is set to NO and the BROWSE OUTPUT field is set to YES, then no SQL processing will be performed but any existing data in the output data set specified will be displayed.

SPUFI Panel - Interrupting Processing

If the EXECUTE field is set to YES in your SPUFI panel, the next stage when you press Enter will see the execution of your SQL statements.

If there are many statements in your input data set or if the table you are interrogating is large, it may take considerable time to process the statements. If this is unacceptable, you can interrupt the processing by using the PA1 key, with the amount of output created depending on how much processing the statement(s) were able to perform before being interrupted.

If SPUFI terminates while executing your statements, it could indicate that DB2 resource limits have been defined by your DB2 administrator and that your SQL execution has exceeded them.

Note: The AUTOCOMMIT option on this page has been changed to NO, so that you can see the SPUFI COMMIT OR ROLLBACK panel on the next page.

```
Specify processing options:
 5 CHANGE DEFAULTS ==> *             (Y/N - Display SPUFI defaults panel?)
 6 EDIT INPUT ..... ==> *            (Y/N - Enter SQL statements?)
 7 EXECUTE ..... ==> YES            (Y/N - Execute SQL statements?)
 8 AUTOCOMMIT ..... ==> NO           (Y/N - Commit after successful run?)
 9 BROWSE OUTPUT ... ==> YES        (Y/N - Browse output data set?)
```

SPUFI Panel - Saving Changes

Normally when processing SQL statements you will want the results saved to the Db2 tables if they have executed successfully. If you are testing statements then you can be given the option to commit them to the database by specifying N or NO in the AUTOCOMMIT field on the SPUFI panel. This will result in the screen shown here being displayed.

```
          SPUFI COMMIT OR ROLLBACK           SSID: DBCG
==> DSNE361I SPUFI PROCESSING COMPLETE
Explanation:
The last SQL statement ran with a return code of -204
Because AUTOCOMMIT was set to NO, you must now decide whether to:
* COMMIT (save) your database changes or to
* ROLLBACK (erase) your database changes or to
* DEFER the decision, which will allow you to continue processing
another input data set. If you select DEFER, it is possible
that you will tie up system resources that others need.

1 NEXT ACTION ==> COMMIT      (Enter COMMIT, ROLLBACK, or DEFER)

PRESS: ENTER to process           HELP for more information
```

SPUFI Panel - Remote Servers

If your SQL statements need to be processed on a remote database server, then the location of that server can be entered into the CONNECT LOCATION field.

```
8 NO/SELECT/PRINT/... ==> YES      S/N?  Commits when successful?  Trans?
9 BROWSE OUTPUT ... ==> YES      (Y/N - Browse output data set?)
For remote SQL processing:
10 CONNECT LOCATION ==> TESTDB  ←
PRESS: ENTER to process      END to exit           HELP for more information
```

If SPUFI is unable to connect to your specified CONNECT LOCATION, then the output data set will display return codes and error messages relating to the attempt.

Interpreting SPUFI Output

Output Format

The ISPF Browse facility is opened and the result of your SQL execution is displayed. At the top of the output produced, the following data is displayed:

- A copy of the SQL statements from the input data set
- The data produced as a result of the processed SQL statements

Browsing data set XAT8.RESULT.

Line 00000000 Col 001 080
scroll ===> CSR

***** Top of Data *****

```
BROWSE XAT8.RESULT
Command ===>
***** Top of Data *****
```

SELECT * FROM CHICAGO.EMP;

EMPLNO	FNAME	LNAME	DEPT	DOB	SALARY
000001	THOMAS	FAARLT	SALES	1985-04-17	52500
000002	TY	NGUYEN	MARKETTING	1986-12-08	41000
000003	SONIA	ELLIOT	SUPPORT	1990-08-07	37750
000004	JOHN	GEYER	SUPPORT	1961-05-27	35000
000006	REECE	TERN	DEVELOPMENT	1977-01-12	41850
000007	EVA	OPROSLKT	SALES	1985-06-20	51200
000010	GREG				44800
000011	WILMA				39850
000014	MOHINDER	SINGH	PRODUCTION	1988-02-28	40025
000015	EVAN	WILSON	SUPPORT	1977-07-01	36660
000016	DOLORES	QUINTANA	NETWORK	1980-09-28	49920
000018	HEATHER	HAMILTON	HR	1987-12-24	45850
000019	BRUCE	IANSON	OPERATIONS	1983-11-19	41075
000021	ANTHIA	STOCKLEY	MARKETING	1987-10-03	43580

Displays all information from the CHICAGO.EMP table.

Column/field names and their values are displayed.

As you scroll toward the bottom of the data, you may encounter warning or error messages associated with the invocation, and will also see summary statistics.

Updating the salary values in CHICAGO.EMP table.

Line 00000000 Col 001 080
scroll ==> CSR

```
Menu Utilities Compile
BROWSE XAT8.RESULT
Command ===>
***** Top of Data *****
```

000183 LI KWONG SUPPORT 1991-10-14
000184 PAULA MASONI MARKETING 1979-05-24

DSNE610I NUMBER OF ROWS DISPLAYED IS 169
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 100

Successfully processed SELECT statements invoked through SPUFI return a SQL code of 100.

UPDATE CHICAGO.EMP
SET SALARY = SALARY * 1.05;

DSNE610I NUMBER OF ROWS AFFECTED IS 169
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0

An SQL code of 0 for any other SQL statements indicates that processing was successful.

DSNE610I COMMIT PERFORMED, SQLCODE IS 0
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0

DSNE601I SQL STATEMENTS ASSUMED TO BE BETWEEN COLUMNS 1 AND 72
DSNE620I NUMBER OF SQL STATEMENTS PROCESSED IS 2
DSNE621I NUMBER OF INPUT RECORDS READ IS 4
DSNE622I NUMBER OF OUTPUT RECORDS WRITTEN IS 191

***** Bottom of Data *****

Sample 1 - Error Message

The example shown here highlights a message indicating that there is a problem. The message says that the table name specified in the SELECT statement is undefined, which indicates that a table of that name could not be located.

As a result of this error, rollback processing is performed.

```
Menu Utilities Compilers Help
BROWSE XAT8.RESULT Line 00000000 Col 001 080
Command ===> Scroll ==> CSR
***** Top of Data *****
+-----+
SELECT * FROM CHIG.EMP;
+-----+
DSNT408I SQLCODE = -204, ERROR: CHIG.EMP IS AN UNDEFINED NAME
DSNT418I SQLSTATE = 42704 SQLSTATE RETURN CODE
DSNT415I SQLERRP = DSNXOTL SQL PROCEDURE DETECTING ERROR
DSNT416I SQLERRD = -500 0 0 -1 0 0 SQL DIAGNOSTIC INFORMATION
DSNT416I SQLERRD = X'FFFFFE0C' X'00000000' X'00000000' X'FFFFFF'
X'00000000' X'00000000' SQL DIAGNOSTIC INFORMATION
+-----+
DSNE618I ROLLBACK PERFORMED, SQLCODE IS 0
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
+-----+
DSNE601I SQL STATEMENTS ASSUMED TO BE BETWEEN COLUMNS 1 AND 72
DSNE620I NUMBER OF SQL STATEMENTS PROCESSED IS 1
DSNE621I NUMBER OF INPUT RECORDS READ IS 1
DSNE622I NUMBER OF OUTPUT RECORDS WRITTEN IS 17
***** Bottom of Data *****

This message occurs when an error is encountered and the AUTOCOMMIT field on the SPUFI panel is set to YES. Rollback will undo any data changes made since the last commit.
```

Sample 2 - Error Message

In this example, the messages indicate that there is an illegal symbol being used to terminate one of the SQL statements. In fact, the problem is associated with a missing corresponding closed parenthesis on the last line.

This highlights that at times it can be difficult to determine the actual cause of a problem from the messages displayed.

```
Menu Utilities Compilers Help
BROWSE XAT8.RESULT Line 00000000 Col 001 080
Command ===> Scroll ==> CSR
***** Top of Data *****
+-----+
CREATE TABLE COURSE5.DET
(EMPNO CHAR(6) NOT NULL,
COURSENAME VARCHAR(36) NOT NULL,
SCORE CHAR(6),
ADMRDEPT CHAR(3) NOT NULL,
LOCATION CHAR(16),
PRIMARY KEY(EMPNO);
+-----+
DSNT408I SQLCODE = 104, ERROR: ILLEGAL SYMBOL "<END-OF-STATEMENT>". SOME
SYMBOLS THAT MIGHT BE LEGAL ARE: , )
DSNT418I SQLSTATE = 42601 SQLSTATE RETURN CODE
DSNT415I SQLERRP = DSNHPARS SQL PROCEDURE DETECTING ERROR
DSNT416I SQLERRD = 3 0 0 -1 452 502 SQL DIAGNOSTIC INFORMATION
DSNT416I SQLERRD = X'00000003' X'00000000' X'00000000' X'FFFFFF'
X'000001C4' X'000001F6' SQL DIAGNOSTIC INFORMATION
+-----+
DSNE618I ROLLBACK PERFORMED, SQLCODE IS 0
DSNE616I STATEMENT EXECUTION WAS SUCCESSFUL, SQLCODE IS 0
```

Batch SPUFI

There is a batch equivalent that you may prefer to use if you have a large amount of SQL statements you need to invoke or there is a big Db2 table you need to access. Several batch programs are available that perform functions similar to those found in SPUFI, with DSNTEP2 and DSNTEP4 being the most popular.

An example of batch SPUFI is shown here.

```
File Edit Edit_Settings Menu Utilities Compilers Test Help
-----
EDIT      JOHN.SPUFI.PDS(BATSPUFI) - 01.00          Columns 00001 00072
Command ==>                                         Scroll ==> CSR
***** **** Top of Data ****
000001 //BATSPUFI JOB (20,FB3),JOHN,MSGLEVEL=(1,1),TIME=20,
000002 //           CLASS=A,MSGCLASS=H,NOTIFY=JOHN,REGION=0M
000003 //DSNC10   JCLLIB ORDER=(VENDOR.PROCLIB,DSNC10.PROCLIB)
000004 //JOBLIB    DD DISP=SHR,DSN=DSNC10.SDSNLOAD
000005 //TEST1AB  EXEC PGM=IKJEFT01,DYNAMNBR=20
000006 //SYSTSPRT DD SYSOUT=*
000007 //SYSPRINT DD SYSOUT=*
000008 //SYSTSIN  DD *
000009   DSN SYSTEM(DBCG)
000010   RUN PROGRAM(DSNTEP2) PLAN(DSNTEP12) -
000011     LIB('DSNC10.DBCG.RUNLIB.LOAD') -
000012     PARMS('/ALIGN(LHS) MIXED TOLWARN(YES)')
000013   END
000014 //SYSIN    DD *
000015   SELECT * FROM DSN81210.EMP;
000016 /*
***** **** Bottom of Data ****
```

General DB2 Operations

Brief Overview

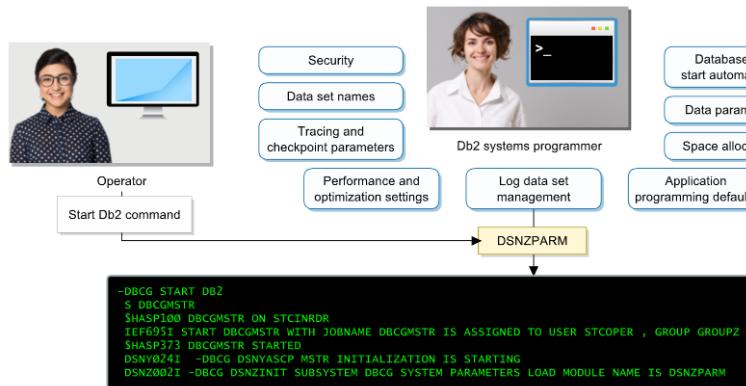
Before discussing one's role as a DB2 operator, you need to be aware of how it is implemented and managed within your organization. This may assist you at a later stage if you encounter a DB2 problem during startup or shut down and need to diagnose and escalate it.

The following are the general phases associated with implementing and managing DB2:

- **Database Plan** - The organisation's data and processing requirements are used to create an operational plan.
- **Logical and Physical Design** - A logical model of the database is created, starting with the identification of database entities, primary keys, the relationship between entities, and the attributes associated with the entities. The physical design is the creation of required tables, tablespaces and indexes. The attributes associated with DB2 components such as storage groups and buffer pools are defined and the identification and creation of stored procedures is undertaken.
- **Data Loaded into DB2** - A load utility is available to move data from sequential data sets to newly created tables. The SQL statement INSERT can also be used to enter data into tables.
- **Managing DB2** - The day to day operation of the DB2 subsystem should require minimal interaction except when there are issues that require you to issue Db2 commands to display status and resolve problems. There are also several utility programs you may be required to run for reporting, data validation, copying, loading, backup, and recovery purposes.
- **Fine Tuning the DB2 Database** - An ongoing process of evaluating the performance of the database is performed, this includes response times and system availability. Fine tuning the database can be undertaken using various utilities and DB2 commands.

DB2 Startup Parameters

As part of the DB2 implementation process, the database administrator or DB2 systems programmer will have created a load module, which contains DB2 subsystem parameters. These parameters are used during DB2 startup to define subsystem characteristics. The default name of this load module is DSNZPARM.



When the start DB2 command is issued, a number of DB2 address spaces may be started. The system services address space (MSTR) and database services address space (DBM1) will always be started, while others shown here are dependent on subsystem parameter settings.

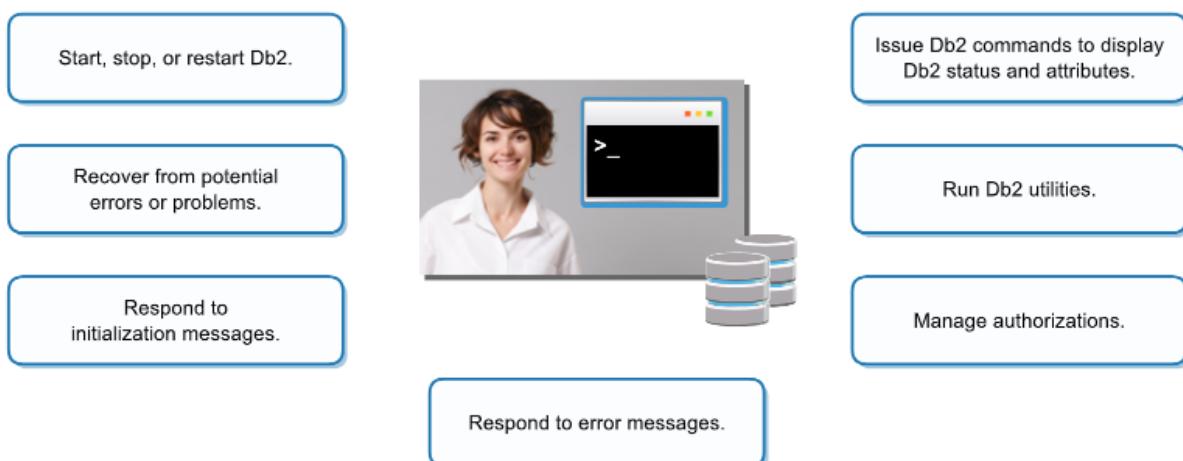
Display Filter View Print Options Search Help									
SDSF DA SOW1 SOW1 PAG 0 CPU 6					CHARS 'DBCG' FOUND				
COMMAND INPUT ==>					SCROLL ==> CSR				
NP	JOBNAME	StepName	ProcStep	JobID	Owner	C	Pos	DP	Real Paging SIO
	DBCGLRLM	DBCGLRLM	IEFPROC	STC05055	STCOPER	NS	FE	3077	0.00 0.00
	DBCGBM1	DBCGBM1	IEFPROC	STC05056	STCOPER	NS	FE	56T	0.00 0.01
	DBCGMSTR	DBCGMSTR	IEFPROC	STC05054	STCOPER	NS	FE	2013	0.00 0.04
	DBCGDIST	DBCGDIST	IEFPROC	STC05057	STCOPER	NS	FE	4964	0.00 0.00
	DBCADM1	DBCADM1	STARTADM	STC05084	STCOPER	IN	C1	2775	0.00 0.10

The purpose of the following address spaces:

- **DBCGLRLM** - The internal resource lock manager (IRLM) is used to ensure the integrity of DB2 data by locking it while it is in use and releasing the lock when the data is no longer required.
- **DBCGBM1** - This address space handles the majority of database related services.
- **DBCGMSTR** - This address space performs a number of system related functions.
- **DBCGDIST** - The distributed data facility provides support for remote requests.
- **DBCADM1** - The administrative task manager (ADMT) is responsible for scheduling the execution of commonly run user-defined tasks.

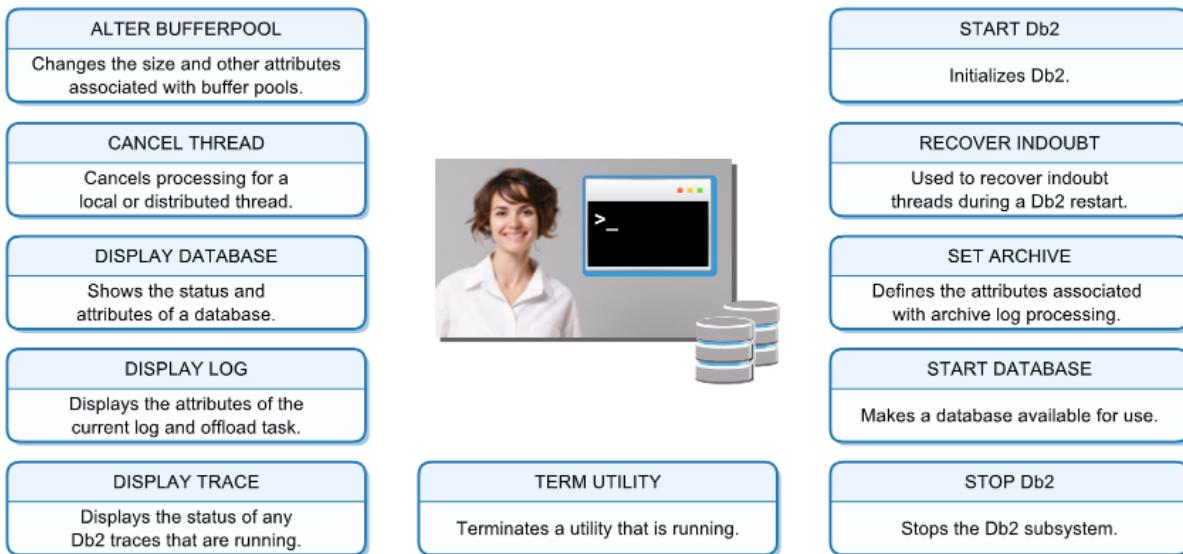
Common Operator Tasks

The information discussed so far has provided details on what to expect when DB2 is started. Once this has occurred, it will generally be the responsibility of the operator to monitor the product and perform initial problem diagnosis should it be required.



Entering DB2 Commands

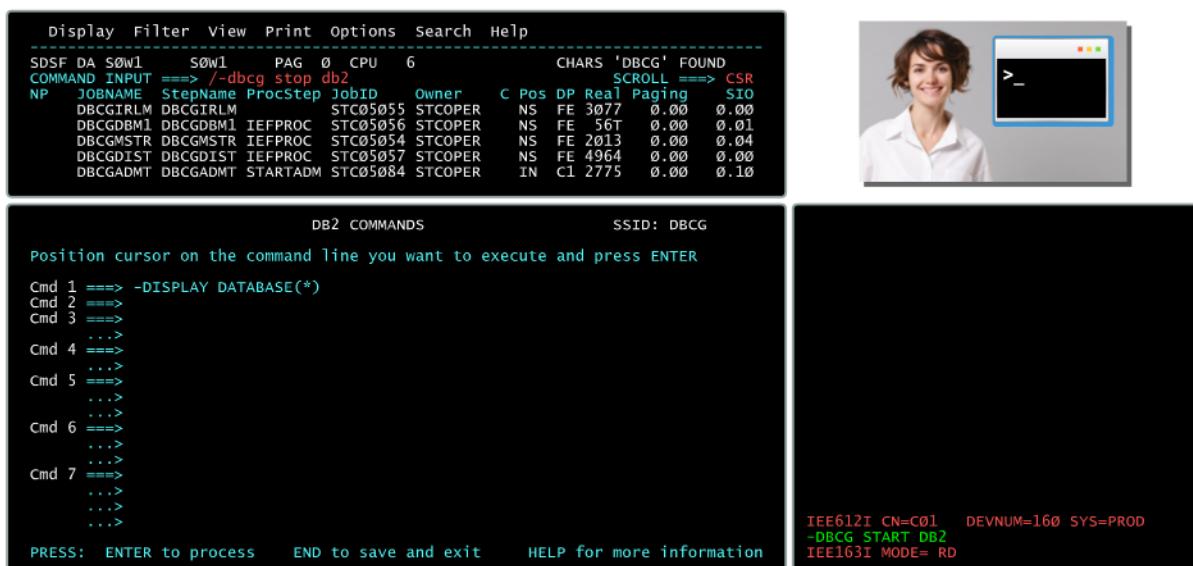
If you have been assigned appropriate access, there are a number of DB2 commands used to assist you with the day-to-day operation and monitoring of DB2.



DB2 commands can be entered from a number of different sources, such as:

- A z/OS console
- A z/OS application program
- APF authorized programs such as SDSF
- An IMS terminal/program
- A DB2I panel
- A CICS terminal
- An IFI application program.

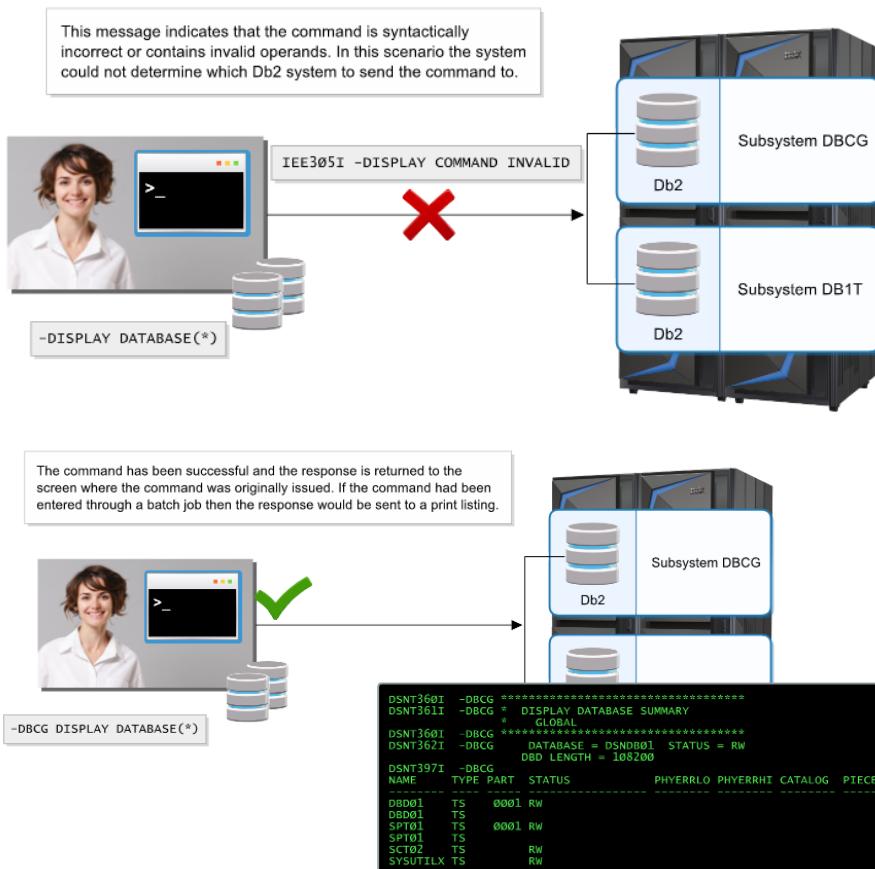
Note: Not all commands can be entered from all the sources mentioned, as they require higher authority.



DB2 Command Syntax

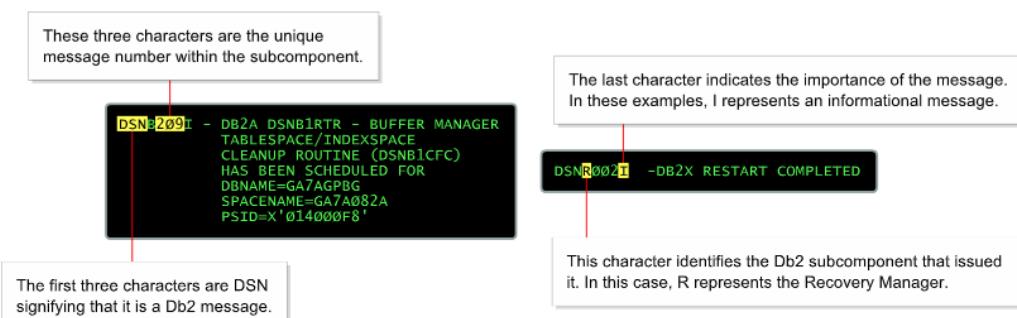
You have probably noticed with the DB2 commands displayed in this module that they are prefixed with a hyphen (-). This character is often used as the default prefix character.

If you have multiple DB2 subsystems, commands need to be further qualified so that the command is sent to the correct subsystem. In this scenario, a command prefix in the form of a one to eight character subsystem name needs to be added.



DB2 Messages

Whether you are looking at messages produced from executing SQL, Db2 initialization messages, or responses to Db2 commands, Db2 produces a unique message using the format displayed here.



Starting and Stopping DB2

DB2 Startup

When your system is IPLed, the message highlighted here will be displayed indicating that a start command can be issued for your Db2 subsystem. The operator or other authorized user must enter the start command to make Db2 operational.

```
IEE252I MEMBER IEFSSNAT FOUND IN SYS1.PARMLIB
IEE538I CTICBR00 MEMBER NOT FOUND IN PARMLIB
CBR7320I The SYSOAM component trace has been initialized successfully
without the CTICBR00 parmlib member.
CBR8001I OAM1 subsystem initialization starting.
CBR8007I No DB2 SSID or the DB2 SSID value of "NONE" has been specified.
OTIS subsystem cannot successfully initialize.
CBR8002I OAM1 subsystem initialization completed.
IEE252I MEMBER IEFSSNDB FOUND IN SVTSC.PARMLIB
DSN3100I -DBCG DSN3UR00 - SUBSYSTEM DBCG READY FOR START COMMAND
IEE252I MEMBER IEFSSN66 FOUND IN SVTSC.PARMLIB
IEE252I MEMBER DFHSSI66 FOUND IN SVTSC.PARMLIB
DFH0100 CICS subsystem is now initialized
IEF196I DFH0100 CICS subsystem is now initialized
IEE389I MVS COMMAND PROCESSING AVAILABLE
ISG359I GRS EXIT CACHE WAS CREATED SUCCESSFULLY
IEE677I 16.41.59 MPF DISPLAY 433
MESSAGE SUPPRESSION AND USER EXITS INACTIVE - NOT INITIALIZED
GENERAL WTO USER EXIT (IEAVMXIT) INACTIVE
SUBSYSTEMS RECEIVING FOREIGN MESSAGES AND DOMS:

IEE612I CN=C01 DEVNUM=160 SYS=PROD
-DBCG START DB2
IEE163I MODE= RD
```

Several screens of DB2 related messages are displayed as a result of DB2 starting.

```
-DBCG START DB2
S DBCGMSTR
$HASP100 DBCGMSTR ON STCINRDR
IEF695I START DBCGMSTR WITH JOBNME DB2
, GROUP GROUPZ
$HASP373 DBCGMSTR STARTED
DSNY024I -DBCG DSNYASCP MSTR INITIALIZATION IS STARTING
DSNZ002I -DBCG DSNZINIT SUBSYSTEM DBCG SYSTEM PARAMETERS LOAD MODULE
NAME IS DBCGPARM
DSNZ016I -DBCG DSNZINIT 135
SUBSYSTEM DBCG SYSTEM PARAMETERS ARE AS FOLLOWS:
  SYSTEM PARM DSNC10.DBCG.SDSNEXIT(DBCGPARM)
  DSNHDECP DSNC10.DBCG.SDSNEXIT(DSNHDECP)
  ACCESS EXIT DSNC10.DBCG.SDSNEXIT(DSNX@XAC)
  IDAUTH EXIT DSNC10.DBCG.SDSNEXIT(DSN3@ATH)
  SIGNON EXIT DSNC10.DBCG.SDSNEXIT(DSN3@SGN)
DSNZ017I -DBCG DSNZINIT 136
SUBSYSTEM DBCG DATE AND TIME EXITS ARE AS FOLLOWS:
  ASCII DATE DSNC10.SDSNLOAD(DSNXVDTA)
  EBCDIC DATE DSNC10.SDSNLOAD(DSNXVDTX)
  UNICODE DATE DSNC10.SDSNLOAD(DSNXVDTU)
  ASCII TIME DSNC10.SDSNLOAD(DSNXVTMA)
  EBCDIC TIME DSNC10.SDSNLOAD(DSNXVTMX)
  UNICODE TIME DSNC10.SDSNLOAD(DSNXVTMU)
DSN7407I -DBCG DSN7GAR1 137
AUTOMATIC RESTART MANAGER REGISTER FAILED.
  MVS IXCARM RETURN CODE = 0000000C,
  MVS IXCARM REASON CODE = 00000160.

IEE612I CN=C01 DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

The MSTR address space responsible for Db2 system related functions is started.

The Db2 subsystem DBCG is being started using the system parameters stored in the DBCGPARM load module.

The following DB2 startup messages continue to scroll during startup.

```
S DBCGIRLM
$HASP100 DBCGIRLM ON STCINRDR
IEF695I START DBCGIRLM WITH JOBNM DBCGIRLM IS ASSIGNED TO USER STCOPER
, GROUP GROUPZ
$HASP373 DBCGIRLM STARTED
DXR180I DJCG001 AUTOMATIC RESTART MANAGER IS NOT ENABLED
DXR117I DJCG001 INITIALIZATION COMPLETE
DSNY001I -DBCG SUBSYSTEM STARTING
DSNJ127I -DBCG SYSTEM TIMESTAMP FOR BSDS= 20.078 12:20:30.62
DSN1001I -DBCG DSNJW007 CURRENT COPY 1 ACTIVE LOG 147
DATA SET IS DSNAME=DSNC10.DBCG,LOGCOPY1.DS03,
STARTRBA=000000000001303DD000,ENDRBA=0000000000013259CFFF
DSN1001I -DBCG DSNJW007 CURRENT COPY 2 ACTIVE LOG 148
DATA SET IS DSNAME=DSNC10.DBCG,LOGCOPY2.DS03,
STARTRBA=000000000001303DD000,ENDRBA=0000000000013259CFFF
DSN1099I -DBCG LOG RECORDING TO COMMENCE WITH 149
STARTRBA=000000000001309C8000
S DBCGDBM1
$HASP100 DBCGDBM1 ON STCINRDR
IEF695I START DBCGDBM1 WITH JOBNM DBCGDBM1 IS ASSIGNED TO USER STCOPER
, GROUP GROUPZ
IEE612I CN=C01 DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

The IRLM address space responsible for data locking is started.

The log manager is being initialized.

The DBM1 address space responsible for database services is started.

Messages relating to further DB2 address spaces being started and data recovery being performed are displayed during the startup process.

```
$HASP373 DBCGDBM1 STARTED
DSNY024I -DBCG DSNYASCP DBM1 INITIALIZATION IS STARTING
S DBCGDIST
$HASP100 DBCGDIST ON STCINRDR
IEF695I START DBCGDIST WITH JOBNM DBCGDIST IS ASSIGNED TO USER STCOPER
, GROUP GROUPZ
$HASP373 DBCGDIST STARTED
DSNY024I -DBCG DSNYASCP DIST INITIALIZATION IS STARTING
DSNR001I -DBCG RESTART INITIATED
DSNR003I -DBCG RESTART...PRIOR CHECKPOINT RBA=000000000001309BC664
DSNR004I -DBCG RESTART...UR STATUS COUNTS 162
IN COMMIT=0, INDOUBT=0, INFLIGHT=0, IN ABORT=0, POSTPONED ABORT=0
DSNR005I -DBCG RESTART...COUNTS AFTER FORWARD 163
RECOVERY
IN COMMIT=0, INDOUBT=0
DSNR006I -DBCG RESTART...COUNTS AFTER BACKWARD 164
RECOVERY
INFLIGHT=0, IN ABORT=0, POSTPONED ABORT=0
DSNG007I -DBCG DB2 CATALOG LEVEL (V12R1M505 ) 165
    CODE LEVEL (V12R1M506 )
    CURRENT FUNCTION LEVEL (V12R1M505 )
    HIGHEST ACTIVATED FUNCTION LEVEL (V12R1M505 )

IEE612I CN=C01 DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

The DIST address space responsible for providing support for remote requests is started.

The Db2 restart process is started to ensure that any recovery is performed so that data is in a consistent state.

The message highlighted here indicates that the START DB2 command was successfully processed.

```
LU      USASDV02.DBCGLU1
      GENERICLU -NONE
      DOMAIN   S0W1.DAL-EBIS.IHOST.COM
      TCPPORT  5040
      SECPORT  5041
      RESPORT  5042
      IPNAME   -NONE
      OPTIONS:
          PKGREL = COMMIT
S DBCGADMT
$HASP100 DBCGADMT ON STCINRDR
IEF695I START DBCGADMT WITH JOBNM DBCGADMT IS ASSIGNED TO USER STCOPER
, GROUP GROUPZ
$HASP373 DBCGADMT STARTED
DSNA671I DSNA&MA1 THE ADMIN SCHEDULER DBCGADMT IS STARTING
DSN9022I -DBCG DSNYASCP 'START DB2' NORMAL COMPLETION
DSNA672I DSNA&MA1 START COMMAND FOR ADMIN SCHEDULER DBCGADMT NORMAL
COMPLETION
DSNL519I -DBCG DSNLIRSY TCP/IP SERVICES AVAILABLE 181
          FOR DOMAIN S0W1.DAL-EBIS.IHOST.COM AND PORT 5042

IEE612I CN=C01 DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

The administrative task scheduler (DBCGADMT), which is responsible for scheduling the execution of commonly run user-defined tasks, is being started automatically.

In the scenario displayed here there are two messages relating to different DB2 subsystems that can be started. The start command used will need to have the subsystem name specified at the beginning of the command.

For example, the DBCG DB2 subsystem would require the following command to initialize it:
-DBCG START DB2

```
DSN3100I -DBBG DSN3UR00 - SUBSYSTEM DBBG READY FOR START COMMAND
DSN3100I -DBCG DSN3UR00 - SUBSYSTEM DBCG READY FOR START COMMAND
IEE389I MVS COMMAND PROCESSING AVAILABLE
ISG359I GRS EXIT CACHE WAS CREATED SUCCESSFULLY
IEE677I 17.52.34 MPF DISPLAY 454
MESSAGE SUPPRESSION AND USER EXITS INACTIVE - NOT INITIALIZED
GENERAL INFO: USER EXIT (TEAMNT) INACTIVE
```

As you can see in the example here, if you accidentally enter the start Db2 command and Db2 is already operational, it will inform you of this fact and ignore the request.

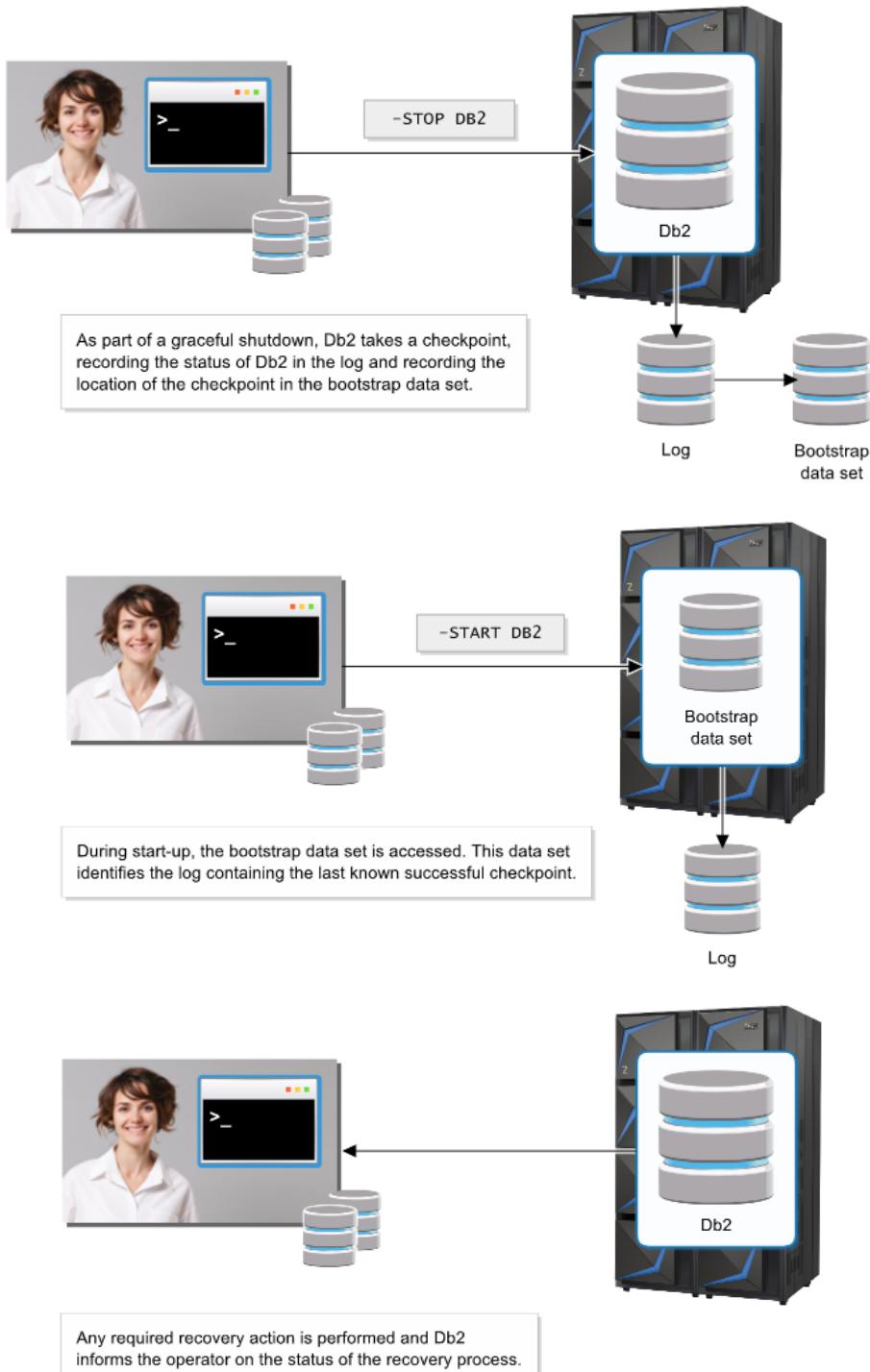
```
-DBCG START DB2
DSNY003I -DBCG SUBSYSTEM IS ALREADY ACTIVE
DSN9023I -DBCG DSNYSCMD 'START DB2' ABNORMAL COMPLETION
```

There are several other parameters that can be specified when starting a Db2 subsystem:

- **-START DB2 PARM(load module name)** if you require DB2 to be started using a different set of system parameters, then the PARM parameter can be used to specify an alternate module.
- **-START DB2 DECP(load module name)** the load module containing the DB2 application parameter defaults can be specified using this parameter. If this parameter is omitted, the DSNHDECP load module is used.
- **-START DB2 ACCESS(MAINT)** you can restrict access to the DB2 subsystem using this command. The MAINT option allows only users with SYSADM, SYSOPR, and SECADM authority to access the database.
- **- START DB2 LIGHT(YES)** if you are in a data sharing environment, this command can be used to recover retained locks being held by a member. During this process, no new work is accepted and once processing is complete, DB2 is terminated normally.
- **-START DB2 DBM1/MSTR(parm)/DIST** this command can be used to pass the parameters to the DBM1, MSTR or DIST address spaces. For example, -START DB2 MSTR('REGION=8000K') would substitute REGION=8000K on the EXEC statement for the JCL used to initiate the MSTR address space.
- **START admtproc, TRACE=ON** the administrative task scheduler is started using an MVS command rather than using DB2 commands. An optional TRACE parameter can be used to turn tracing on or off.

DB2 Restart and Recovery

The examples shown so far assume that DB2 was stopped successfully last time it ran, which will result in DB2 starting smoothly. If there were problems with DB2 previously then you may encounter a number of different start-up messages pertaining to recovery or an unrecoverable error.



DB2 Shutdown

As seen above, when DB2 needs to be brought down, or terminated, the STOP DB2 command can be issued and must be invoked from a source that has appropriate authority. As part of the normal shut down process, executing programs are allowed to complete and no new work is accepted.

Note: Before entering this command you should ensure that Db2 has no outstanding write-to-operator messages, as this could prevent shut down.

```
INFLIGHT=0, IN ABORT=0, POSTPONED ABORT=0
DSNG007I -DBCG DB2 CATALOG LEVEL (V12R1M505 ) 165 CODE LEVEL (V12R1M506 )
          CURRENT FUNCTION LEVEL (V12R1M505 )
          HIGHEST ACTIVATED FUNCTION LEVEL (V12R1M505 )
DSNR002I -DBCG RESTART COMPLETED
-DBCGRECOVER POSTPONED
DSNV434I -DBCG DSNVRP NO POSTPONED ABORT THREADS FOUND
DSN9022I -DBCG DSNVRP 'RECOVER POSTPONED' NORMAL COMPLETION
DSNL003I -DBCG DDF IS STARTING
DSN3029I -DBCG DSN3RRRS RRS ATTACH PROCESSING IS AVAILABLE
DSNL519I -DBCG DSNLILNR TCP/IP SERVICES AVAILABLE 172
          FOR DOMAIN S0W1.DAL-EBIS.IHOST.COM AND PORT 5040
DSNL004I -DBCG DDF START COMPLETE 173
          LOCATION DALLASC
          LU     USASDV02.DBCGLU1
          GENERICCLU -NONE
          DOMAIN   S0W1.DAL-EBIS.IHOST.COM
          TCPPORT  5040
          SECPORT  5041
          RESPORT  5042
          IPNAME   -NONE
          . . .
          DSN9022I -DBCG DSNYASCP 'START DB2' NORMAL COMPLETION

IEE612I CN=C01    DEVNUM=160 SYS=PROD
-DBCG STOP DB2■
IEE163I MODE= RD
```

The messages displayed here provide you with an example of what you would be likely to see during the shutdown process.

```
-DBCG STOP DB2
DSNY002I -DBCG SUBSYSTEM STOPPING
DSNL005I -DBCG DDF IS STOPPING
DSNL006I -DBCG DDF STOP COMPLETE
ATR169I RRS HAS UNSET EXITS FOR RESOURCE MANAGER 196
DSN.RRSATF.IBM.DBCG REASON: UNREGISTERED
ATR169I RRS HAS UNSET EXITS FOR RESOURCE MANAGER 197
DSN.RRSPAS.IBM.DBCG REASON: UNREGISTERED
DSNY025I -DBCG DSNYASCP DBM1 SHUTDOWN IS COMPLETE
DSNY025T -DBCG DSNYASCP DIST SHUTDOWN IS COMPLETE
IEF352I ADDRESS SPACE UNAVAILABLE
$HASP395 DBCGDIST ENDED - RC=0000
IEA989I SLIP TRAP ID=X33E MATCHED.  JOBNAME=*UNAVAIL, ASID=002A.
IEF352I ADDRESS SPACE UNAVAILABLE
$HASP395 DBCGDBM1 ENDED - RC=0000
IEA989I SLIP TRAP ID=X33E MATCHED.  JOBNAME=*UNAVAIL, ASID=0022.
DSNY025I -DBCG DSNYASCP MSTR SHUTDOWN IS COMPLETE
DSN9022I -DBCG DSNYASCP 'STOP DB2' NORMAL COMPLETION
IEF352I ADDRESS SPACE UNAVAILABLE
$HASP395 DBCGMSTR ENDED - RC=0000
IEA989I SLIP TRAP ID=X33E MATCHED.  JOBNAME=*UNAVAIL, ASID=0026.

IEE612I CN=C01    DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

The DBM1, DIST, and MSTR address spaces have completed their shut down processing.

Several other screens of shut down messages will be displayed as all DB2 address spaces are brought down. The highlighted messages here indicate that Db2 has been shut down and that a start command for that DB2 subsystem can now be issued if required.

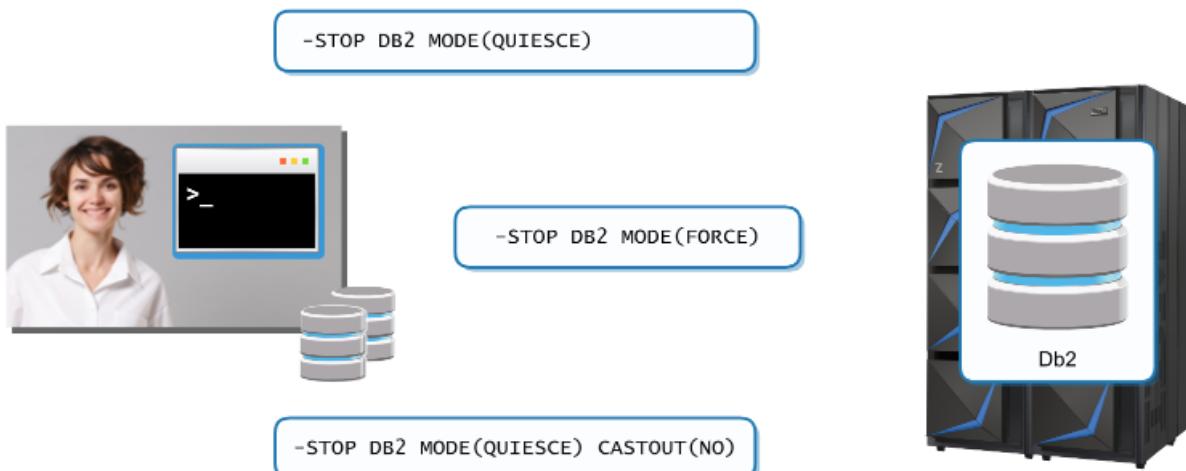
```
$HASP395 DBCGMSTR ENDED - RC=0000
IEA989I SLIP TRAP ID=X33E MATCHED.  JOBNAME=*UNAVAIL, ASID=0026.
DSN3104I -DBCG DSN3ECOX - TERMINATION COMPLETE
DSN3100I -DBCG DSN3ECOX - SUBSYSTEM DBCG READY FOR START COMMAND
DXR110I DJCG001 STOP COMMAND ACCEPTED
DXR121I DJCG001 END-OF-TASK CLEANUP SUCCESSFUL - HI-CSA      499K -
HI-ACCT-CSA   OK - HI-PVT 5615K
IEF352I ADDRESS SPACE UNAVAILABLE
$HASP395 DBCGIRLM ENDED - RC=0000

IEE612I CN=C01    DEVNUM=160  SYS=PROD
IEE163I MODE= RD
```

There are variations of the stop command that can be used in specific situations.

The QUIESCE option is the default when using the -STOP DB2 command and as mentioned previously, will allow existing processing to complete. The FORCE option will terminate any programs executing, which may result in additional error messages and dumps being produced during shut down.

In a data sharing environment, the CASTOUT option can be used to specify the action taken with changed pages residing in a group buffer pool. YES is the default and will write the buffer pool changes to disk.



Monitoring and Resolving DB2 Operational Problems

Monitoring and Managing Databases

With DB2 up and running, there is usually only a minimal amount of monitoring that is required by the operator. The DB2 commands described in this section are used when there is a scenario that requires you to display the status or attributes of DB2 databases or when DB2 databases need to be stopped or restarted.

Displaying Database Status and Attributes

While you may use several tools to measure how your DB2 database is performing, the DISPLAY DATABASE command is capable of providing a good snapshot of your database structure and activity.

```
INFLIGHT=0, IN ABORT=0, POSTPONED ABORT=0
DSNG007I -DB1A DB2 CATALOG LEVEL (V12R1M505 ) 354 CODE LEVEL (V12R1M507 )
CURRENT FUNCTION LEVEL (V12R1M505 ) HIGHEST ACTIVATED FUNCTION LEVEL (V12R1M505 )
DSNR002I -DB1A RESTART COMPLETED
DSN3583I -DB1A DSN3AUGC MFA AUTHCACHE UNUSED TIME IS 356 0 AND NOT UPDATEABLE
DSN3030I -DB1A DSN3RRSI RRS ATTACH WAITING FOR Z/OS 357
RRS INITIALIZATION, RRS CALL=CRGSEIF, RRS RETURN CODE=X'00000720'
-DB1ARECOVER POSTPONED
DSNV434I -DB1A DSNVRP NO POSTPONED ABORT THREADS FOUND
DSN9022I -DB1A DSNVRP 'RECOVER POSTPONED' NORMAL COMPLETION
DSNL003I -DB1A DDF IS STARTING
DSNB317I -DB1A NO OBJECTS IN LPL STATUS
DSNL519I -DB1A DSNLILNR TCP/IP SERVICES AVAILABLE 363
FOR DOMAIN S0W1.DAL-EBIS.IHOST.COM AND PORT 5040
DSNL004I -DB1A DDF START COMPLETE 364
LOCATION DALLASC LU USASDV02.DB1ALU1
GENERICCLU -NONE GENERICCLU -NONE
DOMAIN S0W1.DAL-EBIS.IHOST.COM
TCPPORT 5040 SECPORT 5041
RESPORT 5042
IPNAME -NONE
OPTIONS:
PKGREL = COMMIT
S DB1AADMT
DSN9022I -DB1A DSNYASCP 'START DB2' NORMAL COMPLETION
IEE612I CN=C01 DEVNUM=160 SYS=PROD
-DB1A DISPLAY DATABASE(*)■
IEE163I MODE= RD
```

This command will display information relating to table spaces and index spaces that are defined to the databases that form the DB2 subsystem.

If this command was entered as a result of a performance issue then you will want to look at the status information. A status of RO (read-only) or RW (read-write) may be acceptable but other statuses could indicate that an object requires some attention.

```
-DB1A DISPLAY DATABASE(*)
DSNT360I -DB1A ****
DSNT361I -DB1A * DISPLAY DATABASE SUMMARY
* GLOBAL
DSNT360I -DB1A ****
DSNT362I -DB1A DATABASE = DSNDB01 STATUS = RW
DBD LENGTH = 108200
DSNT397I -DB1A
NAME TYPE PART STATUS PHYERRLO PHYERRHI CATALOG PIECE
-----
DBD01 TS 0001 RW,RECP
DBD01 TS
SPT01 TS 0001 RW,UTRO
SPT01 TS
SCT02 TS RW
SYSUTILX TS RW
SYSLGRNX TS 0001 RW
SYSLGRNX TS
SYSDBDXA LS RW
SYSSPUXA LS RW
SYSSPUXB LS RW
DSNSCT02 IX RW
DSNSPT01 IX L0001 RW
DSNSPT01 IX
DSNSPT02 IX L0001 RW

IEE612I CN=C01 DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

- Item 1 - This information displays the name of the database, its status, and the length of the database descriptor.
- Item 2 - For partitioned tablespaces, the PART field shows the partition number. It is blank for non-partitioned tablespaces. If this column is blank or contains L* for a partitioned object, the data on that line applies to the entire table space or index object.
- Item 3 - If there are physical I/O errors with the data set supporting the table space or index space, then a hexadecimal number will be displayed in PHYERRLO and PHYERRHI fields representing the lowest and highest page containing the error. The CATALOG field will contain the name of the catalog owning the data set with I/O errors. The PIECE field identifies the section within the table space or index space with the error.
- Item 4 - This is a tablespace or index space name.
- Item 5 - The TYPE field indicates what types of object it is. Possible values are TS (Table Space), IX (Index Space) and LS (Large object table space).
- Item 6 - The status field can return many different values some of them are:

RO - the object has been started for read-only activity.

RW - the object has been started for read and write activity.

CHKP - the object is in check pending status.

GRECP - A failed group buffer pool has resulted in a marked recovery pending status.

RBDP - the object is in rebuild pending status.

RECP - the object is in a recovery pending status.

RESTRP - the object is in a restart pending state.

STOP - the object is stopped.

UT - the object is started for utility processing only.

WEPR - there is physical damage to a page or range of pages used by this object.

As the response to this command scrolls through, the highlighted messages indicate that the number of messages created has exceeded a defined maximum.

If you need to control the amount of information produced by Db2 commands, then a LIMIT option can be added to the command. In this scenario, the -DB1A DISPLAY DATABASE(*) LIMIT(*) command can be used to display the response using the maximum amount of space available.

```
SYSEBCDC TS      RW
SYSGPAUT TS     RW
SYSGROUP TS     RW
SYSGRTNS TS     RW
SYSHIST TS      RW
SYSJAXA LS      RW
SYSJAXB LS      RW
SYSJAVA TS      RW
SYSOBJ  TS      RW
SYSPKAGE TS     RW
SYSPLAN TS      RW
SYSPLUXA LS     RW
SYSROLES TS     RW
SYSRTSTS TS     RW
SYSSEQ   TS      RW
SYSSEQ2  TS      RW
SYSSTATS TS     RW
***** DISPLAY OF DATABASE DSNDB06 TERMINATED *****
DSNT311I -DB1A MESSAGE LIMIT EXCEEDED. DISPLAY IS TERMINATED.
DSN9023I -DB1A DSNTDDIS 'DISPLAY DATABASE' ABNORMAL COMPLETION
IEE612I CN=C01  DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

A number of variations can be specified with the DISPLAY DATABASE command that allow you to view more specific information:

- **-DISPLAY DATABASE(DSNDB01)** information relating to a specific database can be displayed using this syntax. The name also accepts wildcard characters so that you can display all databases beginning with certain characters.
- **-DISPLAY DATABASE(*) RESTRICT** this command will only display databases, table spaces, and index spaces with a restricted status, that is, those objects that have been stopped, are in read-only status, or started for utility-only processing.
- **-DISPLAY DATABASE(*) SPACENAM(DBD01)** this option can be used to specify a particular table space or index space for which details will be displayed.
- **-DISPLAY DATABASE(*) USE** this option displays information on objects that are currently in use and shows connection information for the thread linked with the activity, the correlation identifier of the thread, and the user ID associated with the thread.

Another useful option that can be specified on the -DISPLAY DATABASE command is the LOCKS option. If a problem has occurred where access to a particular table space or index space is not possible because another entity has locked it for use, then this option will display details relating to that lock.

```

DSNLUX02 IX      RW
DSNLLX01 IX  L0001 RW
DSNLLX01 IX
DSNLLX02 IX  L0001 RW
DSNLLX02 IX
DSNSPDXA IX      RW
DSNSPEXA IX      RW
DSNDB1XA IX      RW
DSNDB01X IX  L0001 RW
DSNDB01X IX
***** DISPLAY OF DATABASE DSNDB01 ENDED *****
DSN9022I -DBCG DSNTDDIS 'DISPLAY DATABASE' NORMAL COMPLETION

IEE612I CN=C01  DEVNUM=160 SYS=PROD
-DBCG DISPLAY DATABASE(DSN8D12A) LOCKS
IEE163I MODE= RD

```

The output displayed here shows information that describes the lock status, lock state, lock type and lock duration for objects in the specified database. In this example, the LOCKINFO data indicates the following:

- H - the lock is held by the agent or the Db2 member.
- IS - it is a lock with read intentions. IX is a lock with update intentions.
- S - the lock type is a tablespace logical lock.
- C - the lock is freed at commit time.
- T - a table L-lock.
- P - a partition L-lock.

```

DSNT360I -DBCG ****
DSNT361I -DBCG *  DISPLAY DATABASE SUMMARY
           *  GLOBAL LOCKS
DSNT360I -DBCG ****
DSNT362I -DBCG   DATABASE = DSN8D12A  STATUS = RW
               DBD LENGTH = 32294
DSNT397I -DBCG
NAME    TYPE PART STATUS      CONNID   CORRID   LOCKINFO
-----  ---  ---  ---  -----
DSN8S12D TS     RW      AGENT TOKEN 48   TSO     GHP108   H-IS,S,C
11      TB          TSO     GHP108   H-IS,T,C
DSN8S12E TS     0001 RW      AGENT TOKEN 48   TSO     LTE555   H-IX,P,C
DSN8S12E TS     0002 RW      AGENT TOKEN 48
             -THRU 0005
DSN8S12E TS
DSN8S12P TS     RW
DSN8S12R TS     RW
DSN8S12S TS     RW
XACT1  IX      RW
XACT2  IX      RW
***** DISPLAY OF DATABASE DSN8D12A ENDED *****
IEE612I CN=C01  DEVNUM=160 SYS=PROD
IEE163I MODE= RD

```

The CONNID field describes the connection identifier for the thread. In this example it is a thread from a TSO terminal.

The CORRID field displays the name associated with the thread, which in this case shows two TSO user IDs.

Stopping Databases

If a database problem has been identified, you may be required to temporarily stop the database so that maintenance activity can be performed. Rather than bring down the entire Db2 subsystem, the STOP DATABASE command can be used to stop one or more databases or database components, preventing applications from using them.

```
DSNT360I -DBCG ****
DSNT361I -DBCG * DISPLAY DATABASE SUMMARY
           * GLOBAL LOCKS
DSNT360I -DBCG ****
DSNT362I -DBCG   DATABASE = DSN8D12A STATUS = RW
           DBD LENGTH = 32294
DSNT397I -DBCG
NAME  TYPE PART STATUS    CONNID  CORRID  LOCKINFO
-----+
DSN8S12D TS    RW      TSO     GHP108   H-IS,S,C
11     TB    -        AGENT TOKEN 48
          -        TSO     GHP108   H-IS,T,C
DSN8S12E TS    0001  RW      TSO     LTE555   H-IX,P,C
          -        AGENT TOKEN 49
DSN8S12E TS    0002  RW      TSO     -        H-IX,P,C
          -THRU   0005
DSN8S12E TS    -        RW
DSN8S12P TS    RW
DSN8S12R TS    RW
DSN8S12S TS    RW
XACT1  IX    RW
XACT2  IX    RW
***** DISPLAY OF DATABASE DSN8D12A ENDED ****
DSN9022I -DBCG DSNTDDIS 'DISPLAY DATABASE' NORMAL COMPLETION
IEE612I CN=C01  DEVNUM=160 SYS=PROD
-DBCG STOP DATABASE(*)■
IEE163I MODE= RD
```

The messages shown here indicate that the execution of the command has been successful.

```
***** DISPLAY OF DATABASE DSN8D12A ENDED ****
DSN9022I -DBCG DSNTDDIS 'DISPLAY DATABASE' NORMAL COMPLETION
-DBCG STOP DATABASE(*)■
DSN9022I -DBCG DSNTDDIS 'STOP DATABASE' NORMAL COMPLETION
DSNT736I -DBCG ASYNCHRONOUS STOP DATABASE COMMAND 688
HAS COMPLETED FOR COMMAND: STOP DB(*)■
IEE612I CN=C01  DEVNUM=160 SYS=PROD
-DBCG DISPLAY DATABASE(*)■
IEE163I MODE= RD
```

The -DBCG STOP DATABASE(*) command will not automatically shut down databases DSNDB01, DSNDB06, and DSNDB07, but they can be stopped individually using a command such as: **-DBCG STOP DATABASE(DSNDB07)**

```
DSNT360I -DBCG ****
DSNT362I -DBCG   DATABASE = DSNDB07 STATUS = RW
           DBD LENGTH = 4028
DSNT397I -DBCG
NAME  TYPE PART STATUS    PHYERRLO PHYERRHI CATALOG  PIECE
-----+
DSN32K00  TS    RW
DSN32K01  TS    RW
DSN4K00   TS    RW
DSN4K01   TS    RW
***** DISPLAY OF DATABASE DSNDB07 ENDED ****
DSNT360I -DBCG ****
DSNT362I -DBCG   DATABASE = DSN8D12A STATUS = STOP
           DBD LENGTH = 32294
DSNT397I -DBCG
NAME  TYPE PART STATUS    PHYERRLO PHYERRHI CATALOG  PIECE
-----+
DSN8S12D TS    RW
DSN8S12E TS    0001  RW
          -THRU   0005
***** DISPLAY OF DATABASE DSN8D12A ENDED ****
DSNT360I -DBCG ****
DSNT362I -DBCG   DATABASE = DSN8D12P STATUS = STOP
           DBD LENGTH = 32294
IEE612I CN=C01  DEVNUM=160 SYS=PROD
IEE163I MODE= RD
```

A number of variations are possible with the STOP DATABASE command depending on the problem but you would be unlikely to use them unless instructed by the systems programmer.

- **-STOP DATABASE(DTSPATDB) SPACENAM(GSERGEOM)** a specific table space or index space can be targeted with the STOP DATABASE command by using the SPACENAM option. This command might be useful if an object needs to be restored and it first needs to be made unavailable. Wildcard characters can also be specified as part of the name.
- **-STOP DATABASE(DSN8D10A) SPACENAM(DSN8S10E) PART(4)** if a tablespace or index space has been partitioned, then a specific partition can be stopped using this format of the command.
- **-STOP DATABASE(DB2OSC) SPACENAM(DSNR1A77) AT(COMMIT)** this command is slightly different to the regular stop command in that currently executing applications can continue to access the object until they issue their next COMMIT. Following this, the object will be stopped.
- **-STOP DATABASE(DSN00003) SPACENAM(UTPRCX01) CLONE** if a base table has been cloned, then this command can be used to stop just the cloned table objects.

Starting Databases

If a database or one of its components has been stopped and is now ready to be restarted, the START DATABASE command can be invoked.

Note that if the DSNDB01, DSNDB06, or DSNDB07 databases have been specifically stopped, then they will need to be individually started using a command such as -START DATABASE(DSNDB06).

