

I

Products

a) DB2 Flavors

DB2 Product Name	Operating System	Description
1. Everyplace	Mobile computing, PDAs, Handhelds, Windows CE, embedded devices.	No Server Capacity Everyplace Sync Server synchronizes data with the main database
2. DB2 Satellite Edition for Laptops	Windows only	No Server Capacity For single users who operate disconnected from the DB
3. DB2 Personal Edition	Windows/Unix/LINUX/OS	No Server Capacity Includes client components
4. Workgroups Edition(WE)	Windows/Unix/LINUX/OS	Server Capacity. Remote client support LANs and applications that do not need access to remote Databases or hosts (OS/390, VM or OS/400) Includes Extenders and Net.Data
5. Enterprise Edition(EE)	Windows/Unix/LINUX/OS Solaris	Server Capacity + allows host database connectivity More concurrent users than WE DRDA AR support
6. Enterprise Edition Extended (EEE)	Windows/Unix/LINUX/OS Solaris/AIX	Server Capacity + host database connectivity + partitioning across multiple independent computers of the same platform
7. DB2 UDB for OS/390	Z/OS, OS/390, MVS	Server Capacity

b) DB2 UDB Clients

1. Runtime Client	Run SQL statements, ODBC, OLDE DB, JDBC and SQLJ apps Allows applications to access local and Remote databases
2. Administrative Client	Runtime Client + GUI to remotely administer DB2 servers
3. Application Development Client	Administrative client + Developer tools (SDK) like compilers, static libraries, sample programs, SP Builder
4. Thin client	Smallest footprint for remote DB access only

Client Configuration Assistant (db2cca) maintains a list of databases to which applications can connect. It catalogs nodes and databases.

c) DB2 Connectivity Components

1. DB2 Connect 1a. Personal Edition 1b. Enterprise Edition	Required to access DB2 under OS/390, OS/400 and VM/VSE and LINUX on S/390 Not Required to access any of the Unix or Intel platforms based DB2.
2. DB2 Datapropagator	For Replication, Integrated into DB2 for Unix and Intel
3. DB2 Datajoiner	Enables clients to read, join, update DB2 data with non DB2 in single SQL
4. DB2 Relational Connect	Single query can join DB2 data with ORACLE (no update)
5. DB2 Classic Connect	Component of Data Joiner, provides read only access to non-relational data like IMS DB and VSAM datasets on MVS

D) DB2 Development Administrative Tools

On Windows/Unix/OS	
1. DB2 Developers Edition a. Personal Developers Edition b. Universal Developers Edition	For One developer under Windows/OS/2 or Linux. Includes DB2 Personal Edition, DB2 Connect Personal Edition, DB2 Extenders, clients etc., For all platforms. All of PDE plus, DB2EE, DB2 Connect EE, Websphere, NET. Data, DB2 WE.
2. DB2 Relational Extenders	Text, Audio, Image, and Video (TAIV). Spatial and XML Extenders, Net. Search Extender(Solaris and NT only)
3. DB2 OLAP Server Starter Kit	OLAP for DB2
4. DB2 Warehouse Center	GUI tool integrated with DB2 for ETL (Extract, Transformation and Load)
5. DB2 Warehouse Manager	Suit of following products 5.1) Data Warehouse Center 5.2) Information Catalog - To define and administer meta data information 5.3) Query Patroller 5.4) Query Management Facility (QMF)
6. DB2 Datalinks Manager	Enables apps to access external data and file
7. Websphere application Server	Applications server. Supports JSP, Servlets, XML, EJB in addition to dynamic and static content
8. DB2 NET.Data	Ability for Web browser to access Relational(DB2/ORACLE/SYBASE) or non-relational data like flat files and other data sources that support ODBC.

On OS/390	
1. Administration Tool	To manage system catalog, SQLIDs, DB threads, pkgs, security, CDB table, RLIMIT table and issue DB2 commands and also other DB features
2. Forms for OS/390	2.1) DB2 Forms Developer - for forms development for any environment 2.2) DB2 Forms Console - Repository to store forms 2.3) DB2 Forms User - allows access to Form applications from PC 2.4) DB2 Forms Java player - Supports forms for web browser
3. High performance UNLOAD	access DB2 at top speed. Unload from ICs in different formats
4. Log Analyzer	Menu driven log analyzer when DB2 is up
5. Object Restore	Recovery tool. Restores dropped objects & migrate DDL from one DB2 to other
6. Buffer pool tool	Gather buffer tools behavior and statistics
7. Performance Monitor	to get optimum performance & to resolve performance issues, EXPLAIN feature to analyze and optimize SQLs, monitor individual and group DS-ing members monitoring of DB2 SSS, real-time monitor
8. QUERY MONITOR	to monitor queries, terminate problem queries, identify users and locations issuing problem queries by creating <i>profiles</i> and <i>thresholds</i>
9. SQL Performance Analyzer	Data modeling and query cost analyzer, identify resource-intensive queries prior to running queries
10. Data Propagator	Data replication tool using SQL Procedures and Stored Procedures
11. Recovery Manager	Makes a Virtual IC
12. Row Archive Manager	To manage data aging, archiving, & retrieval from archives by setting rules
13. Bind Manager	Way to bind pgms. PATH CHECKER components checks for changes in pgms
14. Web query tool	Web based tool to create, save, execute queries against DB2 DBs. Results are stored either as TXT, XML, CSV(spread sheets)
15. Index advisor	Suggest IXs to be build for optimal data access by building "modeling DB"
16. DB2 Estimator	PC based GUI tool for estimating performance table sizing and similar task from a DB model or info from DB2 Explain or DB2 PM Storage required for a TS and its Ixs, execution time of utility job effects of triggers

E) Application Development - Control Center (db2cc) includes

1. Command Center	To Run DB2 Commands and access plan	db2cmd
2. Script Center	Create & manage script to run SQLs, DB2/OS commands	
3. Alert Center	Enable manage and view alerts	
4. Journal Center	Manage, schedule, and view Script outputs, and recovery history	
5. License center	Manage product Licensing	db2licm
6. Command Line Processor	Prompt to run textual DB2 statements and commands	
7. Visual Explain	GUI display of the access plan (I/O strategy) that DB2 uses for data access	
8. SQL Assist	GUI assistance to visually create and run queries	
9. SP builder	GUI tool for developing, testing, debugging SPs written in SQL/JAVA	
10. Satellite Center	Synchronize and manage DB2 Satellite Edition	
11. Information Center	Product information	db2ic

F) DB2 Clients include

WINDOWS, OS/2, LINUX, UNIX, AIX, WEB BROWSERS, SGI-IRIX

II

Datatypes

a) Types

String	CHAR VARCHAR LONGVARCHAR CLOB	255 chars 32,704 CLOB (n[K/M/G]) 2 gig max	for 32K pages otherwise, 4064 Length can not be specified for LONG CLOB to store Documents. 6 bytes If only n is used, max length is n for K max length is - n * 1024 for M max length is - n * 1024 * 1024 for G max length is - n * 1024 * 1024 * 1024
Integer	SMALLINT INTEGER PC-DB2 BIGINT	-32768 TO +32767 -2,147,483,648 to 2,147,483,647	2 byte integer with precision 5 4 byte with precision 10 8 byte integer with precision 19
Decimal	DECIMAL/NUMERIC	(Precision, Scale)	Packed decimal number Max precision is 31
Float	FLOAT (1-21) or REAL FLOAT (>21) or DOUBLE	Single Precision Double Precision	Though for FLOAT the length can be specified DB2 will round it to either 21 or 53 for REAL, DOUBLE no length should be specified
Double Byte Character	GRAPHIC VARGRAPHIC LONG VARGRAPHIC DBCLOB	127 DBchars DBCLOB (n[K/M/G])	similar to VARCHAR Length can not be specified for LONG Double Byte- 6 bytes
Binary Audio, Video, Image	BLOB	BLOB (n[K/M/G])	Multimedia - 6 bytes
Datetime	DATE TIME TIMESTAMP	10 chars 8 chars 26 chars	y,m,d. 4 bytes h, m, s. 3 bytes y, m, d, h, m, s,ms. 10 bytes
Row-id	ROWID	17 characters 19 bytes	DB2 generated value. Can be used for any tables but a must for LOB col tables. Unique IX needed
On PC-DB2 Datalink	DATALINK		Reference to external file using URL Use DLVALUE built-in-fn to insert value into DATALINK column.

b) Variable columns carry 2 bytes of additional storage for each row.

c) Precision is the number of bits or digits excluding the sign

d) GENERATED BY DEFAULT AS IDENTITY/GENERATED ALWAYS AS IDENTITY

- Can not be specified for column that is ROWID(-846 Sqlcode).
- Column must be either INT, SMALLINT, DECIMAL(without scale)
- Is implicitly NOT NULL
- Only one identity column is allowed for a table(-372 Sqlcode if second is specified)
- But one identity column and one ROWID can be present on same table
- ALTER ADD identity column to a non empty table will place the TS on REORG pending

GENERATED BY DEFAULT/GENERATED ALWAYS

- for ROWID column either GENERATED ALWAYS , or GENERATED BY DEFAULT must be present
- Only one ROWID column is allowed for a table (-372 Sqlcode if second is specified)
- GENERATED BY DEFAULT generates a value if not entered.
- GENERATED ALWAYS columns can not be loaded

e) When a new column of AS IDENTITY is added, the TS will be in REORG status.

f) NOT NULL WITH DEFAULT NULL can not be coded

g) ROWID column can not be part of primary key and foreign key -867 sqlcode
IDENTITY column can be primary key

h) LOB data types

- i) LOB(Binary Large objects) - 2GB - 1byte of binary data like photos, audio, video clips
- ii) CLOB (Character large Objects) - 2GB - 1byte) of single-byte character data. Documents
- iii) DBCLOB (Double byte CLOB) - 1GB - 1 byte of double byte character data
- iv) EXTENDERS use MMDBSYS schema

1) Parameters

Parameter	Description
VOLUMES	"*" for SMS managed volumes. List the volumes for the storage group
VCAT	volume catalog names for objects created USING

- 2) Set of DASD volumes from which DB2 assign space for databases and TSs
- 3) Volumes can be associated with an ICF catalog or VCAT
- 4) ALTER statement can be used to Add or Remove volumes
- 5) DROP SG is possible only if there is no TS or IS using that SG
- 6) Volumes assigned to a SG aren't dedicated to DB2 only. Non-DB2 datasets are also stored in them.
- 7) Maximum no of volumes in a storage group is "133". Maximum no of volumes per dataset is "59"
- 8) A volume removed won't affect already defined datasets in it, REORG or RECOVER will remove them.
- 9) All volumes of a **Storage Group**, must be of same device type (e.g., 3380, 3390 and so on).
- 10) **SYSDEFLT** (default STOGROUP) will be used if none is specified while creating a DB, TS, IX definitions. This should be avoided as it will degrade performance.
- 11) TABLE and INDEX are in different physical datasets and stored in separate STORAGE GROUPs.

1) Parameters

Parameter	Description
BUFFERPOOL	default buffer pool for objects created in this database
INDEXBP	default buffer pool for indexes created for objects in this database; must be a 4K BP
AS TEMP	for creating temporary tables in this database. One TEMP DB per SS. Can not be shared Is needed when DECLARE CURSOR SCROLL...is used
AS WORKFILE	can be used only in a data sharing environment. One WORKFILE per DB2 member
CCSID	ASCII/EBCDIC/UNICODE - encoding scheme. Not for TEMP and WORKFILE
STOGROUP	SYSDEFLT is the default

2. Defaults can be overridden while creating objects on them
3. Database has no prefix, it has to be unique within a DB2 SS
4. When a database is created in a STOGROUP that is not defined previously, it won't fail till you start creating objects in that database.
5. Only one TEMP DB and only for one SS member, means TEMP DB is not shared across SSs
6. Maximum number of Databases in a subsystem - 65279.

V

Tablespace (SYSTABLESPACE)

1) Parameters

Parameter	Description
NUMPARTS	1-254. No of partitions. If > 64, it is a LARGE TS. Not for LOB TS/TEMP DB/WORKFILE DB. (NA)
PART	Specify PART defaults like USING storgroup, PRIQTY, FREEPAGE, PCTFREE, COMPRESS etc
SEGSIZE	Number of segments(multiple of 4) in a Segmented TS(max 64). Not for LOB TS/WORKFILE. (NA)
FREEPAGE	(0-255) reduces REORG-number of empty pages after data pages. Not for LOB TS/TEMP/WORKFILE
PCTFREE	(0-99, 5) reduces the REORG frequency - What % of each page to leave as freespace to be available for future inserts. Not for LOB TS/TEMP/WORKFILE
TRACKMOD	Whether DB2 tracks modified pages in the space-map pages of the TS or partition. Not for LOB TS
COMPRESS	YES enables compress and No disables. Can be specified at part level. Not for LOB TS/TEMP
MAXROWS	maximum rows per page. Default rows per page is 255. Not for LOB TS/WORKFILE
DEFINE	YES - underlying datasets are physically created when CREATE TS is issued NO - not created until the data is inserted into the TS. Only for DB2 managed datasets Not for TEMP/WORKFILE. (NA)
MEMBER	Not to use the default cluster sequence(first IX) or explicit IX. Db2 chooses it. (NA)
CLUSTER	works only for INSERT, REORG/LOAD will pick the CLUSTER order. Not for LOB TS/TEMP/WORKFILE
LOCKSIZE	ANY/TS/TABLE/PAGE/ROW - TABLE only for Segmented TS. Page and Row not for LOB TS Type of initial locking DB2 performs for the given TS but lock escalation occurs
LOCKMAX	Max number of locks that one process can hold before escalating to a higher level lock 0 - turns off escalation
LOCKPART	YES enables selective partition locking (SPL)when locking PTS. NO locks entire PTS
PRIQTY	Space for primary and extents. ALTER will change this and take effect immediately
SECQTY	Maximum SECQTY extents is 251 after that it will abend with -904 Sqlcode
BUFFERPOOL	Name the buffer pool to be used by TS. If not specified DB BP is used
ERASE	YES/NO - specify erase the db2 managed dataset when the TS is dropped or don't erase
GBPCACHE	CHANGED/ALL/SYSTEM/NONE in DSing environment, to specify what pages are written to the GBP
LARGE	Is only for partitioned TS to store more than 64 GB of data in a TS. NUMPARTS is needed. NA not valid if LOB or DSSIZE is specified
DSSIZE	Valid values are 1,2,4,16,32,64. Value > 4GB require DFSMS & Extended address-ability (EA). Max size for each PART/LOB TS dataset. NUMPARTS/LOB is needed if DSSIZE is used. (NA) if DSSIZE or LARGE is omitted for NUMPARTS (1-16) - DSSIZE will be 4 GB for NUMPARTS (17-32) - DSSIZE will be 2 GB for NUMPARTS (33-64) - DSSIZE will be 1 GB for NUMPARTS (65-254)- DSSIZE will be 4 GB (also default for LOBs if DSSIZE is omitted)
LOG	YES/NO - to specify changes to LOB column is logged or not
USING	VCAT - User managed STOGROUP - DB2 managed - if USING is not specified, it will take the default SG of DB
CLOSE	YES makes the dataset eligible for closing when the TS/Index is not used. NO - don't
CCSID	Similar to DB definition. Overrides DB CCSID. All tables in TS should have same encoding scheme. IS will use the same encoding scheme of TS. Not for LOB TS/TEMP/WORKFILE
IN DATABAS	database name - allocates an implicit tablespace

2) Types

Name	Description
Simple	Can hold more than one table. REORG is needed to reclaim DROPPED tables. Limit is 64GB
Segmented	No REORG needed to reclaim DROPPED tables. Limit is 64GB.
Partition	One table per partition TS. -646 Sqlcode when tried to create another. Each partition is separate VSAM dataset. Good for large volumes of data. Two types, Large 1-254 partitions and Non-Large 1-64 partitions. PART Limit is 64GB Partition size max is 64GB. DSSIZE allows each partition to be > 64GB
LOB	1 LOB TS per LOB col in a table. In a PART TS 1 LOB TS per PART per column is required Default is 4GB. DSSIZE can be specified , max no of Datasets is 254.

3) Segsize standards

Number of pages	SEGZIE
<= 28	4 to 28
> 28 < 128 pages	32
>= 128 pages	64

-
- 4) For Partition TS, START and STOP can be issued at the partition level.
- 5) Page-size is 4 (usually), 8, 16, 32k are also supported.
- 6) Partition table must have partitioning IX PART 1 in create IX decides this
- 7) Space map page tells DB2
- where to find free space
 - changed page information to copy utility
 - identify segments in a segmented TS
- 9) LOB TS
- BIND SQLRULES(STD) or CURRENT RULES = STD, makes DB2 to create the LOB TS, AUX table.
 - One LOB TS per LOB column.
 - LOB TS must be created in the same DB of the base table
 - LOB TS can not have regular tables and regular TS can not have AUX tables, **-763 Sqlcode**

10) Space Constraints

- 1 Track = 56 kb and
1 Cylinder = 15 tracks
So 1 cylinder = 15 * 56 = 840 kb
- PRIQTY n - n is kilobytes

for 4KB page sizes-	if n is < 12 or omitted	-	n is 12
for 8KB page sizes-	if n is < 24 or omitted	-	n is 24
for 16KB page sizes-	if n is < 48 or omitted	-	n is 48
for 32KB page sizes-	if n is < 96 or omitted	-	n is 96
- if SECQTY is omitted, and PRIQTY is omitted
same as above for SECQTY
- if SECQTY is omitted, and PRIQTY is specified
SECQTY is 10% of PRIQTY or 3 times of pages size, whichever is larger
- Maximum SECQTY extents is 251 , after that insert will abend with -904 SQLCODE

1. Parameters

Parameter name	Description
LIKE <i>table/view</i>	To derive the attributes of another table or view IDENTITY, check constraints, KEYS, UNIQUE are not derived
INCLUDING IDENTITY COLUMN ATTRIBUTES	IDENTITY is derived if you specify this. Not for views
EDITPROC	invoked during LOAD, INSERT, UPDATE
VALIDPROC	program that validates a row
FIELDPROC	program that is called for a column
OBID	DB2 generates if you omit this parameter
CONSTRAINT <i>name</i> PRIMARY KEY/UNIQUE FOREIGN KEY...REFERENCES... ON DELETE CHECK (condition)	column name or column name REFERENCES or check condition ON DELETE rules are RESTRICT/NOACTION, CASCADE, SET NULL
WITH RESTRICT ON DROP	To prevent inadvertent drops for production tables
AUDIT	NONE/CHANGES/ALL
DATA CAPTURE CHANGES	To enable a table for replication as source to run CAPTURE
CCSID	Encoding scheme, ASCII/EBCDIC, overridden at table level

2. Primary key maximum length is 254 bytes

3. ALTER TABLE can do these things

- can increase the length of a VARCHAR column but can not decrease.
- can add a column with → NULL as well as NOT NULL WITH DEFAULT
- can add a column (at the end), but can't remove a column. DROP & CREATE the table.

4. Self-Referencing constraint is one in which the parent table is also the dependent table. Those must be defined using the DELETE CASCADE or NO ACTION rule. **Be cautious when deleting rows from these type of tables, because a single delete could wipe out the whole table data**

5. Check constraints are used to check the data value that is placed in a column through an expression.

- a) UDFs, host variables, Special registers, cols of FIELDPROCEDURE, CASE are not allowed
- b) 1st oprnd must be col of the tbl, 2nd must be either a col or const of same data type.
- c) Subselect, EXISTS predicates are not allowed

6. Tables created in Partition TS cannot be dropped. TS itself should be dropped.

7. WITH DEFAULT can have following values

- A constant
- Special Registers USER, DATE, TIME, TIMESTAMP and CURRENT SQLID, NULL
- If you don't give any value, System will allocate following default values,
 - CHARACTER - SPACES
 - NUMERIC - 0s
 - VARCHAR - Zero length
 - DATE, TIME, TIMESTAMP - Current Date, Current Time and Current Timestamp

8. Global Temporary Tables

No	Type	CREATE	DECLARE
1	TEMP DB	Is not needed	Needed with SEG TS and USE on them prior to DECLARE
2	SESSION qualifier	Is not needed	Needed explicitly or implicitly(only DECLARE)
3	SYSTABLES	TYPE = 'G'	No catalog entry
4	DELETE	Yes - but no WHERE clause	Yes - but no WHERE clause
5	UPDATE	No - 526 sqlcode	Yes
6	IX	No - Access is TS SCAN	Yes
7	LOG	No	Yes
8	LOCK	No	Yes - Some locking, LOCK TABLE not available
9	Recover	No	Yes, but no forward log recovery
10	PK, Ref Integrity	No	No
11	LOB, ROWID	No	No
12	DB2 utils	No	No
13	Parallelism	No	I/O and CP yes, but no SYSPLEX
14	VIEW	YES but no WITH CHECK	No
15	Create Privilege	CREATETMTAB	PUBLIC
16	GRANT/REVOKE	ALL - but not individual	Not allowed as PUBLIC has all authority
17	ALIAS, VIEW, SYNONYM, RENAME, TRIGGER, UDF, SP INSERT, SELECT INTO	Yes No Trigger - -607 Sqlcode	No - ALIAS, VIEW, SYNONYM, RENAME, TRIGGER, UDF, SP -526 Sqlcode if tried to create these objects
18	COMMIT	Deletes except WITH HOLD	ON COMMIT DELETE/PRESERVE ROWS - decides
19	ROLLBACK	Deletes	Deletes
20	TABLE...LIKE	YES	YES

13. Rebinding is not required for ALTER TABLE ADD CONSTRAINT
14. While formatting TIME in US format as default, it caused TIME to be displayed without the seconds
15. Cascade effect (will be deleted) on dependent objects and definitions during DROP table, IXs, Views, Synonyms, Security Defs, RI Defs, and Check Constraints. (Aliases stay)
16. FOREIGN key can reference a UNIQUE key on the parent table created with
- ```
ADD CONSTRAINT constraint_name UNIQUE(colname)
```

### 18. Auxiliary Tables (LOB data)

- Table that is used to store LOB data is referred as AUXILIARY table and is stored in LOB TS
- LOB TS can not be a partitioned TS but base table's TS can be
- Though the DDL of AUX table will not have columns, DB2 creates three columns by itself like

| EMP_LOB_AUX_AUDIO | LPRADU1 |          |          |    |
|-------------------|---------|----------|----------|----|
|                   |         | AUXID    | VARCHAR  | 17 |
|                   |         | AUXVER   | SMALLINT | 2  |
|                   |         | AUXVALUE | BLOB     | 4  |

Table contains descriptor that points to the actual LOB value(LOB locator).

- Steps ==> Create LOB TS  
Create AUXILIARY TABLE (no column name specified while creating AUX tables)  
Create IX on AUX table(no column name allowed - 767 Sqlcode, only one IX, that too on ROWID is allowed on auxiliary tables)
- Tables with LOB field must have one ROWID (-770 Sqlcode if not specified in the DDL)
- FREE LOCATOR & HOLD LOCATOR are useful in moving LOB data into host variable  
EXECUTE IMMEDIATE is not allowed with the HOLD LOCATOR or FREE LOCATOR when issuing dynamic SQL
- DB2 extenders can be used to extend the LOB data type .
  - Extenders are easy for storing purpose only. More functionality needs lot of work
  - Extenders use MMDBSYS schema and should be enabled for a site
  - Extenders use stored procedures to process API requests
- DMLs not possible on tables with LOB column if no AUX tables & AUX IX are created, -747 SQC

### 19) Field procedure (FIELDPROC) - (SYSFIELDS)

User exit routine to transform values in a single short-string column. Assigned to a column by the FIELDPROC clause of CREATE/ALTER TABLE. Invoked during INS/UPD/DEL(encoded) & SELECT(decoded)

- 20) RENAME possible for tables. Pkgs are invalidated after rename, Rebind or Auto rebind required. -750 sqlcode if attempted to RENAME a table used in VIEW or TRIGGER. -148 Sqlcode if tried to RENAME a table that has a Synonym or rename a VIEW or RENAME a RLST table.

### VII

### Views (SYSVIEWS)

- Views with JOINS, FUNCTIONS, DISTINCT, GROUP BY and HAVING can not be updated, inserted, deleted
- Views defined with math expressions/constants/eliminated-columns without DEFAULT are not insertable
- WITH CHECK has CASCADE or LOCAL option  
 CASCADE - checks the current View's WITH CHECK and any above View's WITH CHECK. Default  
 LOCAL - checks only the current View's WITH CHECK and not above View's WITH CHECK
- Views can be created from other views, will be created under DSNDB06 and SYSVIEWS

### VIII

### Aliases

- Aliases are for remote objects
- Aliases are retained when the base objects are dropped
- CREATE ALIAS is a DB2 SS level authority

### IX

### Synonyms (SYSSYNONYMS)

- Synonyms are for objects within same subsystem
- Avoid giving GRANT on Synonyms as it will also grant on base table.
- Remember this situation  
 Table T1 -  
 ALIAS A1 ON T1  
 SYNONYM S1 ON A1 - records base T1 and not A1 in the catalog.  
 So if DROP ALIAS A1 is performed, SYNONYM stays.
- CREATE SYNONYM will have current sqlid as qualifier and no explicit qualifier. Synonym should not be equal to existing *qualifier.tablename* (-601 sqlcode)

## 1. Parameters

| Parameter name                                                | Description                                                                                                                                                                                      |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DEFER                                                         | NO will build the index - default<br>YES will just create the VSAM dataset not the index. If the table is not empty run REBUILD index to clear pending state. <b>Not for AUXILIARY TABLE Ixs</b> |
| UNIQUE WHERE NOT NULL                                         | Enforce uniqueness, except will allow any number of NULLs                                                                                                                                        |
| COPY YES/NO                                                   | YES allows copy utility for the index                                                                                                                                                            |
| CLUSTER                                                       | the index is CLUSTER INDEX. <b>Not for AUXILIARY TABLE Ixs</b>                                                                                                                                   |
| CLUSTER PART.....VALUES                                       | for PART IX. Specifies the highest value of the index key in one partition                                                                                                                       |
| PIECESIZE int                                                 | maximum addressability of each dataset for a NPI                                                                                                                                                 |
| PCTFERE, FREEPAGE, DEFINE, USING, CLOSE, GBPCACHE, BUFFERPOOL | <b>similar to TS definitions</b>                                                                                                                                                                 |

- IX Data pages are always 4KB in size
- DB2 index is a modified **B-tree(Balanced-tree)**
- IX can have up to 64 columns and a maximum of 254 bytes
- For easy maintenance of ISs use 8 Chars for index, though it allows 18 Chars for naming.
- Is composed of following data pages
  - SPACE MAP PAGES
  - ROOT PAGE
  - NON-LEAF Page - Contains keys and page number of other pages in the index. Non leaf pages never point to actual data.
  - LEAF PAGE - Contains pointers(record ID or RID) to the data rows of the table. RID is a combination of the TS page number and the row pointer for the data value
- Creating IXs to already populated table is less efficient

### 8. Cardinality - number of distinct values in an indexed column

In general, cardinality should be > 5% of the count(\*) in the table for a IX to be created

### 9. Clustering Index

One IX can be CLUSTER IX (-623 Sqlcode if attempted to create the second). Controls the physical order of the table rows. In TS, if CLUSTER IX is not created, the first IX is used for clustering sequence. In PTS IX key range for each PART should be specified with-CLUSTER (PART 1 VALUES(300), PART 2 VALUES 500))

### 10. Type 2 indexes,

- eliminate index locking, no index subpages,
- support row level locking, data sharing, full partition independence, UR, and parallelism.

### 11. IXs are not used when;

- **Data is converted during comparison of two columns** (STAGE2, though the predicate is STAGE1)
- **Host variable** is of **different data type**
- Length of host variable is longer than the column length
- **LIKE** uses % sign or \_ sign at the beginning of the comparison string
- **NOT** , <>
- **predicate COLUMN** is an **arithmetic expression** (E.g., WHERE COL\_NAME - 10 = :host-variable)
- SCALAR(ROW) functions are used
- FOR UPDATE OF with IXed columns

9. ALTER IX can't alter CLUSTER, UNIQUE, UNIQUE WHERE NOT NULL and DEFER

10. From version 7, IXs can not be dropped until the respective constraint is dropped

11. DB2 often does a TS scan for a small table, though a matching IX scan is available, this can be changed and forced to use IX scan by using **NPGTHRS** SS parameter

**14. Stage I/Stage II processing** (Stage 1 processing is efficient than STAGE2 processing)

a) Following is a list that satisfies Stage 1 processing

COLUMN\_NAME **operator** value

COLUMN\_NAME **IS NULL**

COLUMN\_NAME **BETWEEN** val1 **AND** val2

COLUMN\_NAME **IN** (list of columns)

COLUMN\_NAME **IN** (non-correlated subquery)

COLUMN\_NAME **LIKE** pattern

COLUMN\_NAME **LIKE** host-variable

A.COLUMN\_NAME **operator** B.COLUMN\_NAME (only when A and B refer Different tables,

If A & B refer same tables it is **STAGE-2**)

COLUMN\_NAME **operator** (**non-correlated subquery**)

b) Stage 2 predicates take more CPU time, Path length is long, Involve data conversion, calculation and Non-indexable.

17) Recommendations to build indexes for columns involved in:

WHERE, ORDER BY, GROUP BY, DISTINCT

BETWEEN, LIKE, > , <

Primary key, Unique key, Foreign key

Column functions(vector) functions

18. Index can be explicitly named, but IS is implicitly named by DB2 as below

**vcat.DSNDBx.databasename.indexname.I0001.Annn**

vcat - ICF catalog name (ZPARM → CATALOG)

X - is C if a cluster, D if a data object ; nnn - partition number starting 001

19) IX-ing VARCHAR, VARGRAPHIC cols will expand the col to max len, increasing DASD use - Avoid this

20) Partition IX itself is partitioned with same number of VSAM datasets as the data.

21) Partition IX must be CLUSTER. But no need to be UNIQUE.

22) In DB2 Version 7, indexes of VARCHAR columns are padded to create fixed-length index entries. Additional disk storage was required to hold these index values.

In DB2 Version 8, indexes can be truly variable in length. This reduces the amount of storage required to hold them. Also, index-only access is now allowed for indexes that contain VARCHAR columns

**XI****Schemas**

1. SCHEMA name is essential for UDTs, UDFs, Triggers, SPs
2. SCHEMA name and the object name must be unique
3. CREATEIN auth to create objects in a schema.
4. SCHEMA names cannot begin with SYS except SYSADM.
5. Built in functions are within **SYSIBM** schema
6. SECHMA processor (DSNHSP) can be run in batch job to CREATE SCHEMAS

**XII****UDTs (SYSDATATYPES)**

1. WITH COMPARISONS - specifies that system generated comparison operators are to be created for comparing two instances of the distinct type
2. DB2 enforces **STRONG TYPING**(Prohibits non-defined operations between different data types) on UDTs
3. A ROWID must appear in every table that contains a UDT column based on a LOB data type
4. For UDTs, DB2 creates two CASTING functions.
5. GRANT **USAGE** privilege on UDT

## 1. Important parameters

| Parameter name               | Description                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RETURNS...CAST FROM          | Identifies the output of the UDF. CAST FROM converts a type to the RETURNS type                                                                                                                                                                                                                                                                                                                                            |
| SPECIFIC                     | Unique function name                                                                                                                                                                                                                                                                                                                                                                                                       |
| LANGUAGE                     | ASSEMBLE/C/COBOL/JAVA/PL1. Programming language in which the UDF is written                                                                                                                                                                                                                                                                                                                                                |
| RETURNS NULL ON INPUT        | fn returns NULL when try to call that function will null arguments                                                                                                                                                                                                                                                                                                                                                         |
| [NO] EXTERNAL ACTION         | whether the fn talks external to DB2 like writing in a file, sending a message                                                                                                                                                                                                                                                                                                                                             |
| [NO] SCRATCHPAD              | scratchpad saves the previous invocation values                                                                                                                                                                                                                                                                                                                                                                            |
| [NO] FINAL CALL              | to free the resources used by the function                                                                                                                                                                                                                                                                                                                                                                                 |
| [DIS]ALLOW PARALLEL          | whether parallelism to be used or not                                                                                                                                                                                                                                                                                                                                                                                      |
| PARAMETER STYLE              | linkage convention to pass additional parameters other than in CALL<br>DB2SQL(default), along with parameter it passes null indicator and SQLSTATE,<br>qualified name of the SP, specific name, diagnostic string. REXX can not use<br>JAVA - only for COMPJAVA/JAVA<br>GENERAL - only the parameters on the CALL stmt are passed - only for SP<br>GENERAL WITH NULLS, an array of null indicators is passed - only for SP |
| WLM ENVIRONMENT              | WLM environment name. NO not possible for UDFs. UDF runs in WLM address space                                                                                                                                                                                                                                                                                                                                              |
| <b>Common for UDF and SP</b> |                                                                                                                                                                                                                                                                                                                                                                                                                            |
| CALLED ON NULL INPUT         | fn can be passed with NULL arguments, should be handled in the function                                                                                                                                                                                                                                                                                                                                                    |
| CONTAINS SQL                 | can have SQL but can not READ or MODIFY data using that SQL                                                                                                                                                                                                                                                                                                                                                                |
| READS SQL DATA               | can not execute modifying SQL - default                                                                                                                                                                                                                                                                                                                                                                                    |
| NO SQL                       | can not execute any SQL, but DECLARE CURSOR stmt is ok                                                                                                                                                                                                                                                                                                                                                                     |
| MODIFIES SQL DATA            | execute any SQL other than that are prohibited in UDFs. Not for ALLOW PARALLEL                                                                                                                                                                                                                                                                                                                                             |
| SECURITY                     | DB2/USER/DEFINER.                                                                                                                                                                                                                                                                                                                                                                                                          |
| ASUTIME [NO] LIMIT           | total amount of processor time in CPU service units                                                                                                                                                                                                                                                                                                                                                                        |
| [NOT] DETERMINISTIC          | whether the SP/UDF returns same results for identical input arguments                                                                                                                                                                                                                                                                                                                                                      |
| [NO] COLLID name             | NO COLLID (default) takes the calling program collection to get SP/UDF pkg.                                                                                                                                                                                                                                                                                                                                                |
| [NO] DBINFO                  | additional info like schema, auth id, name of server are passed. Not for JAVA                                                                                                                                                                                                                                                                                                                                              |
| RUN OPTIONS                  | not for COMPJAVA/LANGUAGE JAVA                                                                                                                                                                                                                                                                                                                                                                                             |
| FENCED                       | UDF/SP runs in an external address space out of DB2 address space- default                                                                                                                                                                                                                                                                                                                                                 |
| STAY RESIDENT                | YES - to stay in memory after execution - NO deletes from memory                                                                                                                                                                                                                                                                                                                                                           |
| PROGRAM TYPE                 | SP/Function runs as subroutine/runs as main routine                                                                                                                                                                                                                                                                                                                                                                        |
| SUB/MAIN                     | MAIN can be used only for WLM managed SPs - functions are anyway WLM managed                                                                                                                                                                                                                                                                                                                                               |
| INHERIT/DEFAULT              |                                                                                                                                                                                                                                                                                                                                                                                                                            |
| SPECIAL REGISTERS            |                                                                                                                                                                                                                                                                                                                                                                                                                            |
| PARAMETER CCSID              | Encoding scheme for string parameters is ASCII, EBCDIC, UNICODE                                                                                                                                                                                                                                                                                                                                                            |

- UDFs are two types **SOURCED**(based on existing built in/external functions and **EXTERNAL**(user written) and categorized further to two **SCALAR** and **TABLE**
- Scalar fns (row fns) operate on each row - one result per row.  
Column fns (vector fns) operate on entire column to return one single value. Not for UDFs.  
Table fns return entire table - means can only be referenced in FROM clause of a SELECT
- Similar functions will be executed based on earlier promotion date.
- Timestamp of UDF must be before the timestamp of package/plan that invokes the UDF.
- Supports function overloading, which means, multiple functions have same name.
- Commit, Rollback, RRSF calls cannot be used in a UDF.
- Use DSN\_FUNCTION\_TABLE using EXPLAIN, to analyze the function resolution
- An UDF can call a Store Procedure and vice-versa

## 1. Important parameters

| Parameter name                                                                                                                                                                                                         | Description                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| IN                                                                                                                                                                                                                     | input parameter                                                                       |
| OUT                                                                                                                                                                                                                    | output parameter                                                                      |
| INOUT                                                                                                                                                                                                                  | either input or output parameter                                                      |
| AS LOCATOR                                                                                                                                                                                                             | for LOB data type                                                                     |
| RESULT SET                                                                                                                                                                                                             | no of result sets(cursors) returned-0-32767, cursors are read only                    |
| EXTERNAL                                                                                                                                                                                                               | external load module name of the SP                                                   |
| LANGUAGE                                                                                                                                                                                                               | external pgm language C/C++/ASSEMBLE/COBOL/OO-COBOL/COMJAVA/JAVA/PLI/REXX/ <b>SQL</b> |
| COMMIT ON RETURN                                                                                                                                                                                                       | NO - DB2 does not issue commit when the SP returns. YES - commits                     |
| [NO] WLM ENVIRONMENT                                                                                                                                                                                                   | WLM environment name. SECURITY USER not for NO WLM ENVIROMENTS                        |
| ASUTIME, RUN OPTIONS, COLLID, SECURITY, FENCED, STAY RESIDENT, PARAMETER CCSID, DETERMINISTIC, DBINFO, NO SQL, MODIFIES/READS/CONTAINS SQL, CALLED ON NULL INPUT, INHERIT/DEFAULT SPECIAL REGISTERS<br>PARAMETER STYLE | <b>same as in UDF definition</b>                                                      |

2. Calling program and stored procedure can be of different languages
3. Can use Static/Dynamic SQLs, DB2 commands and IFI calls with the exception of SET CURRENT SQLID
4. Can access Flat files, VSAM files, and other files as well as DB2 tables.
5. Should be compiled AMODE=31, RMODE = ANY and preferably REENT
6. Can access resources in CICS, IMS, and other MVS address spaces
7. Run in a separate address space known as *Stored Procedure Address Space (SPAS)* or *WLM address spaces*
8. Major advantages are reusability, consistency, data integrity, maintenance, performance, security
9. Can call another stored procedure (nested procedure to 16 levels), triggers, UDFs and subprograms
10. DBRM of SPs must be bound into a PKG, no plan is required for the SPs run using RRSAPF.
11. Must be link edited with DSNALI for (CAF) or DSNRLI (for RRSAPF)
12. Parm lists are stored in SYSIBM.SYSPARMS
13. ALTER can't alter the type of PARM passed to stored procedure. Drop and recreate is the only way.
12. Processing within the SP is same UOW as of calling pgm. Locks acquired by the SP are to be held until released by the calling pgm. Commits issued inside SP commits changes of calling pgm.
13. Supports Procedural SQL called SQL Procedures Language SPL.
14. Calling Pgm will not have a record in SYSROUTINEAUTH if the STORED PROCEDURE call is DYNAMIC.
- 17) **To debug** a SP under IBM DEBUGGER, you should  
ALTER PROCEDURE *schema.spname*  
RUN OPTIONS 'TEST(,,MFI%CT00Q005:\*)'; → static LU/IP address of the emulator session
- 18) For returning result set to a program,
  - a) RESULT SET must be specified correctly on the CREATE or ALTER PROCEDURE statement
  - b) Specify WITH RETURN clause on each OPEN cursor stmt for which results should be returned
  - c) Stored procedure should not close the cursor that is returned to the calling program
  - d) DESCRIBE PROCEDURE/DESCRIBE CURSOR are available if return sets from the SP are not known
  - e) Coding the calling program to accept the result set (See examples below)
19. SPs executing within WLM needs a refresh whend compiled similar to CICS new copy.  
If WLM refresh is automatic, you need to wait for that much of period to prevent -805 abends.

**Operator command WLM related**

```

/D WLM,APPLENV=XPAE0001 to display status of the WLMs
/V WLM,APPLENV=XPAE0001,RESUME to start a stopped WLM
/V WLM,APPLENV=XPAE0001,REFRESH to refresh the WLM to pick new load modules

```

ALTERing needs STOP & START, program change does not START just refereshing the WLM will do

20. In a datasharing environment
  - on subsystem 1 - stop procedure
  - on subsystem 2 - call store procedure
 Will not abend, because if you did not specify GROUP - it is just local (default)

## 20. Examples for programs calling SPs

Mnemonic **ASAL** : Associate and Allocate20.1) Static call - Batch

```

**** CALLING STORED PROCEDURE STATICALLY

01 LOCVAR USAGE SQL TYPE IS RESULT-SET-LOCATOR VARYING.

PROCEDURE DIVISION.

 EXEC SQL CALL LPRSP002(:WS-SP-SQL-CODE) END-EXEC.
 EXEC SQL ASSOCIATE LOCATOR(:LOCVAR) =>if the SP returns a cursor
 WITH PROCEDURE LPRSP002

 END-EXEC.
 EXEC SQL ALLOCATE C1 CURSOR FOR RESULT SET :LOCVAR END-EXEC.
 PERFORM B120-FETCH-PARA UNTIL EOF-CURSOR='T'.

B120-FETCH-PARA.
 EXEC SQL FETCH C1 INTO :DCLEMP-SAMPLE END-EXEC.

```

20.2) Dynamic call - Batch

```

MOVE ZEROS TO WS-SP-SQL-CODE.
MOVE 'LPRSP002' TO WS-SP-NAME. (In batch it is not significant change between
 static and dynamic calls - but in CICS it is)
EXEC SQL CALL :WS-SP-NAME(:WS-SP-SQL-CODE) END-EXEC

```

20.3) Dynamic call - CICS

```

**** CALLING STORED PROCEDURE DYNAMICALLY

MOVE 'LPRSP002' TO WS-SP-NAME.
EXEC SQL
 SET CURRENT SQLID = 'WELZ492' =>failed when AUTHID =blank and AUTHTYPE=USERID
 SET CURRENT SQLID = 'MRKADU1' =>worked when AUTHID='MRKADU1' and AUTHTYPE=blank
 below method is the preferred method
 SET CURRENT SQLID = 'MRKADU1' =>worked when AUTHID=blank and AUTHTYPE=GROUP
END-EXEC.
EXEC SQL
 SET CURRENT PATH = 'MRKADU1' => for static this is not needed
END-EXEC.
EXEC SQL CALL :WS-SP-NAME(:WS-SP-SQLCODE) END-EXEC.

```

Sample DB2E in CICS

Is listed using the CICS command **CEMT I DB2E(LPR\*)**

```

Db2entry(LPR2)
Authtype()
...
Plan(LPRONLU1)
Authid(LPRWAU1)

```

21) More on SPs can be found in [storedprocedures\\_faq](#)

23) To drop a UDF/SP use DROP FUNCTION/PROCEDURE name **RESTRICT**; restrict enforces

Not dropped if another SP/UDF/VIEW/TRIGGER is using this SP/UDF

When a UDF/SP is dropped, the package is placed into an [inoperative state](#).

## 1. Parameters

| Parameter name       | Description                                                                                                                                                              |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NO CASCADE BEFORE    | BEFORE trigger can not trigger other triggers, NO CASCADE must be specified                                                                                              |
| AFTER                | AFTER trigger                                                                                                                                                            |
| INSERT/UPDATE/DELETE | Type of trigger                                                                                                                                                          |
| REFERENCING          | giving Correlation names like OLD/NEW as OLD/NEW OLD TABLE/NEW TABLE AS<br>OLD and NEW are allowed only FOR EACH ROW<br>OLD TABLE and NEW TABLE are valid only for AFTER |
| MODE DB2SQL          | currently only DB2SQL is supported                                                                                                                                       |
| FOR EACH ROW         | ROW is allowed for BEFORE and AFTER triggers                                                                                                                             |
| FOR EACH STATEMENT   | STATEMENT is not allowed for BEFORE triggers                                                                                                                             |
| BEGIN ATOMIC...END   | to specify multiple sql statements                                                                                                                                       |

2. Triggers are automatic, implicit, non-bypassable (except during loads and other utilities, SHRLEVEL CHANGE during LOAD will fire a TRIGGER)

3. Associated with schema, which is the authid by default

4. Two triggers of same type in a table will be fired in the order in which it is created

5. Cannot define Triggers on Views, Aliases, Synonyms, 3-part names, System Catalog Tables.

## 6. Trigger Package

- is created automatically when CREATE TRIGGER is executed and records it in SYSIBM.SYSPACKAGE
- Uses SCHEMA name as COLLECTION name
- can not use multiple versions
- BIND is not allowed, but REBIND TRIGGER PACKAGE command rebinds to change BIND defaults.
- Trigger pkgs can't be Freed/Dropped/Copied. DROP TRIGGER will drop trigger & trigger pkg.

6. When tables are dropped all associated triggers to the tables are dropped too.

## 7. Restrictions

- Cursors & Commit can't be used in Triggers. SPs called by Triggers can't issue COMMIT
- SQL SET variable statement - only in Before Trigger.
- INSERT, UPDATE, DELETE between BEGIN ATOMIC..END - only in After Trigger
- BEFORE triggers can not invoke another trigger
- BEFORE triggers can not have FOR EACH STATEMENT
- No ALTER for triggers (-199 sqlcode)
- SQLs can not have host variables, DTT
- can only refer tables on current server

a) Triggers can SIGNAL SQLSTATE to signal errors (-438 Sqlcode indicating it signaled)

In a program SQLSTATE can be trapped from SQLSTATE and the error message from SQLERRM of SQLCA

## 9. Example Create Trigger statement

```
CREATE TRIGGER LPRTRG01
NO CASCADE BEFORE
INSERT
ON MRKADU1.EMP
REFERENCING NEW AS NEW_VAR
FOR EACH ROW
MODE DB2SQL
WHEN NEW_VAR.WORKDEPT
NOT IN (SELECT DEPTNO FROM MRKADU1.DEPT)
BEGIN ATOMIC
SIGNAL SQLSTATE 'LPR00' ('DEPARTMENT NOT VALID');
END
```

- ➔ BEGIN ATOMIC & END are used
- ➔ for multiple SQLs, but for clarity
- ➔ use it even for single SQL stmt

**XVI****Bind (SYSPLAN, SYSPACKAGE)**

1) To use Package versioning to bind more than one version of a package into same collection

```
//PRECOMP EXEC PGM=DSNHPC,PARM='HOST(COB2),APOST,APOSTSQL,SOURCE=XREF,VERSION(AUTO)'
```

**2) Bind Parameters**

| Parameter name                                                               | Description                                                                                                                                                                                                  |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ACQUIRE</b><br>ALLOCATE<br>USE (recommended)                              | ALLOCATE - when the first SQL stmt is issued maximum required lock is taken on all the objects in the package<br>USE- only when the objects are involved                                                     |
| COPY pkg command                                                             | you are copying an existing package and names the package                                                                                                                                                    |
| CURRENTDATA(YES/NO)<br>(Only for CS)                                         | Enables BLOCK FETCH for DISTRIBUTED applications<br>For read only plans/packages it is use CURRENTDATA(NO) - means lock avoidan                                                                              |
| CURRENTSERVER( <i>locname</i> ) -Plan                                        | location to connect before binding                                                                                                                                                                           |
| <b>RELEASE</b><br>DEALLOCATE<br>COMMIT (recommended)                         | TS or Table locks are released<br>DEALLOCATE - at the end of the package use<br>COMMIT - at commit time                                                                                                      |
| DBPROTOCOL (DRDA/PRIVATE)                                                    | which protocol to use during remote site connection using three part names                                                                                                                                   |
| DEGREE (ANY   1)                                                             | <a href="#">ANY for parallelism</a>                                                                                                                                                                          |
| DISCONNECT - Plan<br>AUTOMATIC   CONDITIONAL<br>EXPLICIT)                    | AUTOMATIC - disconnects all remote locations during COMMIT<br>CONDITIONAL- disconnects all remote locations during COMMIT except WITH HOI<br>EXPLICIT - only release pending states are destroyed            |
| DYNAMIC RULES<br>(RUN/BIND/DEFINEBIND/<br>DEFINERUN/INVOKEBIND<br>INVOKERUN) | what values apply at run-time for <b>dynamic</b> SQL attributes                                                                                                                                              |
| ENABLE DISABLE<br>BATCH/CICS/DB2CALL/IMS/RRSAF<br>IMSBMP/REMOTE/IMSMPP       | which connections can use the plan/pkg                                                                                                                                                                       |
| EXPLAIN NO/YES                                                               | whether or not to populate the PLAN_TABLE                                                                                                                                                                    |
| <b>ISOLATION</b> (page/row level)<br>CS/RR/RS/UR                             | UR reads uncommitted data is for overriding locks. Only (TYPE2).<br>For TYPE1 it forces TS scan. UR is for SELECT, DB2 uses CS for IUD<br>RS is similar to RR but INSERTs are allowed for other applications |
| KEEPDYNAMIC(YES NO)                                                          | YES - also must use NOREOPT(VARS) avoids re-preparing of PREPARE stmts after commits for dynamic sqls                                                                                                        |
| NODEFER(PREPARE)<br>DEFER (PREPARE)                                          | whether to defer preparation of SQL that refer to remote objects or to prepare them immediately                                                                                                              |
| OPTHINT(hinted)                                                              | to make OPTIMIZER to use a hint specified in EXPLAIN table                                                                                                                                                   |
| OPTIONS ( <u>COMPOSITE</u>  COMMAND)<br>package                              | During copy for options not specified use the SOURCE (COMPOSITE).<br>Use defaults(COMMAND)                                                                                                                   |
| OWNER                                                                        | by default, OWNER is the Primary ID,.                                                                                                                                                                        |
| PKLIST - Plan                                                                | to list the collection and pklist like <i>COLLECTION.*</i>                                                                                                                                                   |
| QUALIFIER                                                                    | by default, QUALIFIER is the OWNER id                                                                                                                                                                        |
| REOPT (VARS)<br>NOREOPT(VARS)                                                | REOPT(VARS) make DB2 to reoptimize chosen access both during bind time and run time, performance cost is involved.<br>In CURSOR usage, REOPT is performed only during OPEN not during FETCH                  |
| REPLACE,<br>REPLACE REPLVER- Pkg<br>REPLACE RETAIN - Plan<br>ADD             | RETAIN retains EXEC privilege on plan other than OWNER                                                                                                                                                       |
| SQLERROR(NOPACKAGE CONTINUE)                                                 | NOPACKAGE - package is not created during SQL error. CONTINUE creates pkg.                                                                                                                                   |
| SQLPATH(SCHEMA NAMES)                                                        | schema names must be in upper case                                                                                                                                                                           |

3) REBIND is recommended if the following is true in RUNSTATS from the previously recorded values

```
HIGH2KEY & LOW2KEY ranges change > 20%
Cardinality & row count change > 20%
Changes > 20 % (NLEAF, NPAGES, NACTIVE)
Cluster ratio < 80%
```

4) When objects are dropped, dependent plans are invalidated.

5) DB2 marks plan or package as invalid when;

- a object that the plan or package depends is dropped or renamed
- authorization of the owner to access of those objects is revoked
- table is altered to add a TIME/DATE/TIMESTAMP column or a UDF is altered

**XVII****CURRENT Special Registers**

- 1) CURRENT RULES (STD/DB2)
1. This is set using BIND SQLRULES option or SET CURRENT RULES statement
  2. Affected Statements

| Statement                                                                  | STD<br>sql standard rules                                                                                             | DB2<br>DB2 rules                   |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------|
| ALTER TABLE ADD CONSTRAINT<br>existing rows of Table violate the constrain | statement FAILS                                                                                                       | TS in CHKP                         |
| CREATE TABLE with LOB column<br>ALTER TABLE ADD LOB column                 | LOB TS and auxiliary table are created<br>automatically                                                               | LOB TS & AUX tbl<br>aren't Created |
| If DELETE RULE is not specified                                            | NO ACTION                                                                                                             | RESTRICT                           |
| DELETE FROM table WHERE column=value<br>(searched delete)                  | DELETE privilege<br>SELECT privilege                                                                                  | DELETE privilege                   |
| GRANT privilege TO yourself(id of grantor)                                 | Allowed                                                                                                               | Not allowed                        |
| CREATE TABLE table (COL1 ROWID)<br>ALTER TABLE table ADD (COL1 ROWID)      | Automatically creates Unique IX on the<br>ROWID column. Name of the IX will be<br>I+10chars+colname+7digits random no | IX Not Created                     |

- 2) CURRENT SQLID
- a) Default CURRENT SQLID is the primary id.
  - b) This is set by an authorization exit routine invoked at connection to DB2
  - c) Can be changed dynamically by the SET CURRENT SQLID statement
  - d) If tried to SET to an invalid **-553 Sqlcode**
- 3) CURRENT USER - This can not be set, it is always user's primary id
- 4) CURRENT DATE/TIME/TIMESTAMP/TIMEZONE
- 5) CURRENT PATH/SCHEMA
- 6) CURRENT SERVER
- 6) CURRENT PACKAGE SET to set a collection to search in specific collection for a package
- 7) CURRENT DEGREE - to set ANY or 1. 1 - inhibits parallel ANY is parallel
- 8) CURRENT OPTIMIZATION HINT -
- 9) CURENT PACKAGESET -
- 10) CURENT PRECISION - for decimal arithmetic

**XVIII****Joins**

- 1) An inner join is used to return only data that has matching rows in both tables
- 2) An outer join includes the data that is in both tables and data that is in only either one of the tables. That is **non-matching rows** in left or right or both tables.

**Example:-**

- i) Following query will return all non matching rows of table B  
SELECT A.EMP\_NO, B.MGRNO FROM MRKADU1.EMP\_SAMPLE A **RIGHT** OUTER JOIN MRKADU1.DEPT B  
ON A.EMP\_NO = B.MGRNO
- ii) This will return all non matching rows of table A  
SELECT A.EMP\_NO, B.MGRNO FROM MRKADU1.EMP\_SAMPLE A **LEFT** OUTER JOIN MRKADU1.DEPT B  
ON A.EMP\_NO = B.MGRNO
- iii) This will return all non matching rows of table A and table B  
SELECT A.EMP\_NO, B.MGRNO FROM MRKADU1.EMP\_SAMPLE A **FULL** OUTER JOIN MRKADU1.DEPT B  
ON A.EMP\_NO = B.MGRNO

**3) Star Join**

Is enabled in a SS parameter STARJOIN to 1 or 0 and also when cardinality of the fact table is 25 times of cardinality of dimension table  
Has a fact table and number of dimension tables

**4) Hybrid Join**

Is only to a inner join and requires an index on the join columns  
Steps

- Outer table scan and joins with the RID of the inner table producing intermediate table(I1)
- Sorts intermediate tables
- Retrieves data of inner table using list prefetch giving I2
- I1+I2
- In PLAN\_TABLE, METHOD=4, and SORTC\_JOIN=Y/SORTN\_JOIN=Y,N/PREFETCH=L

**1) SQL**

- 1.1) FETCH FIRST n ROWS will retrieve only n rows from the table
- 1.2) If SELECT INTO ... and FETCH FIRST 1 ROW is used no -811 Sqlcode as it fetches only one row
- 1.3) OPTIMIZE FOR n ROWS will retrieve all qualifying rows but will optimize only for n Rows, there by reducing the time to optimize the entire table
- 1.4) If both FETCH and OPTIMIZE are used as below  
 FETCH FIRST n ROWS ONLY - optimized for n if m > n and for m if m <=n  
 OPTIMIZE for m ROWS
- 1.5) OPTIMIZE will be ignored if
  - UNION, DISINCT, GROUP BY and ORDER BY but no IX
  - column function but no GROUP BY
- 1.6) VALUE & COALESCE do the same function
- 1.7) CORELATED sub-query refers to at-least one column of the outer query. For each qualifying row in the outer table, evaluates the query for the inner table.
- 1.8) ORDER BY can reference *column + column expression*

**2) Embedded SQL**

- 2.1) SQLCA
  - i. First variable SQLCAID contains SQLCA value to locate easily in the dump
  - ii. Length is 136 as of version 6 and is stored in SQLCABC variable
  - iii. SQLERRD(3) - number of rows inserted , deleted, updated
  - iv. SQLCODE is different among platforms. SQLSTATE is consistent
- 2.2) Host variables must be prefixed with colon
- 2.3) Null indicator variables are PIC S9(4)
- 2.4) OCCURS clause is allowed only for null indicator structure and not allowed for host variables.
- 2.5) DECLARE CURSOR with UNION/DISTINCT/GROUP BY/ORDER BY/JOINS/subqueries is a READ ONLY cursor
- 2.6) CURSOR WITH HOLD closes with a ROLLBACK/CONNECT/RRSAF TERMINATE THREAD
- 2.7) SCROLL clause is used to declare scrollable cursors
- 2.8) SENSITIVE STATIC on DECLARE and FETCH stmt is whether changes in the underlying table should be reflected on the result set
- 2.9) If FETCH SENSITIVE does not find a row (hole) gives -222 and -224 if values are different
- 2.10) Functions are reevaluated if FETCH SENSITIVE is used

3) CALL DSNTIAR that returns standard, textural error messages.

**4) Nested table expressions or temporary views or inline views**

```
SELECT MAX(avgscore) FROM
(SELECT NO, AVG(INTEGER(SCORE) AS avgscore FROM tbl_name GROUP BY NUMBER) AS AVERAGES
will create a temporary table called AVERAGES
```

- 5) SQL update may increase the length of a Variable length row. If DB2 won't be able to place the expanded row in the same position because of lack of free space it will leave a pointer (RID) in the original location pointing to the new location causing more overhead. REORG will correct this
- 6) The SQLDA variables are options that can be used by the PREPARE, OPEN, FETCH, EXECUTE, and CALL statements. An SQLDA communicates with dynamic SQL; modified with the addresses of host variables, and then reused in a FETCH statement.
- 7) PRECOMPILER does not access DB2

## 8) Dynamic SQL :

- 5.1) Dynamic SQL caching should be enabled but cautiously to use DYNAMIC caching.
- 5.2) Dynamic SQLs can not have host variable use parameter marker
- 5.4) No OPEN/CLOSE/FETCH/DECLARE/DESCRIBE/EXECUTE/EXECUTE IMMEDIATE/PREPARE/INCLUDE/WHENEVER

a) Execute Immediate (NOT FOR SELECT) :

- No explicit PREPARE (which is similar to bind). Repeated access path determination for repeated execution causing overhead

b. Non - Select

## b.1) Prepare and Execute (PE)

- No SELECT stmt

```

WORKING-STORAGE SECTION.
.
.
.
EXEC SQL
 INCLUDE SQLCA
END-EXEC.
.
.
01 STRING-VARIABLE.
 49 STRING-VAR-LEN PIC S9(4) USAGE COMP.
 49 STRING-VAR-TXT PIC X(100).
.
.
PROCEDURE DIVISION.
.
.
MOVE +45 TO STRING-VAR-LEN.
MOVE "DELETE FROM DSN8310.PROJ WHERE DEPTNO = 'A00'"
 TO STRING-VARIABLE.
EXEC SQL
 PREPARE STMT1 FROM :STRING-VARIABLE;
END-EXEC.
EXEC SQL
 EXECUTE STMT1;
END-EXEC

```

## b.2) Non-Select with parameter markers (PEUPM)

- Use ? instead of host variables
- Similar to PE , PREPARE followed by EXECUTE :stmt using :parameter-marker

3. Fixed List Select (Declare, Prepare, Open) - (DPO)

- When the SELECT stmt know the number and name of columns ahead
- SQLDA can be used

```

*** DYNAMIC SQL - FIXED SELECT EXAMPLE

WORKING-STORAGE SECTION.
.
.
.
*BELOW DEFINITION AND LEVEL NUMBERS SHOULD MATCH EXACTLY
01 WS-DYNAMIC-SQL.
 49 WS-DYNAMIC-LEN PIC S9(4) COMP VALUE 143.
 49 WS-DYNAMIC-TEXT PIC X(143).
.
.
PROCEDURE DIVISION.
.
.
.
MOVE 'SELECT COL1, COL2, COL3 FROM TABLE1 WHERE COL1=?'
 TO WS-SQL-TEXT.
PERFORM B100-PREPARE-DYNAMIC-SQL.
EXEC SQL OPEN CRSR1 USING :KEY-EMP-NO 3rd step END-EXEC.
PERFORM D100-FETCH-PARA UNTIL FETCH-NO = 'T'.
EXEC SQL CLOSE CRSR1 END-EXEC.
B100-PREPARE-DYNAMIC-SQL.
EXEC SQL DECLARE CRSR1 CURSOR FOR FLSQL 1st step END-EXEC.
MOVE WS-SQL-TEXT TO WS-DYNAMIC-TEXT.
EXEC SQL PREPARE FLSQL FROM :WS-DYNAMIC-SQL 2nd step END-EXEC.
D100-FETCH-PARA.
EXEC SQL FETCH CRSR1 INTO :WS-OUTPUT-REC END-EXEC.

```

d) Variable List Select

- Used when the number of selected columns or which columns are not known.
- Steps
  - DECLARE CURSOR
  - PREPARE
  - DESCRIBE(must use SQLDA)
  - OPEN
  - FETCH using DESCRIPTOR
  - CLOSE

## 10. SQL ACCESS guide-lines

- a) When *LOW* and *HIGH* are specified with BETWEEN, LOW value must precede high value like;  
**BETWEEN low AND high** → Switching will cause **unpredictable results**.
- b) Use IN instead of LIKE
- c) You can code **OR 0 =1**, to **disable index access**. For character use CONCAT ` `
- d) Use NOT EXISTS instead of NOT IN
- e) COUNT returns INTEGER, COUNT\_BIG returns DECIMAL.
- f) **NULL**
  - If WHERE condition yields no records, **Column fns(AVG/MAX/MIN)** will give **NULL** instead of -100.
  - Data overflow (if host variable length is small for data) will cause NULL to be returned
  - WHERE **column=NULL** is incorrect, specify → WHERE **column IS NULL**
  - NULL does not participate in inner join.
  - SET column = NULL is possible in UPDATE statements
  - Concatenation of NULLs results in NULL
  - NULLS won't participate in mathematical functions like AVG(COLUMN), SUM(COLUMN)
  - **-305 Sqlcode** for → NULL values returned, but no NULL indicator is speceified.

**XX Authority/Security/Privileges**

- 1) Having DBCTRL authority at-least (DBADM included) will authorize to create table with any qualifier in a SS in a database
  - 2) Duplicate GRANTS are not recorded(+562 Sqlcode), avoid duplicate grants
  - 3) Provides a mechanism to replace internal DB2 security with RACF security
  - 4) Secondary authid will ease the GRANTING procedures when it is given to groups
  - 5) Granting access to SYNONYM, grants access to the underlying base table, avoid it.
  - 6) Creator(for the ones which he created), SYSADM, SYSCTRL can grant access to the objects
  - 7) Only way to change implicit authority is to drop and recreate it
  - 8) Dropping a object will remove the authority on them. Freeing a plan will remove the authority on it.
  - 9) Multiple authorizations should be GRANTED at same time to prevent duplicates in the catalog table.
  - 10) SYSIBM.DBAUTH, will have an entry for each DBADM authority that was granted
  - 11) BIND PLAN privilege can free the plan but BIND PKG can not free a PKG. BINDAGENT can't execute
  14. GRANT REFERENCES and GRANT UPDATE can be given to columns (not for AUX tables) but REVOKE can be issued only to the whole table and not in column level
  15. Granting certain privileges will grant some privileges IMPLICITLY. If you revoke the original grant, the privileges that were granted IMPLICITLY will stay.
- Revoking DBADM removes the DBADM authority, but it does not remove the underlying privileges that were granted.

## 15. OS/390 privileges are; Ten predefined sets of Authorities -Table

| Function                                   | ISA         | SA | SC                  | ISO                                    | SO        | DA   | DC                            | DM                             |
|--------------------------------------------|-------------|----|---------------------|----------------------------------------|-----------|------|-------------------------------|--------------------------------|
| Who gives it                               | Install     |    |                     | Install                                | N         | SYSA | SYSA/C                        | SYSA/C                         |
| CATMAINT                                   | Y           | N  | N                   | N                                      | N         | N    | N                             | N                              |
| DROP DSNDB07                               | Y           | Y  | N                   | N                                      | N         | N    | N                             | N                              |
| ST DB2 ACCESS (MAINT)                      | Y           | N  | N                   | Y                                      | N         | N    | N                             | N                              |
| ARCHIVE LOG                                | N           | Y  | Y                   | Y                                      | N         | N    | N                             | N                              |
| RECOVER BSDS                               | N           | Y  | Y                   | N                                      | N         | N    | N                             | N                              |
| RECOVER/RESET<br>INDOUBT/POSTPONED         | N           | Y  | Y                   | N                                      | Y         | N    | N                             | N                              |
| START/STOP DDF/RLIMIT                      | N           | Y  | Y                   | N                                      | Y         | N    | N                             | N                              |
| SET SYSPARM/ARCHIVE/LOG                    | N           | Y  | Y                   | N                                      | Y         | N    | N                             | N                              |
| TERM UTIL on DB                            | Only 06     | Y  | Y                   | N                                      | Y         | Y    | Y, except<br>DIAG<br>STOSPACE | Y, except<br>DIAG,<br>STOSPACE |
| STOSPACE                                   | N           | Y  | Y                   | N                                      | N         | N    | N                             | N                              |
| DIAGNOSE                                   | Y with WAIT | Y  | Y                   | Only DSNDB01/06                        | N         | Y    | Y                             | N                              |
| CHECK DATA/IX/LOB                          | N           | Y  | Y                   | Only DSNDB01/06/LOB                    | N         | Y    | Y                             | Y                              |
| COPY(allforms)/Quiesce<br>MODIFY           | N           | Y  | Y                   | Only DSNDB01/06                        | N         | Y    | Y                             | Y                              |
| Reorg                                      | Only 01/06  | Y  | Y                   | Only DSNDB01/06                        | N         | Y    | Y                             | N                              |
| Recover/Repair/Runstats<br>Report          | N           | Y  | Y                   | Only DSNDB01/06<br>Runstats only on 06 | N         | Y    | Y                             | Runstats                       |
| Load/Unload/Rebuild                        | N           | Y  | Y<br>ULd only on 06 | N                                      | N         | Y    | Y<br>No UNLD                  | N                              |
| Start/Stop/Display DB                      | N           | Y  | Y                   | No STOPDB,CHGMOD                       | just Disp | Y    | Y                             | Y                              |
| Create Tables/TS                           | N           | Y  | Y                   | N                                      | N         | Y    | Y                             | Y                              |
| Create ALIAS                               | N           | Y  | Y                   | N                                      | N         | N    | N                             | N                              |
| DMLs                                       | N           | Y  | N                   | N                                      | N         | Y    | N                             | N                              |
| ALTER/INDEX<br>REFERENCES/TRG              | N           | Y  | Y                   | N                                      | N         | Y    | N                             | N                              |
| BIND/COPY/EXECUTE/FREE<br>plan and package | N           | Y  | No EXE/FREE         | N                                      | N         | N    | N                             | N                              |

16. SYSCTRL can not give SYSADM, DBADM, PACKADM, EXECUTE, S/I/U/D on user tables or views

## 17. SS level authorities

CREATEALIAS, CREATEDBA, CREATEDBC, CREATEESG, CREATETMTAB, DISPLAY MONTIOR1, MONTIOR2, RECOVER, STOPALL, STOSPACE, TRACE, ARCHIVE, BINDADD, BINDAGENT, BSDS, SYSADM, SYSCTRL, SYSOPR

## 18. Utility level authorities

IMAGCOPY(gives copy, quiesce, mergecopy), LOAD, RECOVERDB(recover, rebuild, report), REORG, REPAIR, (repair, diagnose except repair DBD, diagnose WAIT, STATS(runstats, check))

## 19. Object level Authorization - Table

| No       | Object                   | Operate             | Authority                                      | Privilege                                                     | Indirect Privilege                                                      |
|----------|--------------------------|---------------------|------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------------------|
| 1        | SG                       | CREATE              | SYSADM, SYSCTRL                                | CREATESG                                                      |                                                                         |
|          |                          | USE                 | above, Creator                                 | USE OF STOGROUP                                               |                                                                         |
| 2        | BP                       | ALTER               | SYSADM, SYSCTRL, SYSOPR                        |                                                               |                                                                         |
|          |                          | USE                 | above                                          | USE OF BUFFERPOOL                                             |                                                                         |
| 3        | DB                       | CREATE              | SYSADM, SYSCTRL                                | CREATEDBA (SS), CREATEDBC (SS)                                | no CREATEDBM privilege                                                  |
|          |                          | DROP                | above and creator                              | DROP, DBADM, DBCTRL                                           |                                                                         |
|          |                          | USE                 | above and creator                              | DBADM, DBCTRL, DBMAINT                                        |                                                                         |
|          |                          | START               | above and creator                              | STARTDB, DBADM, DBCTRL, DBMAINT                               |                                                                         |
|          |                          | STOP                | above and creator                              | STOPDB, DBADM, DBCTRL, DBMAINT                                |                                                                         |
|          |                          | DB Utils            |                                                |                                                               | DBMAINT limited utils                                                   |
|          |                          | REBLD,<br>RECR/REPT | above and DBADM/CTRL                           | RECOVERDB                                                     |                                                                         |
|          |                          | REORG               | above, DBADM/CTRL                              | REORG                                                         |                                                                         |
|          |                          | LOAD                | above, DBADM/CTRL, owner                       | LOAD                                                          | ownership of the tables                                                 |
|          |                          | UNLOAD              | SYSADM, DBADM and owner                        | SELECT                                                        |                                                                         |
|          |                          | COPY<br>QUIESCE     | above, DBADM/CTRL/MAINT                        | IMAGCOPY                                                      |                                                                         |
|          |                          | CHECK<br>RUNSTATS   | above, DBADM/CTRL/MAINT                        | STATS                                                         |                                                                         |
|          |                          | DIAGNOSE<br>REPAIR  | above, DBADM/CTRL                              | REPAIR                                                        | REPAIR DBD only by<br>SYSADM/CTRL/OPR                                   |
| LISTDEF  | all                      | all                 | SELECT-SYSIXS,SYSTBS,SYSTSS                    |                                                               |                                                                         |
| STOSPACE | above                    | STOSPACE            |                                                |                                                               |                                                                         |
| 4        | TS                       | CREATE              | SYSADM, SYSCTRL,<br>DBADM/CTRL/MAINT, DB owner | CREATETS (Database)                                           | USE OF STOGROUP<br>USE OF BUFFERPOOL                                    |
|          |                          | USE                 | above,creator of TS                            | USE OF TABLESPACE                                             |                                                                         |
| 5        | Table                    | CREATE              | SYSADM, SYSCTRL<br>DBADM/CTRL/MAINT, CREATETS  | CREATETB                                                      | USE OF TABLESPACE<br>DBADM/CTRL can create<br>tables with any qualifier |
|          |                          | DROP                | SYSADM,SYSCTRL, DBA owner                      |                                                               |                                                                         |
|          |                          | USE                 | SYSADM, DBADM, creator                         | SEL, INS, UPD, DEL                                            |                                                                         |
| 6        | Index                    | CREATE              | SYSADM, SYSCTRL<br>DBADM/CTRL/MAINT, tbl owne  | INDEX                                                         | USE OF STOGROUP<br>USE OF BUFFERPOOL                                    |
| 7        | View                     | CREATE              | SYSADM, SYSCTRL<br>DBADM, table owner          | only ON the AUTHID qualifiers<br>if DSNTIPP CREATE AUTH is NO | SELECT on tables.<br>SYSCTRL only on catalog tbls                       |
| 8        | Alias                    | CREATE              | SYSADM, SYSCTRL                                | CREATEALIAS(SS)                                               |                                                                         |
| 9        | SP, UDF<br>UDT,<br>Trigr | CREATE              | SYSADM, SYSCTRL                                | CREATEIN. ID in AUTHID group                                  | BINDADD<br>CREATE IN on a collection<br>CREATE TRIGGER on a tbl         |
|          |                          | ALTER               | above and creator                              | ALTERIN                                                       |                                                                         |
|          |                          | DROP                | above and creator                              | DROPIN                                                        |                                                                         |
|          |                          | Invoke              | above and creator                              | EXECUTE ON routines,functions<br>USAGE ON DISTINCT TYPE       | EXECUTE on SP Collection                                                |
| 10       | PLAN                     | ADD                 | SYSADM, SYSCTRL                                | BINDADD                                                       |                                                                         |
|          |                          | REBIND              | above and Plan owners                          | BINDADD, BINDAGENT, BIND                                      | for PKLIST execute authority                                            |
|          |                          | FREE                | above and Plan owners                          | BINDADD, BINDAGENT, BIND                                      |                                                                         |
|          |                          | EXECUTE             | SYSADM and Plan owners                         | EXECUTE                                                       |                                                                         |
| 11       | Package                  | ADD                 | SYSADM, SYSCTRL, PACKADM                       | CREATE IN                                                     | PACKADM is collection level                                             |
|          |                          | REBIND              | above and Pkg creators                         | BINDAGENT, BIND                                               |                                                                         |
|          |                          | FREE/DROP           | above and Pkg creators                         | BINDAGENT                                                     |                                                                         |
|          |                          | EXECUTE             | above and Pkg creators                         | EXECUTE                                                       |                                                                         |
|          |                          | COPY                | above and Pkg creators                         | BINDAGENT, COPY                                               |                                                                         |
| 12       | DB2                      | START               | only from MVS console                          | only from MVS console                                         | only from MVS console                                                   |
|          |                          | STOP                | SYSADM, SYSCTRL,SYSOPR                         | STOPALL (SS privilege)                                        |                                                                         |
| 13       | Temp<br>table            | CREATE              | SYSADM, SYSCTRL<br>DBADM, DBCTRL, DBMAINT      | CREATETMTAB (SS level)<br>CREATETAB                           |                                                                         |
|          |                          | DECLARE             | PUBLIC                                         |                                                               | SELECT privilege for LIKES                                              |
| 15       | TRACE                    |                     | SYSADM, SYSOPR, SYSCTRL                        | TRACE                                                         |                                                                         |
| 16       | ARCHIVE LOG              |                     | SYSADM, SYSCTRL, ISYSOPR                       | ARCHIVE                                                       |                                                                         |

1. Utilities can be executed from DB2I, DSNU CLIST (TSO) & DSNUPROC, Control center, DSNUUTILS, SP
2. Utilities update SYSUTILX directory table
3. Online utilities determine the LRECL,RECFM,BLKSIZE for output datasets.
4. PDS not allowed for output.
5. Utility control statements are read from SYSIN
6. LISTDEF control statements may be from SYSLISTD
7. TEMPLATE control statements may be from SYSTEMPL dataset
8. Column 73 - 80 are ignored on the control statements and there can be multiple utility stmts.
9. Comments will have - before it starts.
10. Control statements can be  
CATMAINT, LOAD, REORG INDEX, REORG TABLESPACE, REPAIR, COPY, DIAGNOSE, LISTDEF, TEMPLATE, STOSPACE,  
CHECK DATA, CHECK INDEX, CHECK LOB, MERGECOPY, MOIDFY RECOVERY MODIFY STATISTICS, OPTIONS, QUIESCE  
RECOVER, REBUILD INDEX, REPORT, RUNSTATS, UNLOAD

11) DD names can be

| DDnames  | Utility used                                       | changed by      | Description                                         |
|----------|----------------------------------------------------|-----------------|-----------------------------------------------------|
| SYSDISC  | LOAD, REORG DISCARD                                | DISCARDN        | Contains discarded records                          |
| SYSOCOPY | LOAD, REORG TS, COPY(all forms)                    | COPYDDN         | copy dataset                                        |
| SYSREC   | LOAD, REORG, UNLOAD                                | INDDN<br>UNLDDN | input dataset for load                              |
| SYSMAP   | LOAD                                               | MAPDDN          | info about what i/p records violated constraint     |
| SYSERR   | LOAD, CHECK DATA                                   | ERRDDN          | info about errors encountered during processing     |
| SYSPUNCH | REORG, UNLOAD                                      | PUNCHDDN        | LOAD control card is generated and stored           |
| UTPRINmm | LOAD, REORG, REBUILD, INDEX                        | None            | when SORTKEYS keyword is specified                  |
| UTPRINT  | LOAD, REORG, CHECK, REBUILD                        | none            | messages from DFSORT                                |
| SORTOUT  | LOAD, REORG, CHECK DATA                            | WORKDDN         | sorted keys and so that SORT phase can be restarted |
| SORTWKnn | LOAD, REORG, CHECK, REBUILD                        |                 | work data set for sorting indexes                   |
| SORTDATA | REORG                                              |                 | work dataset for sorting data                       |
| SYSPRINT | All                                                | None            | utility messages                                    |
| DSSPRINT | COPY                                               |                 | for output messages when CONCURRENT copy is used    |
| SYSUT1   | LOAD, REORG, CHECK, REBUILD<br>MERGECOPY, CATMAINT | WORKDDN         | temporary work datasets that holds sorted keys      |

- 12) DSNUPROC (General Skeleton) (PROC NAME could be different (like DBDDPROC) in your site)  
From SYS1.DBM.PROCLIB(DBDDPROC-changed at the site)

```
//DBDDPROC PROC LIB='DBDD.DBA.DB2.DSNLIB', SYSTEM=DBDD,
// SIZE=600K,UID='',UTPROC=''
//*****
//DBDDPROC EXEC PGM=DSNUTILB,REGION=&SIZE, PARM='&SYSTEM,&UID,&UTPROC'
//STEPLIB DD DSN=&LIB,DISP=SHR
//*****
//SYSPRINT DD SYSOUT=*
//UTPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//*DSNUPROC PEND REMOVE * FOR USE AS INSTREAM PROCEDURE
```

- 12) COPYDDN, RECOVERYDDN can be used in LOAD REPLACE, REORG TS, COPY, MERGECOPY, COPYTOCOPY,  
13) LOG YES can be used in LOAD, REORG TS, REPAIR  
14) SHRLEVEL can be mentioned for  
    NONE, CHANGE LOAD  
    NONE, CHANGE, REFERENCE REORG  
    REFERENCE, CHANGE RUNSTATS, COPY, UNLOAD (CHANGE)  
15) Inline statistics is possible LOAD, REORG TS/IX, REBUILD INDEX  
17) LISTDEF is not allowed for LOAD, CHECK DATA/LOB, REPAIR

3) Four broad categories of utilities

| 1) Online                                                                                                                                                                                                                                                                    | 2) Offline                                                                                                                                                              | 3) Service ads                                                                                                              | 4) Sample programs                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A) Data Consistency Utilities (4)<br>a.1) CHECK DATA/INDEX/LOB<br>a.2) REPAIR<br>a.3) REPORT<br>a.4) DIAGNOSE<br>a.5) LISTDEF, TEMPLATE, OPTIONS                                                                                                                             | E) Change log inventory Utility ( <b>DSNJU003</b> )<br><br>changes the contents of BSDS. add or change log datasets                                                     | I)Catalog and Directory integrity verification utility<br><br>( <b>DSN1CHKR</b> )                                           | N)Dynamic SQL Processor( <b>DSNTEP2</b> )<br>• PL1 program<br>• Used to simulate SPUFI to issue DCL, DDL, DML, in batch                                                                                                     |
| B) Backup and Recovery Utilities (8)<br>b.1) COPY/MERGECOPY/COPYTOCOPY<br>b.2) QUIESCE<br>b.3) RECOVER<br>b.4) REBUILD INDEX<br>b.5) REPAIR<br>b.6) REPORT RECOVERY                                                                                                          | F)Print Log Map Utility<br><br>( <b>DSNJU004</b> )<br><br>prints the status of the BSDS logs, like log data set names.                                                  | J) Data compression analysis utility<br><br>( <b>DSN1COMP</b> )<br><br>Do not run on Index Spaces<br>Do not LOB columns TSS | O) Dynamic SQL Update Program ( <b>DSNTIAD</b> )<br>• Assembler program<br>• Similar to SPUFI, except,<br>• SELECT can not be used<br>• Recommended for DDL                                                                 |
| C) Data Organizational Utilities(2)<br>c.1) LOAD<br>c.2) UNLOAD<br>c.3) REORG                                                                                                                                                                                                | G)Log Preformat Utility ( <b>DSNJLOGF</b> )<br><br>Saves preformat time of VSAM active logs                                                                             | K) Offline tablespace copy utility ( <b>DSN1COPY</b> )<br><br>copy from VSAM to Seq and vice versa. IMAGE COPY to VSAM      | P) SAMPLE Unload Program ( <b>DSNTIAUL</b> )<br>• Assembler program<br><br>• Can build control cards for the LOAD utility<br><br>• WHERE and ORDER BY can be used with DSNTIAUL<br><br>• Can not exceed 72 total characters |
| D) Catalog Manipulation Utilities (5)<br>d.1) CATMAINT<br>d.2) MODIFY RECOVERY/STATISTICS<br>d.3) RUNSTATS<br>d.4) STOSPACE                                                                                                                                                  | H)Dataset dump creator - Formatted TS dump utility ( <b>DSN1PRNT</b> )<br><br>Can print TS, IS from VSAM and print image cop dataset sequential datasets that ha TS, IS | L) Dump and Trace utility<br><br>( <b>DSN1SDMP</b> )                                                                        | • LOCK TABLE can be used with DSNTIAUL                                                                                                                                                                                      |
| ♦ Db2 needs to be active<br>♦ Run using <b>DSNUTILB</b> program from DSNUPROC<br>♦ Reads SYSIN, first word is the utility name<br>♦ Can be monitored using DB2 commands                                                                                                      | <b>STOP DB2 MODE(QUIESCE)</b><br><br>will be used to avoid inconsistency before running offline and service ads                                                         | M)Recovery log extractor utility<br><br>( <b>DSN1LOGP</b> )                                                                 |                                                                                                                                                                                                                             |
| Required following specification to run correctly<br><br>LIB - DB2 link library<br>SYSTEM - DB2 SS anme<br>UID - Utility identifier<br>UTPROC - This is initially blank.                                                                                                     | Db2 can be inactive                                                                                                                                                     | Performs administrative activities                                                                                          |                                                                                                                                                                                                                             |
| Assigned a value only during restart. A value of 'RESTART(PHASE)' restarts the util from beginning the last executed phase. The phase must be determined by analyzing the type of utility and the abend Restartable utilities can be run using <b>UTPROC=RESTART</b> keyword | For DSNJU003 - DB2 can not be running                                                                                                                                   | Except for DSN1SDMP DB2 can be inactive                                                                                     | DB2 needs to be active                                                                                                                                                                                                      |



## A) Data consistency utilities

## Parameters

|                                                      |                                                                                                                                                                                                                                                                             |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A.1) CHECK DATA</b><br>(NR)                       | <ul style="list-style-type: none"> <li>▪ Checks the accuracy and integrity of DB2 data structures.</li> <li>▪ run against a single, multiple or partition of PART TSs</li> <li>▪ base TSs only, not LOB TSs - DSNU074I</li> <li>▪ Run CHECK IX before CHECK data</li> </ul> |
| LIST is not allowed                                  |                                                                                                                                                                                                                                                                             |
| TABLESPACE/PART                                      | Are similar to other definitions . "*" can't be used for TS                                                                                                                                                                                                                 |
| SCOPE                                                | PENDING - Only ROWS with PENDING status set will be checked.<br>AUXONLY - Only LOB cols check and not referential or constraint checks<br>REFOONLY - except LOB column check is not performed<br>ALL - all of them are performed                                            |
| AUXERROR REPORT/INVALIDATE                           | REPORT sets the base TS to CHECK PENDING (ACHKP) STATUS.<br>INVALIDATE sets the base TS to AUXILIARY warning (AUXW) status<br>Orphan Lob - LOB found in LOB TS but not referenced by Base TS<br>Missing LOB - LOB not found in LOB TS but referenced by Base TS             |
| FOR EXCEPTION IN t1 USE t2                           | Invalid rows are copied into exception table TIMESTAMP & RID cols                                                                                                                                                                                                           |
| DELETE (YES/NO)                                      | Yes - Resets the Check Pending Status flags                                                                                                                                                                                                                                 |
| EXCEPTIONS integer                                   | maximum number of exceptions, 0 is no limit                                                                                                                                                                                                                                 |
| ERRDDN ddname                                        | dd stmt for error processing dataset, SYSERR - default                                                                                                                                                                                                                      |
| WORKDDN ddname1, ddname2                             | temporary workfile for sort input(SYSUT1) and sort output(SORTOUT)                                                                                                                                                                                                          |
| SORTDEVT devicetype                                  | sort device type allocated by DFSORT                                                                                                                                                                                                                                        |
| SORTNUM integer                                      | number of temporary datasets to be allocated                                                                                                                                                                                                                                |
| <b>CHECK INDEX</b><br>Only below options are allowed | <ul style="list-style-type: none"> <li>▪ Checks the consistency of IX data and table data</li> <li>▪ freq inconsistent reason is partial recovery or uncontrolled DSNICOPY</li> </ul>                                                                                       |
| LIST, TABLESPACE, PART                               | similar to other definitions. LIST is not specified with TS or IX                                                                                                                                                                                                           |
| ALL                                                  | all indexes in the specified TS                                                                                                                                                                                                                                             |
| WORKDDN/SORTDEVT/SORTNUM                             | same as CHECK DATA definitions                                                                                                                                                                                                                                              |
| <b>CHECK LOB (R)</b><br>LIST is not allowed          | <ul style="list-style-type: none"> <li>▪ To verify the accuracy and integrity of data in AUXILIARY TABLESPACES</li> <li>▪ Successful execution will reset CHKP and AUXW pending flags</li> <li>▪ Exceptions will be reported, utility can't be used to fix them</li> </ul>  |
| TABLESPACE, EXCEPTIONS, SORTDEVT, SORTNUM            | same as above definitions                                                                                                                                                                                                                                                   |

**A.2 REPAIR (REPAIR OBJECT, REPAIR DBD, REPAIR LOCATE)**

|                                                                              |                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>REPAIR OBJECT (NR)</b>                                                    | <ul style="list-style-type: none"> <li>▪ Zaps DB2 data</li> <li>▪ Functions similarly to the <b>AMASZAP</b> utility</li> </ul>                                                                                                                                                                               |
| TABLESPACE, PART, LOG                                                        | similar to other definitions                                                                                                                                                                                                                                                                                 |
| LEVELID                                                                      | sets the level identifies of the named TS.                                                                                                                                                                                                                                                                   |
| INDEX                                                                        | specifies the index whose level identifier is set                                                                                                                                                                                                                                                            |
| SET TABLESPACE/INDEX                                                         | NOCOPYPEND, NORCVRPEND, NOCHECKPEND, NOAUXWARN, NOAUXCHKP - for TS<br>NOCOPYPEND, NORCVRPEND, NOCHECKPEND, NORBDPEND - for IX                                                                                                                                                                                |
| <b>REPAIR LOCATE TABLESPACE</b><br>RID/PAGE/PART/KEY/INDEX/<br>ROWID/VERSION | <ul style="list-style-type: none"> <li>▪ locates TS, IX, data to be repaired</li> <li>▪ By specifying page locations and offsets, RIDs, key data, REPAIR utility can be used to alter the data stored at specific location</li> </ul>                                                                        |
| <b>REPAIR LOCATE INDEX</b><br>PART/PAGE                                      | <ul style="list-style-type: none"> <li>▪ <b>Never run REPAIR LOCATE on DB2 Catalog and DIRECTORY</b></li> <li>▪ Careful when giving this auth as it can't be broken down into options</li> </ul>                                                                                                             |
| <b>VERIFY</b> OFFSET...DATA                                                  | to verify particular data area contains a specified value                                                                                                                                                                                                                                                    |
| <b>REPLACE</b> RESET/OFFSET ...DATA                                          | RESETS the inconsistent indicator<br>OFFSET -where data is to be replaced by a RBA within the row or page<br>DATA defines the new data that is to be entered                                                                                                                                                 |
| DELETE                                                                       | deletes a single row                                                                                                                                                                                                                                                                                         |
| <b>DUMP</b> OFFSET/MAP/DATA ...<br>LENGTH ...PAGES                           | hexadecimal dump. No effect on VERIFY, REPLACE                                                                                                                                                                                                                                                               |
| <b>REPAIR DBD</b><br>DROP/DATABASE/DBID/TEST<br>/DIAGNOSE/REBUILD/OUTDDN     | <ul style="list-style-type: none"> <li>▪ Test DBD definitions</li> <li>▪ Report diffs between Catalog info and DBD Stored in the Directory</li> <li>▪ To Rebuild a DBD definition in the DB2 directory based on DB2 catalog</li> <li>▪ To Drop an invalid database(Consult IBM before doing this)</li> </ul> |

|                                       |                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A.3 REPORT RECOVERY</b>            | <ul style="list-style-type: none"> <li>▪ report of available recovery data</li> <li>▪ To GENERATE a report on TS recovery information.</li> <li>▪ Provides information to the last recoverable point</li> <li>▪ Provides list of VOL, SER numbers for the image copy datasets and archive log</li> <li>▪ Data sets needed for recovery</li> </ul> |
| TABLESPACE <i>ts</i> LIST <i>name</i> | TS info for which the RECOVERY being requested                                                                                                                                                                                                                                                                                                    |
| INDEXSPACE <i>is</i> LIST <i>name</i> | IS being reported                                                                                                                                                                                                                                                                                                                                 |
| INDEX <i>ix</i> LIST <i>name</i>      | index in the index space being reported                                                                                                                                                                                                                                                                                                           |
| INDEX NONE                            | does not report INDEX spaces associated with the specified TS, default                                                                                                                                                                                                                                                                            |
| INDEX ALL                             | reports recovery information of all index spaces associated with the TS                                                                                                                                                                                                                                                                           |
| DSNUM ALL/integer                     | identifies a partition to be reported. integer the PART number                                                                                                                                                                                                                                                                                    |
| CURRENT                               | only the SYSCOPY entries after the last recoverable pt of the TS is reported                                                                                                                                                                                                                                                                      |
| SUMMARY                               | only the summary of the volume serial numbers is to be reported                                                                                                                                                                                                                                                                                   |
| LOCALSITE                             | report of SYSCOPY from a local site system                                                                                                                                                                                                                                                                                                        |
| RECOVERYSITE                          | report of SYSCOPY from the recovery site                                                                                                                                                                                                                                                                                                          |
| ARCHLOG 1/2/ALL                       | which archive log set to be reported, 1 is default                                                                                                                                                                                                                                                                                                |
| <b>A.3 REPORT TABLESPACESET</b>       | <ul style="list-style-type: none"> <li>▪ Generates a report detailing all tables and TSs in a referential TS set, LOB</li> <li>▪ Ensure that the QUIESCE utility, when executed against these TSs, is codes to Quiesce all TSs identified by the report</li> </ul>                                                                                |

|                     |                                                                                |
|---------------------|--------------------------------------------------------------------------------|
| <b>A.4 DIAGNOSE</b> | To diagnose problems with other DB2 utilities.                                 |
| END                 | ends diagnose processing                                                       |
| TYPE                | one ore more type of diagnose                                                  |
| ALLDUMPS            | forces a dump                                                                  |
| NODUMPS             | suppresses a dump                                                              |
| DISPLAY OBD/        | displays object identifier                                                     |
| SYSUTIL             | formats every SYSUTIL record                                                   |
| MEPL                | dumps the module point list to SYSPRINT                                        |
| AVAILABLE           | displays the utilities installed on the subsystem - needs DISPLAY              |
| DBET                | dumps the database exception table                                             |
| WAIT                | after encountering a utility message or trace id - message to console and wait |
| ABEND NODUMP        | after encountering a utility message or trace id - forced abend                |
| MESSAGE             | message id to make it wait or forced abend                                     |
| TRACEID             | trace id to make it wait or forced abend                                       |

|                      |                                                                                                                                                                                                                                                                      |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A.5 LISTDEF</b>   | Dynamically creates List of objects. Can be run for CHECK IX, COPY(all forms), MODIFY, QUIESCE, UNLOAD REBUILD/RECOVER/REORG/REPORT/RUNSTATS                                                                                                                         |
| <i>listname</i>      | Give a list name                                                                                                                                                                                                                                                     |
| INCLUDE              | To do a base include of objects                                                                                                                                                                                                                                      |
| EXCLUDE              | To exclude from the above included list                                                                                                                                                                                                                              |
| <i>objtype spec</i>  | DATABASE/TABLESPACE/INDEXSPACE/TABLE/INDEX/LIST                                                                                                                                                                                                                      |
| <i>listtype spec</i> | For <i>listtype</i> for the above <i>objecttypes</i> these are the defaults<br>DATABASE           it is TABLESPACES or INDEXSPACES<br>TABLESPACE/TABLE   it is TABLESPACES<br>INDEXSPACE/INDEX   it is INDEXSPACES<br>LIST                 it is <i>the listname</i> |
| COPY YES/NO          | YES builds a list with ISs defined with COPY YES, is for COPY & RECOVER.<br>NO - builds a list with ISs defined with COPY YES, is for REBUILD                                                                                                                        |
| RI                   | Only those objects that are RI related                                                                                                                                                                                                                               |
| ALL/BASE/LOB         | Base and Lob objects/BASE TS and IS only / LOB only                                                                                                                                                                                                                  |
| <b>A.5 TEMPLATE</b>  | Dynamically does the dataset allocation when multiple TS are used with LISTDEF<br>Can be used by CHECK/COPY(all forms) /LOAD/REBUILD/REORG/UNLOAD                                                                                                                    |
|                      | &JOBNAME, &STEPNAME , &USERID, &UTILID, &SYSUID, &UTILNAME, &SEQ, &ICTYPE, &LOCREM, &PRIBAC &LIST, &DB, &TS, &IS, &SN, &PART                                                                                                                                         |
| <b>A.5 OPTIONS</b>   | for many utilities                                                                                                                                                                                                                                                   |
| PREVIEW              | Checks syntax errors, expands LISTDEFs                                                                                                                                                                                                                               |
| OFF                  | Restores defaults                                                                                                                                                                                                                                                    |
| TEMPLATEDD/LISTDEFDD | To change the defaults                                                                                                                                                                                                                                               |

**B) Backup and recovery utilities**

|                                                |                                                                                                                                                                                             |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>B.1 COPY ( R )</b>                          | Creates IC backup for a complete TS, a single part or a full IS                                                                                                                             |
| LIST, TS, IS, IX                               | Similar to other defs. IS name is preferred, but IX name is allowed                                                                                                                         |
| DSNUM ALL/int                                  | Identifies a PART or dataset within the TS                                                                                                                                                  |
| COPYDDN ddname1, ddname2                       | Local site backup copies, SYSCOPY                                                                                                                                                           |
| RECOVERYDDN ddname1, ddname2                   | For offsite copies                                                                                                                                                                          |
| PARALLEL                                       | Max number of objects in the list that should be processed  Y                                                                                                                               |
| CHECKPAGE                                      | Checks each page in the TS or IS for validity                                                                                                                                               |
| FULL YES/NO                                    | YES - Full IC. NO - incremental IC. for IS only full IC is allowed<br>Full IC takes dual copies, incremental IC takes single copy                                                           |
| FILTERDDN ddname                               | DD name of the filter dataset                                                                                                                                                               |
| SHRLEVEL (REFERENCE/CHANGE)                    | Other applications updates (CHANGE) are put on the log (fuzz copy)                                                                                                                          |
| CONCURRENT                                     | Executes DFSMS concurrent copy to make a full IC                                                                                                                                            |
| CHANGELIMIT ( l , h )<br>REPORTONLY            | Set % of changed pages and initiate copy if it exceeds the limit<br>REPORTONLY - only to report and works with CHANGELIMIT                                                                  |
| <b>B.1) MERGECOPY (R)</b>                      | Merges multiple incremental ICs into a new incremental/full copy<br>Specify SYSUT1 to avoid rerunning MERGECOPY<br>BUFNO creates read & write buffers in main storage, improves performance |
| LIST, TS, DSNUM, WORKDDN, COPYDDN, RECOVERYDDN | similar to other definitions                                                                                                                                                                |
| NEWCOPY NO/YES                                 | No - Inc ICs are merged into single inc-IC but not merged with Full IC<br>Yes- Inc ICs are merged into Full IC to form a new full IC                                                        |
| LIST, TS, IS, IX, DSNUM, COPYDDN, RECOVERYDDN  | similar to other utility definitions                                                                                                                                                        |
| <b>B.1) COPYTOCOPY</b>                         | Makes ICs from an IC taken by COPY(all forms) except CONCURRENT                                                                                                                             |
| FROMLASTCOPY                                   | Last copy either full or incremental                                                                                                                                                        |
| FROMLASTFULLCOPY                               | Last full copy                                                                                                                                                                              |
| FROMLASTINRCOPY                                | Last incremental copy                                                                                                                                                                       |
| FROMCOPY dsn-name                              | Specify DSN to be copied from                                                                                                                                                               |

|                                                                       |                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>B.2 QUIESCE</b>                                                    | <ul style="list-style-type: none"> <li>▪ sets a consistency point(referential intact) between TSs before COPY</li> <li>▪ COPY, CHKP, RECP Flags prevent running QUIESCE</li> <li>▪ TSs processed by QUIESCE can't be modified till QUIESCE completes</li> </ul> |
| LIST, TS, TSSET, PART                                                 | Similar to other definitions                                                                                                                                                                                                                                    |
| WRITE YES/NO - to tell the changed pages to be written in disk or not |                                                                                                                                                                                                                                                                 |

|                                   |                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>B.3 RECOVER DATA/INDEX (R)</b> | <ul style="list-style-type: none"> <li>▪ standard recovery unit is TS, single table can not be recovered</li> <li>▪ Recover multiple objects with single RECOVER</li> <li>▪ Does not require work data sets to recover DB2 TS and IXs</li> <li>▪ DSNU510I-if recovery fails for copies not found and LOG is incomplete</li> </ul> |
| LIST, TS, IS, INDEX, DSNUM        | similar to other definitions                                                                                                                                                                                                                                                                                                      |
| <b>PAGE</b> page number           |                                                                                                                                                                                                                                                                                                                                   |
| TORBA                             | For Point INTIME recovery in non Data sharing                                                                                                                                                                                                                                                                                     |
| TOLOGPOINT                        | For Point INTIME recovery in data sharing                                                                                                                                                                                                                                                                                         |
| TOCOPY                            | Specify a DSN for recovery                                                                                                                                                                                                                                                                                                        |
| TOVOLUME                          | Identifies the IC dataset                                                                                                                                                                                                                                                                                                         |
| TOLASTCOPY                        | Recovers from last FULL copy to the last incremental copy if any                                                                                                                                                                                                                                                                  |
| TOLASTFULLCOPY                    | Recovers from last FULL copy and not any incremental IC                                                                                                                                                                                                                                                                           |
| LOGONLY                           | Recovery only by applying only log records                                                                                                                                                                                                                                                                                        |
| ERROR RANGE                       | To specify pages within range of reported I/O errors to be recovered                                                                                                                                                                                                                                                              |
| REUSE/PARALLEL                    | Same as other definitions                                                                                                                                                                                                                                                                                                         |

- DB2 automates tasks like,
  - ❖ Retrieving FULL IC DSN & vol-ser numbers from SYSCOPY & merges with incremental copies
  - ❖ Retrieving log data set names and volume serial numbers in LOGAPPLY process in SYSLGRNX
  - ❖ Coding the DD statement for each of these in RECOVER JCL
- DISASTER RECOVERY needs
  - o Image copies of all user data, catalog and directory
  - o Archive logs
  - o ICF export and list (ICF should be time consistent with DB2)
  - o BSDS lists, Some DB2 system libraries

|                                                                                    |                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>B.4 REBUILD IX (R)</b>                                                          | <ul style="list-style-type: none"> <li>▪ Rebuilds indexes using external sort from current data using   ism</li> <li>▪ IXs defined as COPY NO are always to be REBUILD from table data</li> <li>▪ Efficient to use REBUILD IX than CREATE IX for large existing tables</li> </ul> |
| TS, PART, LIST, REUSE, SORTDEVT, SORTNUM, SORTKEYS - see above definitions         |                                                                                                                                                                                                                                                                                   |
| STATISTICS, REPORT, UPDATE, HISTORY, FORCEROLLUP, KEYCARD, FREQVAL, NUMCOLS, COUNT |                                                                                                                                                                                                                                                                                   |
| <b>inline statistics - similar to RUNSTATS definition</b>                          |                                                                                                                                                                                                                                                                                   |

## C) Data organization utilities

| <b>C.1 LOAD DATA</b>                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                        | <ul style="list-style-type: none"> <li>Restart capability if Catalog work datasets are allocated. difficult</li> <li>No Restart capability if Work datasets are temporary</li> <li>Automatic data conversion is with additional CPU processing</li> <li>Use EXTERNAL for data conversion for DATE, TIME, TIMESTAMP</li> <li>From ver 7, <b>Cross Loader</b> function (loading the output of a SELECT)</li> <li>ROWID column with GENERATED ALWAYS can not be loaded</li> </ul> |
| INDDN                                                                                  | DD name of the input dataset. SYSREC                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| INCURSOR                                                                               | specifies the cursor for the input dataset. Can not load the same table where you define the cursor.                                                                                                                                                                                                                                                                                                                                                                           |
| PREFORMAT                                                                              | specifies the remaining pages are preformatted up to the high allocated RBA in the TS and IS                                                                                                                                                                                                                                                                                                                                                                                   |
| RESUME NO/YES                                                                          | NO - loads into an empty TS. YES - loads into a non-empty TS                                                                                                                                                                                                                                                                                                                                                                                                                   |
| SHRLEVEL NONE/CHANGE                                                                   | for CHANGE → RESUME YES, LOG YES, ENFORCE YES<br>no REUSE, no COPYDDN, no RECOVERYDDN, no STATISTICS, no KEEPDICTIONARY<br>no INCURSOR, no SORTKEYS, no PREFORMAT, no                                                                                                                                                                                                                                                                                                          |
| REPLACE                                                                                | TS and IX will be reset to empty.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| KEEPDICTIONARY                                                                         | prevents from building a new compression dictionary                                                                                                                                                                                                                                                                                                                                                                                                                            |
| REUSE                                                                                  | Tell DB2 to reuse the DB2 managed datasets                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| LOG YES/NO                                                                             | whether to LOG or NOT                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| WORKDDN ddname1, ddname2                                                               | temp work file for sort input(SYSUT1) and sort output(SORTOUT)                                                                                                                                                                                                                                                                                                                                                                                                                 |
| SORTKEYS integer                                                                       | index keys will be sorted in parallel during the SORTBLD phase                                                                                                                                                                                                                                                                                                                                                                                                                 |
| FORMAT UNLOAD, SQL/DS, FLOAT, EBCDIC, ASCII, UNICODE, CCSID, NOSUBS                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| ENFORCE CONSTRAINTS, NO                                                                | LOAD to enforce CHECK constraints and referential constraints                                                                                                                                                                                                                                                                                                                                                                                                                  |
| MAPDDN ddname(SYSMAP)                                                                  | Work dataset for error processing. maps the identifier of a table row back to the input record that caused an error. needed if ENFORCE CONSTRAINTS is used.                                                                                                                                                                                                                                                                                                                    |
| DISCARD DD ddname(SYSDISC)                                                             | dd stmt for a discard dataset.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| DISCARDS                                                                               | Maximum number of discards                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| CONTINUEIF                                                                             | Allows each input record a portion of larger record                                                                                                                                                                                                                                                                                                                                                                                                                            |
| IGNOREFIELDS                                                                           | LOAD skips fields                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| NULLIF                                                                                 | to set NULL if a string is found at a location NULLIF (22) = '?'                                                                                                                                                                                                                                                                                                                                                                                                               |
| DEFAULTIF                                                                              | to set to a predefined default eg., DEFAULTIF FIELD='DEFLT'                                                                                                                                                                                                                                                                                                                                                                                                                    |
| WHEN(start:end)                                                                        | tells which record to be loaded                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| SORTDEVT/SORTNUM                                                                       | <b>similar to CHECK utility definitions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| COPYDDN/RECOVERYDDN                                                                    | <b>inline copy - similar to COPY util definitions</b> only for LOAD REPLACE                                                                                                                                                                                                                                                                                                                                                                                                    |
| STATISTICS/TABLE/INDEX/REPORT/UPDATE/HISTORY/FORCEROLLUP/KEYCARD/FREQVAL/NUMCOLS/COUNT | <b>inline statistics - similar to RUNSTATS definitions</b>                                                                                                                                                                                                                                                                                                                                                                                                                     |

If a TS is COPY PENDING, running LOAD REPLACE NOCOPYPEND won't reset the previous COPY PEND STATE

| <b>C.2 UNLOAD</b>          |                                                                                                                                                                                                       |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | can be unloaded from Specific PART or entire TS or List of TSs<br>can be unloaded from Certain tables or rows or columns only<br>no support for LOB/IS/Views/Concurrent IC, reflen > 38 KB, Directory |
| TABLESPACE, PART, LIST     | <b>Similar to other definitions</b>                                                                                                                                                                   |
| FROMCOPY dataset name      | From single IC dataset                                                                                                                                                                                |
| FROMVOLUME                 | Identifies the IC dataset                                                                                                                                                                             |
| FROMCOPYDDN ddname         | To Unload from multiple IC datasets of COPY(all forms), Copy of PART                                                                                                                                  |
| UNLDDN SYSREC              | DD name for output dataset                                                                                                                                                                            |
| PUNCHDDN SYSPUNCH          | load card dataset                                                                                                                                                                                     |
| EBCIDE/ASCII/UNICODE/CCSID | Data can be formatted and translated to EBCDIC, ASCII, UNICODE                                                                                                                                        |
| NOSUBS                     | Specifies CCSID code substitution not performed                                                                                                                                                       |
| NOPAD                      | Variable length columns in the unloaded records occupy actual length with out padding. is only for UNLOAD EXTERNAL                                                                                    |
| MAXERR integer             | maximum number of errors allowed before abending - default 1                                                                                                                                          |
| SHRLEVEL CHANGE/ REFERENCE | CHANGE - ISOLATION CS or UR can be specified                                                                                                                                                          |

|                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>C.3) REORG TS</b>                                                                                | <ul style="list-style-type: none"> <li>Reclaims fragmented space of TS/IS and improves performance</li> <li>REORG re-clusters data, recreates ROWID &amp; Rebuilds IXs</li> <li>Reclaims free space to that specified in the CREATE DDL.</li> <li>Deletes and redefines VSAM Datasets(if REUSE is not specified)</li> <li>SYSUTILX and SYSLGRNX can not be REORG ed</li> </ul> |
| LIST/REUSE/PART/LOG                                                                                 | Similar to other utility definitions                                                                                                                                                                                                                                                                                                                                           |
| FASTSWITCH YES/NO                                                                                   | YES - switching methodology will cause IDCAMS RENAME.                                                                                                                                                                                                                                                                                                                          |
| DEADLINE NONE/timestamp                                                                             | Deadline for the switch phase to finish,                                                                                                                                                                                                                                                                                                                                       |
| DRAIN_WAIT integer                                                                                  | Number of second the utility will wait for the DML when draining                                                                                                                                                                                                                                                                                                               |
| RETRY integer                                                                                       | Maximum number of RETRIES that can be attempted                                                                                                                                                                                                                                                                                                                                |
| MAXRO 300, DEFER                                                                                    | Amount of time for the last iteration, DEFER continues indefinite                                                                                                                                                                                                                                                                                                              |
| DRAIN WRITERS/ALL                                                                                   | drain behavior ,                                                                                                                                                                                                                                                                                                                                                               |
| REPORTONLY                                                                                          | reorg report will be displayed                                                                                                                                                                                                                                                                                                                                                 |
| DELAY integer                                                                                       | Minimum interval between console message and LONGLOG start                                                                                                                                                                                                                                                                                                                     |
| TIMEOUT ABEND/TERM                                                                                  | Action to be taken when TIMEOUT condition occurs for DRAIN to occur                                                                                                                                                                                                                                                                                                            |
| LONGLOG CONTINUE/TERM/DRAIN                                                                         | If number of records in next iteration is not lower than the prev                                                                                                                                                                                                                                                                                                              |
| UNLOAD                                                                                              | CONTINUE - after unload continue processing. Always for SHR REF<br>PAUSE - process ends, RESTART(PHASE) to finish. no LIST<br>ONLY - utility job ends<br>EXTERNAL (only for REORG TS)                                                                                                                                                                                          |
| SORTDATA                                                                                            | data is to be unloaded by TS scan, sorted in clustering order                                                                                                                                                                                                                                                                                                                  |
| NOSYSREC                                                                                            | output of sorting is the input to reloading                                                                                                                                                                                                                                                                                                                                    |
| COPYDDN/RECOVERYDDN                                                                                 | inline copy similar to COPY utility. SHRLEVEL REFERENCE needs this                                                                                                                                                                                                                                                                                                             |
| SHRLEVEL NONE/CHANGE/REFERENCE                                                                      | - See online reorg below                                                                                                                                                                                                                                                                                                                                                       |
| OFFPOSLIMIT value                                                                                   | If $(NEAROFFPOSF + FAROFFPOSF) * 100 / CARDF >$ specified value- REORG                                                                                                                                                                                                                                                                                                         |
| INDREFLIMIT value                                                                                   | IF $((NEARINDREF + FARINDREF) * 100 / CARDF) >$ specified value - REORG                                                                                                                                                                                                                                                                                                        |
| MAPPINGTABLE tablename                                                                              | For SHRLEVEL CHANGE only - not for REORG IX                                                                                                                                                                                                                                                                                                                                    |
| TABLE                                                                                               | Table name for which STATISTICS is collected ALL/SAMPLE/COLUMN                                                                                                                                                                                                                                                                                                                 |
| NOPAD, PUNCHDDN, DISCARD, DISCARD DDN, DISCARD FROM TABLE, SORTKEYS, LOG, KEEPDICTIONARY            | <b>similar to UNLOAD/LOAD definitions</b>                                                                                                                                                                                                                                                                                                                                      |
| STATISTICS, REPORT, UPDATE, HISTORY, FORCEROLLUP, KEYCARD, FREQVAL, NUMCOLS, COUNT                  | <b>inline statistics - NO is default similar to RUNSTATS</b>                                                                                                                                                                                                                                                                                                                   |
| <b>C.3) REORG IX</b>                                                                                | database.is name or qualifier.ix name                                                                                                                                                                                                                                                                                                                                          |
| LIST/REUSE/PART/SHRLEVEL/FASTSWITCH/DEADLINE/DRAIN_WAIT/MAXRO/DRAIN/LONGLOG/DELAY/REPORTONLY/UNLOAD | <b>are same as REORG IX definitions</b>                                                                                                                                                                                                                                                                                                                                        |
| STATISTICS, REPORT, UPDATE, HISTORY, FORCEROLLUP, KEYCARD, FREQVAL, NUMCOLS, COUNT                  | inline RUNSTATS - NO is default, <b>are similar to RUNSTATS definitions</b>                                                                                                                                                                                                                                                                                                    |
| WORKDDN                                                                                             | DD name for the unload dataset - SYSUT1 default                                                                                                                                                                                                                                                                                                                                |
| LEAFDISTLIMIT 200, value                                                                            | LEAFDIST in SYSINDEXPART > this value, perform REORG                                                                                                                                                                                                                                                                                                                           |
| PREFORMAT                                                                                           | <b>Similar to LOAD definitions</b>                                                                                                                                                                                                                                                                                                                                             |
| <b>C.3) REORG LOB TS</b>                                                                            | OFFPOSLIMIT and INDREFLIMIT are not used for LOB TSs<br>SHRLEVEL NONE is the only one allowed                                                                                                                                                                                                                                                                                  |

- Binding the table involved in REORG is essential for optimal performance
- REORG of DB2 catalog and DB2 directory is permitted but not often required
- Separate REORG IX isn't needed if REORG TS is done. No REORG needed if LOAD REPLACE is done.
- REORP status on Partitioned TS force only SHRLEVEL NONE to be used
- First General chart on when to REORG Application TSs and ISs on the basis of RUNSTATS

| Value                                | Obj   | When  | Description                                                                                                                                                                                       |
|--------------------------------------|-------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PERCDROP                             | TS    | > 10% | % of space occupied by rows of dropped tables                                                                                                                                                     |
| $(NEARINDREF + FARINDREF) / CARDF$   | TS    | > 10% | No of rows that are relocated <b>far</b> ( $\geq 16$ ) from their original page. Not for LOB TS. Relocation occur when variable length rows are updated and the new row doesn't fit in that space |
| $FAROFFPOSF / CARDF$                 | TS    | > 10% | No of rows inserted far from optimal pos. Not for AUX tbl                                                                                                                                         |
| CLUSTERRATIOF                        | TS    | < 80% | CLUSTERRATIO < 90%, < 95 performance degrade for large tables. 98% for Med, 100% for small                                                                                                        |
| No of extents                        | TS/IS | > 50  |                                                                                                                                                                                                   |
| $(LEAFNEAR+LEAFAR)/SYSINDEXES.NLEAF$ | IS    | > 10% | Avg no of leaf pages between successive active leaf pages of the IX                                                                                                                               |
| PSEUDO_DELETED_ENTRIES/ CARDF        | IS    | > 10% |                                                                                                                                                                                                   |

▪ **Second General Chart on when to REORG Catalog, useful DB2 Catalog statistics**

- "+" - REORG more often as the value gets larger - urgent if more +s (like PERCDROP)  
 "- " - REORG frequently as the value gets smaller - urgent if more -s (like CLUSTERRATIOF)

| Value         | Reorg Obj | Impact | Catalog Table | Description                                                                                                                                                                                                |
|---------------|-----------|--------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PERCDROP      | TS        | +++++  | SYSTABLEPART  | % of space occupied by rows of dropped tables                                                                                                                                                              |
| FARINDREF     | TS        | +++++  | SYSTABLEPART  | No of rows that are relocated <b>far</b> ( $\geq 16$ ) from their original page. Not for LOB TS.<br>Relocation occur when variable length rows are updated and the space is not enough for updated values. |
| NEARINDREF    | TS        | +      | SYSTABLEPART  | No of rows that are relocated <b>near</b> (2-15) their original page. Not for LOB TS                                                                                                                       |
| FAROFFPOSF    | TS        | ++++   | SYSINDEXPART  | No of rows inserted <b>far</b> from optimal pos. Not for AUX tbl                                                                                                                                           |
| NEAROFFPOSF   | TS        | +      | SYSINDEXPART  | No of rows inserted <b>near</b> but not in optimal pos. Not for AUX tbl                                                                                                                                    |
|               |           |        |               |                                                                                                                                                                                                            |
| LEAFDIST      | IX        | +++    | SYSINDEXPART  | Avg no of leaf pages between successive active leaf pages of the IX                                                                                                                                        |
| CLUSTERRATIOF | TS        | -----  | SYSINDEXES    | CLUSTERRATIO < 90%, < 95 performance degrade for large tables. 98% for Med, 100% for small                                                                                                                 |

Online Reorg(OLR)

- Uses shadow copy technique and SWITCH phase to achieve max availability of data concurrency
- Explicit shadow copy datasets are required, if the object uses user-defined VSAM datasets instead of STOGROUPS
- COPYDDN(or SYSCOPY) is needed for REFERENCE/CHANGE or while REORG ing a PART in REORP status
- REFERENCE won't allow - LOG, MAPPINGTABLE, MAXRO, LONGLOG, DELAY, UNLOAD (UNLOAD CONTINUE is default)
- CHANGE won't allow - LOG, SORTDATA, SORTKEYS, NOSYSREC, UNLOAD(UNLOAD CONTINUE is default)
- Need MAPPING tbl in SEGMENTED TS other than the REORGED TS & IX when you use **SHRLEVEL CHANGE**
- On LOG phase no writing is allowed and on SWITCH phase no operation is allowed. These phases are only for online REORGS

```
//SYSIN DD *
REORG TABLESPACE LPRUB01.LPRTS001
MAPPINGTABLE MRKADU1.MAPTAB1
OFFPOSLIMIT 0 INDREFLIMIT 0 SHRLEVEL CHANGE
/*
```

| <u>DDL to create Mapping table</u>                                                                                                                                                                   | <u>supporting index</u>                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>CREATE TABLE MRKADU1.MAPTAB1 ("TYPE" CHARACTER(1) NOT NULL ,SOURCE_RID CHARACTER(5) NOT NULL ,TARGET_XRID CHARACTER(9) NOT NULL ,LRSN CHARACTER(6) NOT NULL) EBCDIC IN LPRUB01.LPRTS004 ;</pre> | <pre>CREATE UNIQUE INDEX MRKADU1.MAPIND1 ON MRKADU1.MAPTAB1 (SOURCE_RID ASC ,"TYPE" ASC ,TARGET_XRID ASC ,LRSN ASC ) USING STOGROUP SYSDEFLT PRIQTY 12 SECQTY 12 ERASE NO FREEPAGE PCTFREE 10 BUFFERPOOL BP1 CLOSE YES PIECESIZE 2097152 K;</pre> |

Online vs Offline Reorgs

- 1) about the same amount of CPU time
- 2) During abends or termination Online can be restarted from the beginning (EXCEPT if it is terminated during SWITCH phase) as it does not touch the originals.

**D) Catalog manipulation utilities****D.1) CATMAINT (no restart)**

- Updates a catalog. Run during migration to new version of DB2 or when instructed by IBM
- Install SYSADM is the only one who can run this
- UTILINIT and UTILTERM are the only two phases, CATMAINT UPDATE - only parameter

|                                            |                                                                                                                                                                                                 |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>D.2) MODIFY RECOVERY</b>                | Deletes records from the SYSIBM.SYSCOPY catalog table.<br>Should be run regularly to clean SYIBM.SYSCOPY and SYSIBM.SYSLGRNX<br>If it deletes all ICs of object, the TS will go to COPY pending |
| LIST, TABLESPACE, DSNUM                    | <b>similar to other definitions</b>                                                                                                                                                             |
| DELETE AGE <i>integer</i> /DATE <i>int</i> | indicates the records to be deleted                                                                                                                                                             |
| <b>D.2) MODIFY STATISTICS</b>              | Deletes unwanted stats from SYSIBM.%_HIST except SYSTABLES_HIST.<br>Run this utility to clear outdated information                                                                              |
| DELETE ALL/ACCESSPATH/SPACE                | delete SYSTABLES_HIST table also by specifying DELETE ALL                                                                                                                                       |
| LIST, TS, IS, IX, DELETE AGE/DATE          | <b>are similar to MODIFY RECOVERY</b>                                                                                                                                                           |

|                                            |                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>D.3 RUNSTATS TABLESPACE</b>             | <ul style="list-style-type: none"> <li>▪ Inline stat during load with lots of DISCARDS should RUNSTAT again</li> <li>▪ use RUNSTATS before and after REORG, inline RUNSTATS is available</li> <li>▪ RUNSTATS can be run for TS, IS, object or even for a column</li> <li>▪ RUNSTATS can be run on the SYSTEM CATALOG tables</li> </ul> |
| LIST / PART/SHRLEVEL REFERENCE/CHANGE      | <b>similar to other definitions</b>                                                                                                                                                                                                                                                                                                    |
| TABLE ALL/SAMPLE/ <i>tablename</i> /COLUMN | to give to what the information to be gathered                                                                                                                                                                                                                                                                                         |
| INDEX ALL/PART <i>integer</i>              | to give to what the information to be gathered                                                                                                                                                                                                                                                                                         |
| REPORT NO/YES                              | set of messages to generated to report the collected statistics                                                                                                                                                                                                                                                                        |
| UPDATE ALL/ACCESSPATH/SPACE/NONE           | whether the collected stats are inserted into the catalog tables                                                                                                                                                                                                                                                                       |
| HISTORY<br>ALL/ACCESSPATH/SPACE/NONE       | records catalog tables inserts/updates in catalog HIST tables                                                                                                                                                                                                                                                                          |
| FORCEROLLUP                                | YES,NO - aggregation of rollup of statistics will takes place                                                                                                                                                                                                                                                                          |
| KEYCARD                                    | collects all of the distinct values                                                                                                                                                                                                                                                                                                    |
| FREQVAL                                    | controls the collection of frequent value stats                                                                                                                                                                                                                                                                                        |
| NUMCOLS                                    | number of key columns to concatenate together                                                                                                                                                                                                                                                                                          |
| COUNT                                      | number of frequent values to be collected                                                                                                                                                                                                                                                                                              |
| <b>D.3 RUNSTATS INDEX</b>                  | <b>all definitions are similar to RUNSTATS TS</b>                                                                                                                                                                                                                                                                                      |

1) Useful statistics on the report

Table space (SYSTABLEPART)

AVGROWLEN - To estimate space on utility run to unload/sort Varlen rows  
 NEARINDREF and FARINDREF - Variable Length Records relocation. TS REORG if >= 5%  
 NLEVELS and NLEAFS -

Index

SYSINDEXPART.PSEUDO\_DEL\_ENTRIES - TS REORG if this is > 10%  
 SYSINDEXPART.LEAFDIST - TS REORG if this is > 200  
 SYSINDEXPART.NEAROFFPOS -  
 SYSINDEXPART.FAROFFPOS -  
 LEAFFAR, LEAFNEAR - Calculated based on the number of DASD seeks.  
 SYSINDEXES.CLUSTERRATIOF - % of rows in clustering order. Consider TS REORG if <= 95%  
 SYSINDEXES.FIRSTKEYCARDF - number of distinct values of the first key column  
 SYSINDEXES.FULLKEYCARDF - number of distinct values of the full key column

**D.4) STOSPACE**

Collects information from VSAM catalogs for Storage groups TS,IX  
 Executed on a storage group or list of STOGROUPS.  
 Need STOSPACE privilege, SYSCTRL authority, SYSADM authority

STOSPACE STOGROUP *stogroupname* - only method

## 4) Offline Utilities

## a) DSN1COPY

DB2 can be down

```
//RUNCOPY EXEC PGM=DSN1COPY,PARM='CHECK'
//*RUNCOPY EXEC PGM=DSN1COPY,PARM='NUMPARTS(16),RESET,FULLCOPY'
//STEPLIB DD DSN=ssn.DBA.DB2.SDSNLOAD,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSUT1 DD DSN=imagecopy,lds,sequential,DISP=OLD
//SYSUT2 DD DSM=sequential,lds,DUMMY,
```

```

//*RUNCOPY EXEC PGM=DSN1COPY,PARM='OBIDLAT' => needs SYSXLAT ddname, also performs CHECK
//SYSPRINT DD SYSOUT=*
//SYSUT1 DD DSN=imagecopy,lds,sequential,DISP=OLD
//SYSUT2 DD DSM=sequential,lds,DUMMY,
//SYSXLAT
 source-integer, target-integer => of DBIDs => Database ids
 source-integer, target-integer => of PSIDs,or ISIDs => TS ids / IS ids
 source-integer, target-integer => of OBIDs => Table ids
 .
 .
```

To obtain DBIDs, PSIDs, ISOBIDs, OBIDs , run the below SQLs

```
a) SELECT A.DBNAME, A.DBID,A.NAME AS TSNAME, PSID
 B.NAME AS TBNAME, B.OBID AS TBOBID
FROM SYSIBM.SYSTABLESPACE A,
 SYSIBM.SYSTABLES B
WHERE A.DBNAME = 'LPRUDB01'
AND A.NAME = B.TSNAME
```

## 5) DB2 Sample Programs

A) The Dynamic SQL Processor(DSNTEP2)

```
//DB201 EXEC PGM=IKJEFT01,COND=(4,LT)
//*****
//STEPLIB DD DSN=DBDD.DBA.DB2.DSNLIB,DISP=SHR
// DD DSN=DBDD.DBA.DB2.RUNLIB,DISP=SHR
//SYSPRINT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSOUT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSTSIN DD *
 DSN SYSTEM(DBDD)
 RUN PROGRAM(DSNTEP2) PLAN(DSNTEP2)
 END
/*
//SYSIN DD *
 SELECT * FROM MRKADU1.EMP_SAMPLE
/*
```

B) Dynamic SQL Update Program(DSNTIAD)C) Sample Unload program DSTIAUL

Using TSO attach

```
//STEP0020 EXEC PGM=IKJEFT01, DYNAMNBR=20
//SYSPRINT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSREC00 DD DSN=CSS8.V7F.TESTDB2.EMPSAMPL.UNLOAD.DTPSF,
// DISP=(NEW,CATLG,DELETE),
// SPACE=(CYL,(1,2),RLSE)
//SYSPUNCH DD DSN=CSS8.V7F.TESTDB2.EMPSAMPL.LOADCRD.DTPSF,
// DISP=(NEW,CATLG,DELETE),
// DCB=(LRECL=80),SPACE=(TRK,(1,1),RLSE)
//SYSTSIN DD *
 DSN SYSTEM(DBDD)
 RUN PROGRAM (DSNTIAUL) -
 PLAN (DSNTIAUL) -
 LIB ('DBDD.DBA.DB2.RUNLIB')
 END
//SYSIN DD *
 MRKADU1.EMP_SAMPLE WHERE EMP_NO < '00600' ORDER BY EMP_NO
/*
```

Using DBATTACH(DSNTIAUZ)

```
//STEP0010 EXEC PGM=DSNTIAUZ,DYNAMNBR=20
//* PARM='SQL'
//SYSOUT DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSREC00 DD DSN=CSS8.V7F.TESTDB2.EMP.UNLOAD.DTPSF,
// DISP=(NEW,CATLG,DELETE),
// SPACE=(CYL,(1,2),RLSE)
//SYSPUNCH DD DSN=CSS8.V7F.TESTDB2.EMP.LOADCRD.DTPSF,
// DISP=(NEW,CATLG,DELETE),
// DCB=(LRECL=80),SPACE=(TRK,(1,1),RLSE)
//SYSTSIN DD *
 DSN SYSTEM(DBDD)
/*
//SYSIN DD *
 MRKADU1.EMP WHERE EMPNO < '000600' ORDER BY EMPNO
/*
```

## 4) DB2 Utility Table

- UTLRSTRT system parameter by default is OFF. If set to ON, DB2 can restart the abended utilities implicitly

| UTILITY TYPE | PHASE       | Terminate flag | RESTART PHASE                   | DESCRIPTION                                                                                                |
|--------------|-------------|----------------|---------------------------------|------------------------------------------------------------------------------------------------------------|
| CATMAINT     | 1.UTILINIT  | Rebuild        | No restart possible             | This utility updates the catalog, Only SYSADM can run this                                                 |
|              | 2.UTILTERM  |                |                                 | Cleanup                                                                                                    |
| CHECK DATA   | 1.UTILINIT  |                |                                 |                                                                                                            |
|              | 2.SCANTAB   |                |                                 | Extracts foreign keys and places them in SYSUT1 DD                                                         |
|              | 3.SORT      |                |                                 | Sorts SYSUT1 using SORTOUT DD                                                                              |
|              | 4.CHECKDAT  | Check          |                                 | Compares the extracted foreign key to the INDEX entries for the corresponding primary key.                 |
|              | 5.REPORTCK  |                |                                 | copies the invalid rows to the exception table and deletes them from the source table                      |
|              | 6.UTILTERM  |                |                                 | Cleanup                                                                                                    |
| CHECK IX     | 1.UTILINIT  |                |                                 |                                                                                                            |
|              | 2.UNLOAD    |                |                                 | Unloads index entries to the SYST1                                                                         |
|              | 3.SORT      |                |                                 | Sorts SYSUT1 using SORTOUT DD                                                                              |
|              | 4.CHECKIDX  |                |                                 | Scan the table to validate the index entries                                                               |
|              | 5.UTILTERM  |                |                                 | Cleanup                                                                                                    |
| CHECK LOB    | 1.UTILINIT  |                |                                 |                                                                                                            |
|              | 2.CHECKLOB  | Check          |                                 | Scans all active pages of the LOB TS                                                                       |
|              | 3.SORT      |                |                                 | Sorts four types of records from the previous phase                                                        |
|              | 4.REPRTLOB  |                |                                 | examines the records of previous phase                                                                     |
|              | 5.UTILTERM  |                |                                 |                                                                                                            |
| COPY         | 1.UTILINIT  |                |                                 |                                                                                                            |
|              | 2.REPORT    |                |                                 | Reporting for CHANGLIMIT option .                                                                          |
|              | 3.COPY      |                |                                 | Copies the TS or IX to a sequential file(SYSCOPY)                                                          |
|              | 4.UTILTERM  |                |                                 |                                                                                                            |
| COPY-MERGE   | 1.UTILINIT  |                |                                 |                                                                                                            |
|              | 2.MERGECOPY |                |                                 | Merges the FULL & incremental IC datasets for a TS the SYSUT1 TEMP datasets & creates merged copy(SYSCOPY) |
|              | 3.UTILTERM  |                |                                 |                                                                                                            |
| COPYTOCOPY   | 1.UTILINIT  |                | TERM and resubmit               |                                                                                                            |
|              | 2.CPY2CPY   |                | CURRENT<br>PHASE is not allowed | copying of an image copy does not support CONCURRENT copies, DBD01, SYSUT1LX, SYSCOPY                      |
|              | 3.UTILTERM  |                | PHASE                           |                                                                                                            |
| DIAGNOSE     |             | none           | Restarts from the beginning     | Diagnose is intended to be used only under the direction of IBM support center                             |
| LISDEF       |             | none           | Restarts from the beginning     |                                                                                                            |

**DB2 STUDY**

| <u>UTILITY TYPE</u>               | <u>PHASE</u>                            | <u>Terminate flag</u>                                  | <u>RESTART PHASE</u>                                                                                                  | <u>DESCRIPTION</u>                                                                                                  |
|-----------------------------------|-----------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| LOAD                              | 1.UTILINIT                              |                                                        | CURRENT/PHASE or TERM and RESUBMIT,                                                                                   | Initialization and setup                                                                                            |
|                                   | 2.RELOAD                                | RECVR on TS<br>REBLD on IX<br>COPY on TS<br>CHCK on TS | CURRENT                                                                                                               | Reads the QSAM, loads the data to the specified table also populates SYSUT1, With index and foreign key data.       |
|                                   | 3.SORT                                  |                                                        | CURRENT/PHASE<br>with SORTKEYS DB2 will restart from RELOAD                                                           | Sort the index and foreign key data                                                                                 |
|                                   | 4.BUILD                                 | RBLD on<br>Non-unique IX                               | CURRENT/PHASE -<br><br>Can't restart RESUME YES -TERM & REBUILD IXs<br><br>with SORTKEYS DB2 will restart from RELOAD | Builds IXs and identifies duplicate keys, placing the error information(SYSERR)<br>RECP reset for all non-unique IX |
|                                   | 5.SORTBLD                               |                                                        | CURRENT/PHASE<br><br>Can't restart RESUME YES -TERM & REBUILD IXs<br><br>with SORTKEYS DB2 will restart from RELOAD   | SORT + BUILD for SORTKEYS option                                                                                    |
|                                   | 6.INDEXVAL                              | RBLD on Uniq IX<br>CHCK on TS                          | PHASE                                                                                                                 | Reads SYSERR dataset to correct unique IX violations.                                                               |
|                                   | 7.ENFORCE                               | CHCK on TS                                             | PHASE                                                                                                                 | Checks foreign key for conformance to referential constraints and stores the error (SYSERR)Resets CHKP              |
|                                   | 8.DISCARD                               |                                                        | CURRENT                                                                                                               | Puts Discarded records in DISCARD dataset                                                                           |
|                                   | 9.REPORT                                |                                                        | PHASE                                                                                                                 |                                                                                                                     |
|                                   | 10.UTILTERM                             |                                                        | PHASE or no-need to restart                                                                                           | Cleanup                                                                                                             |
| MODIFY<br>RECOVERY/<br>STATISTICS | 1.UTILINIT<br>2.MODIFY/ST<br>3.UTILTERM | none                                                   |                                                                                                                       | delete phase, deletes statistics or recovery information                                                            |
| REBLD IX                          | 1.UTILINIT                              | RCVR on TS                                             |                                                                                                                       | Initialization and setup                                                                                            |
|                                   | 2.UNLOAD                                |                                                        |                                                                                                                       | Unload of index entries                                                                                             |
|                                   | 3.SORT                                  |                                                        |                                                                                                                       | Sorting of unloaded index entries                                                                                   |
|                                   | 4.BUILD                                 |                                                        |                                                                                                                       | Building of indexes                                                                                                 |
|                                   | 5.SORTBLD                               |                                                        |                                                                                                                       | SORTKEYS invoke parallel IX bld, SORT+BUILD occur this phas                                                         |
|                                   | 6.UTILTERM                              |                                                        |                                                                                                                       | Clean-up                                                                                                            |
| RECOVER DATA<br>RECOVER IX        | 1.UTILINIT                              |                                                        |                                                                                                                       | Initialization and setup                                                                                            |
|                                   | 2.RESTORE                               | RECP on TS<br>RBDP on IX                               |                                                                                                                       | Locates and Merges all appropriate IC data sets                                                                     |
|                                   | 3.RESTORER                              | RCVR on TS<br>RBDP on IX                               |                                                                                                                       | For RECOVER with PARALLEL option, reads & merges the image copies                                                   |
|                                   | 4.RESTOREW                              | RECP on TS<br>RBDP on IX                               |                                                                                                                       | For RECOVER with PARALLEL option, writes & pages to the obj                                                         |
|                                   | 5.LOGAPPLY                              | RCVR on TS<br>RBDP on IX                               |                                                                                                                       | Locates outstanding modifications from the log and applies them to the TS or IS being recovered                     |
|                                   | 6.UTILTERM                              | RECP on TS<br>RBDP on IX                               |                                                                                                                       | Cleanup                                                                                                             |

**DB2 STUDY**

| <u>UTILITY TYPE</u>                                                    | <u>PHASE</u>                                                     | <u>Terminate flag</u>         | <u>RESTART PHASE</u>                                                                                                   | <u>DESCRIPTION</u>                                                                                 |
|------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| REORG IX                                                               | 1.UTILINIT                                                       | none but REORG                | from the beginning                                                                                                     |                                                                                                    |
|                                                                        | 2.UNLOAD                                                         | none but REORG                | CURRENT/PHASE                                                                                                          | Unloads the IX and writes the keys to SYSREC                                                       |
|                                                                        | 3.BUILD                                                          | RECP/RDBP on IX based on COPY | CURRENT/PHASE always start from the beginning of this phase                                                            | Build indexes and index statistics (based on SHRLEVEL NONE)                                        |
|                                                                        | 4.LOG                                                            | none but REORG                | CURRENT                                                                                                                | for SHRLEVEL CHANGE is used, process log iteratively                                               |
|                                                                        | 5.SWITCH                                                         | RECP/RBDP on IX based on COPY | CURRENT/PHASE                                                                                                          | for SHRLEVEL REFERENCE. switches access between original and new copy of IS (if the rename failed) |
|                                                                        | 6.UTILTERM                                                       | REORG                         | RESTART(PHASE)                                                                                                         | Cleanup - utility deletes the original copy of the IS                                              |
| REORG TS                                                               | 1.UTILINIT                                                       | none                          | Resubmit                                                                                                               |                                                                                                    |
|                                                                        | 2.UNLOAD                                                         | none                          | Resubmit                                                                                                               | Unloads TS; sorts data                                                                             |
|                                                                        | 3.RELOAD                                                         | RECP on TS, IX                | CURRENT or PHASE both will restart from RELOAD phase if SORTKEYS is specified, else will restart from the UNLOAD phase | Reloads from the above into the TS; creates FULL IC if COPYDDN is specified                        |
|                                                                        | 4.SORT                                                           | RECP/RBDP                     | CURRENT/PHASE will restart from the beginning of the phase                                                             | Sort INDEX KEYS.                                                                                   |
|                                                                        | 5.BUILD                                                          | RECP/RBDP                     | CURRENT/PHASE will restart from the beginning of the phase                                                             | Build IXs to reflect the new location of records and updates IX stats                              |
|                                                                        | 6.SORTBLD                                                        | RECP/RBDP                     | CURRENT/PHASE will restart from the beginning of the RELOAD phase                                                      | combination of SORT and BLD, if you had specified SORTKEYS                                         |
|                                                                        | 7.LOG                                                            | RECP/RBDP                     |                                                                                                                        | Used when SHRLEVEL CHANGE is used                                                                  |
|                                                                        | 8.SWITCH                                                         | RECP on TS                    | CURRENT/PHASE                                                                                                          | Used when SHRLEVEL CHANGE or Reference is used.                                                    |
|                                                                        | 9.BUILD2                                                         | RECP/RBDP                     | If you Rebuild IX, REORG is done                                                                                       | Corrects non partitioning indexes                                                                  |
|                                                                        | 10.UTILTERM                                                      |                               | Done                                                                                                                   |                                                                                                    |
| REORG LOB TS                                                           | 2.REORGLOB                                                       |                               |                                                                                                                        | Rebuilds the LOB TS; LOBS are not unloaded or reloaded                                             |
| 1.REPAIR<br>2.RUNSTATS TS<br>3.RUNSTATS IX<br>3. QUIESCE<br>4.STOSPACE | 2.REPAIR<br>2.RUNSTATS<br>2.RUNSTATS<br>2. QUIESCE<br>2.STOSPACE | none                          | REPAIR can't be RESTARTED, TERM & RE Submit<br>CURRENT<br>CURRENT<br>CURRENT<br>CURRENT                                | Determines the point of consistency and updates the SYSIBM.                                        |
| UNLOAD                                                                 | 1.UTILINIT<br>2.UNLOAD<br>3.UTILTERM                             | none                          | CURRENT                                                                                                                |                                                                                                    |

## 6) Important Pending States - Table

| Pending flag         | Reasons                                                                                                                                                                                                                                                                                          | corrective action                                                                                                                  | Table state                                                                                                                                                                                                                                                                                                |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ACHKP<br>AUXW        | Auxiliary check pending<br>Auxiliary warning                                                                                                                                                                                                                                                     | Update or delete invalid LOB<br>using SQL<br>CHECK DATA TO verify LOB                                                              | base TS - error in the log column<br>base TS, LOB TS                                                                                                                                                                                                                                                       |
| AREST                | Advisory RESTART pending                                                                                                                                                                                                                                                                         | RECOVER POSTPONED<br>Recycling SSN, LBACKOUT=AUTO                                                                                  |                                                                                                                                                                                                                                                                                                            |
| CHKP                 | Running LOAD with ENFORCE NO<br>Running CHECK DATA ..DELETE NO<br>ALTER to add Foreign key or<br>Table constraints<br><br>Adding check constraint in a<br>table where violating rows already<br>and when<br>CURRENT RULES=DB2<br><br>Point in time recovery<br><br>when CHECK Util is Terminated | CHECK DATA... DELETE YES<br>CHECK DATA... DELETE NO with no<br>violating row<br>START DB(..) SPACENAM(..)<br>REPAIR .. NOCHECKPEND | SIUD are not allowed<br>DROP and ALTER allowed<br><br>NO COPY/REORG<br>CHECK DATA, LOAD REPLACE, RECOVER<br>allowed<br><br>No update of PK when FK is in check<br>pending<br><br>if child TS is in CHKP and<br>"Delete from the Parent Tbl"<br>will give -904 as the child<br>TS is not able to be checked |
| COPY                 | RUNNING LOAD with LOG NO                                                                                                                                                                                                                                                                         | Image copy<br>Load again with LOG YES<br>REPAIR NOCOPYPEND<br>START DB                                                             | cann't issue IUD<br><br>SELECT, UNLOAD possible                                                                                                                                                                                                                                                            |
| ICOPY                | Informational copy pending                                                                                                                                                                                                                                                                       | copy the affected index                                                                                                            | Partitioned index, NP index, index on<br>auxiliary table                                                                                                                                                                                                                                                   |
| GRECP                | GBP recover pending                                                                                                                                                                                                                                                                              | recover the object or<br>Start database                                                                                            | TS, IS                                                                                                                                                                                                                                                                                                     |
| LPL                  | Logical Page list                                                                                                                                                                                                                                                                                | DROP<br>START DATABASE<br>RECOVER or REBUILD INDEX<br>LOAD REPLACE                                                                 | TS , IS<br>LOAD RESUME CAN NOT BE RUN                                                                                                                                                                                                                                                                      |
| LSTOP                | NPI is stopped                                                                                                                                                                                                                                                                                   |                                                                                                                                    |                                                                                                                                                                                                                                                                                                            |
| LPL                  | Logical Page list                                                                                                                                                                                                                                                                                | DROP<br>START DATABASE<br>RECOVER or REBUILD INDEX<br>LOAD REPLACE                                                                 | TS , IS<br>LOAD RESUME CAN NOT BE RUN                                                                                                                                                                                                                                                                      |
| PSRBD                |                                                                                                                                                                                                                                                                                                  | REBUILD INDEX<br>RECOVER INDEX                                                                                                     | NP INDEX, INDEX on auxiliary table                                                                                                                                                                                                                                                                         |
| RBDP                 | Load fails before INDEXVAL runs<br>successfully<br><br>Point in time recovery<br><br>when LOAD, REBUILD, CATMAINT is<br>TERMINATED                                                                                                                                                               | REBUILD (COPY NO on INDEXES)<br>or RECOVER                                                                                         | RBDP allows SELECT but not insert                                                                                                                                                                                                                                                                          |
| RECP                 | TS or IS<br><br>When RECOVER is terminated                                                                                                                                                                                                                                                       | RECOVER<br>REBUILD INDEX<br>REPIAR SET NORECVRPEND<br>START DB(..) SPACENAM(..)                                                    |                                                                                                                                                                                                                                                                                                            |
| REFP                 |                                                                                                                                                                                                                                                                                                  | LOAD REPLACE                                                                                                                       | TS, IS                                                                                                                                                                                                                                                                                                     |
| RESTOP               | Restart pending                                                                                                                                                                                                                                                                                  |                                                                                                                                    | objects are unavailable until back out<br>work is complete or until restart is<br>is canceled and a conditional restart o<br>cold start is performed                                                                                                                                                       |
| RELDP                | has release dependency                                                                                                                                                                                                                                                                           |                                                                                                                                    |                                                                                                                                                                                                                                                                                                            |
| REORGP               | ALTER TABLE ADD IDENTITY to a<br>non empty table                                                                                                                                                                                                                                                 | LOAD REPLACE<br>REORG TABLESPACE SHRLEVEL NONE<br>REORG PART N:M                                                                   |                                                                                                                                                                                                                                                                                                            |
| STOPP                | Stop pending                                                                                                                                                                                                                                                                                     |                                                                                                                                    |                                                                                                                                                                                                                                                                                                            |
| UTILITY              | When a utility terminates and<br>proper restart is not done                                                                                                                                                                                                                                      | TERMINATE UTILITY                                                                                                                  |                                                                                                                                                                                                                                                                                                            |
| UTRO<br>UTRW<br>UTUT | Utility in progress and the TS<br>is in RO/RW/UT status                                                                                                                                                                                                                                          |                                                                                                                                    | UTRO is set when CHECK LOB is Terminate                                                                                                                                                                                                                                                                    |
| WEPR                 | Write Error Page Range                                                                                                                                                                                                                                                                           | RECOVER                                                                                                                            |                                                                                                                                                                                                                                                                                                            |

## 1) DB2 Commands can be entered in

|                              |                                                     |
|------------------------------|-----------------------------------------------------|
| MVS Console or MVS appln pgm | - START DB2 only on MVS console, all other anywhere |
| IMS terminal or pgm          | - /SSR prefix                                       |
| CICS terminal                | - DSN -DISPLAY DATABASE(LPRUDB01)                   |
| TSO terminal                 | - from DSN session                                  |
| APF authorized pgm           | - from APF authorized program                       |
| IFI appln pgm                |                                                     |

## 2) General syntax to issue in ISPF panel(=d;7) is

*cp command operand*  
*cp command prefix , single DB2 SS*

## 3) Six categories of DB2 commands

| DB2 Environment commands<br>3 types                                                                                                                                                                                                   | DSN<br>CMDS                                                             | IMS<br>Cmds | CICS commands                                                                                                                                                                  | IRLM Commands                                                                              | TSO commands                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) Information-gathering commands<br>(DISPLAY)<br>-DISPLAY DATABASE(dbname) LIMIT(*)<br>USE/LOCKS/ONLY<br>-DIS DB(DSNDB01) SPACE(*) LIMIT(*)-<br>to see the Directory Entries<br>-DISPLAY UTILTITY(*)<br>-DISPLAY GROUP/LOG/PROCEDURE | DSN<br>ABEND<br>BIND<br>DCLGEN<br>END<br>FREE<br>REBIND<br>RUN<br>SPUFI |             | DSNC - to issue DB2<br>cmds from CICS<br><br>Eg: DSNC - DISPLAY THREAD(*)<br><br>DSNC DISPLAY- Display RCT<br>DSNC STOP<br>DSNC START<br>DSNC MODIFY - To Modify RCT<br>online | Must originate<br>from MVS console<br>MODIFY<br>START irlm proc<br>STOP irlmproc,<br>TRACE | DSNH is used to<br>precompile<br>translate<br>compile link bind<br>and run DB2 pgm<br><br>DSNU is used to<br>generate JCL for<br>any online DB2<br>utility |
| b) Administrative commands<br>ALTER, CANCEL, MODIFY, RECOVER,<br>RESET, START, STOP TERM                                                                                                                                              |                                                                         |             |                                                                                                                                                                                |                                                                                            |                                                                                                                                                            |
| c) Environment control commands                                                                                                                                                                                                       |                                                                         |             |                                                                                                                                                                                |                                                                                            |                                                                                                                                                            |

## 4) DB2 COMMANDS in BATCH Example:

```
//STEP0010 EXEC PGM=IKJEFT01,DYNAMNBR=20
//SYSTSPRT DD SYSOUT=*
//SYSPPRINT DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
//SYSTSIN DD *
DSN SYSTEM(DBDD)
-DISPLAY DB(NFOCDB01) LIMIT(*)
END
//
```

## 5) In data sharing, TERMINATE UTILITY can terminate an active utility of that Subsystem only

## 1) Attachment Facility table

| Environment | Language Interface | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSO         | DSNELI             | for online ISPF and TSO<br>DSNZPARM, parameters IDFORE, IDBATCH apply to this<br>IDFORE, controls the number of foreground users that can access DB2<br>Users of DB2I, QMF, REXX, CLIST, ISPF, tso/DB2 programs through TSO attach facility are considered foreground<br>IDBATCH controls the DB2 batch connections.<br>Users of batch DB2 jobs using the DSN command and CAF, QMF batch jobs, DB2 Utilities.<br>Use IKJEFT1B instead of IKJEFT01 to check for system error and user abends |
| CICS        | DSNCLI             | Task Related User Exit (TRUE) formats the request for DB2 and passes it to CICS attach facility, which creates a thread. If CICS attach facility are not up we will get AEY9<br>Threads are three types, COMD(for DSN commands), ENTRY(high priority) , POOL(low priority)                                                                                                                                                                                                                  |
| IMS         | DFSLI00            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CALL ATTACH | DSNALI             | Reduces overhead compared to TSO attach                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| RRSAF       | DSNRLI             | Recovery Resource Manager Services Attachment Facility)                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## 1) Terminal Monitor Programs

IKJEFT01

Intercepts system/application abend codes. Will not pass them to JES for subsequent return-code checking in JCL .Datasets with (NEW,CATLG,DELETE) will be cataloged, since the job end normally even if there is an abend.

IKJEFT1A

Intercepts application abend codes (will not pass them to JES for subsequent return-code checking in JCL). Will pass system abends to JES. Datasets with (NEW,CATLG,DELETE) will be cataloged for application abends and deleted for system abends

IKJEFT1B

Does not intercept either system or application abend codes, all abend codes will be passed to JES. Datasets with DISP=(NEW,CATLG,DELETE) will be deleted for a system abends as well as application abends.

1. Multiple DB2 SSSs, max is 32, grouped to form a DS group. All members have same location name.
2. Increases flexibility of configuring DB2 operates in parallel sysplex environments
3. Expanded capacity because more processor are available to execute the DB2 application programs
4. SYSPLEX-set of OS/390 images are connected and coupled by sharing one or more Sysplex timers
5. Requires some special hardware and setup
  - 5.1) Multiple Central Processor Complexes (CPCS - probably CMOS)
  - 5.2) Coupling facility CF high-speed shared memory run in dedicated 9674 or ICF 9672 processor
  - 5.3) Sysplex timer (to co-ordinate multiple CPCs)
  - 5.4) XCF
  - 5.5) Shared DASDs
6. Parallel Sysplex = Basic Sysplex + CF as external shared memory for data integrity with a set of hardware protocols to share enabled applications and SS
7. Coupling Facility is defined using Coupling Facility Resource Management(CFRM). CFRM is created by the IXCMIAPU utility.
9. Requires three structures to synchronize the activities of the data sharing group members
  - a) Lock structure - inter system locking and serialization on recs, pages, TSS
  - b) list structure (Shared Communication Area)
    - i) Lock List - names of modified sources, lock status
    - ii) Lock Hash table - lock contention detection
  - c) Cache Structure(group BPs) -
- 10) DB2 Catalog, Directory, Lock Structures, Group Buffer Pools are shared between DB2 SSSs
- 16) DSNZPARM, LOG, BSDS, DSNDB07, EDM, IRLM, local BPs, Sort, RID, trace data - separate to each SS
- 17) Primary function of CF is to ensure data availability and maintaining data Integrity.
- 18) In a DS environment, data pages can be found in Local BPs, Hiperpools, Group BPs, DASD
- 19) Group BP Duplex prevents recovery of group buffer pool during failure

1. Analyzes a SQL stmt and determines the efficient access path available in static & dynamic SQLs
2. Indexed scan are two types:
  - a) matching or absolute positioning, starting pt is determined
  - b) non-matching or relative positioning, starting pt isn't determined, uses Leaf Pages but not IX tree structure

### 3. Parallelism

- Moves elapsed time towards CPU time to improve performance
- Only for SELECT statements
- CURRENTDATA(NO) bind parameter must be specified
- DEGREE = ANY, indicate that DB2 should try to use, Query I/O, CPU and SYSPLEX parallelism
- Parallelism can not be used with UNION, EXISTS
  - ❖ I/O ||ism is single processor, multiple I/O streams
  - ❖ CPU ||ism =I/O ||ism + large query split to many queries and run ||y in many processors.
  - ❖ SYSPLEX parallelism, across multiple SSS within a data sharing group
- For cursors defined as WITH HOLD, only I/O parallelism can be deployed
- ||ism is disabled at run, if hardware sort is not installed or ambiguous cursors are used

### 4. Predicate Transitive Closure(PTC),

For LIKE & IN redundant predicates help. But PTC does not use redundant predicates with =

### 5. Performance

Sequential Prefetch (S) Many data pages(usually 32) are read instead of one page at a time with one asynchronous I/O thereby reducing the I/O. This usually is invoked during TS scan. Max Number is determined by BP size. For utilities LOAD/REORG/RECOVER prefetch can be twice

Sequential detection DB2 dynamically detects this. Occurs when Synchronous Read is in effect. Takes effect on the 8<sup>th</sup> read

List Prefetch(L) is sorting the IX entries into order by record identifier(RID). So IXs which are needed to access same page are accessed contiguously reducing the I/O.

Index Lookaside is IX traversing. DB2 looks for the RID of the desired row on the current leaf page and the immediate higher non-leaf page

### 6. OPTHINT

- Subsystem parameter for OPTIMIZATION HINTS must be set to YES to use OPTHINT in a Subsystem.
- Update the PLAN\_TABLE with SET OPTHINT='hint-value'  
REBIND plan with OPTHINT(hint-value)

## 7. Catalog columns analyzed by the Optimizer and updated by RUNSTATS

| Catalog table | Column          | Description                                                                |
|---------------|-----------------|----------------------------------------------------------------------------|
| SYSTABLESPACE | NACTIVEF        | number of allocated active tablespace pages                                |
|               |                 |                                                                            |
| SYSTABLES     | CARDF           | Number of rows for the table                                               |
|               | NPAGEF          | number of pages used by the table                                          |
|               | EDPROC          | name of the EDITPROC exit routine, if any                                  |
|               | PCTROWCOMP      | percentage of active rows compresses for this table                        |
|               |                 |                                                                            |
| SYSCOLUMNS    | LOW2KEY         | second lowest key for the column                                           |
|               | HIGH2KEY        | second highest key for the column                                          |
|               | COLCARDF        | number of distinct values for the column                                   |
|               |                 |                                                                            |
| SYSINDEXES    | CLUSTERRATIO    | percentage of TS rows in clustering order                                  |
|               | CLUSTERING      | whether the INDEX is clustered or NOT                                      |
|               | CLUSTERED       | Whether the table is actually clustered by the index                       |
|               | FIRSTKEYCARDF   | number of distinct values for the first column of the index key            |
|               | FULLKEYCARDF    | number of distinct values for the full index key                           |
|               | NLEAF           | number of active leaf pages                                                |
|               | NLEVELS         | number of index b-tree levels                                              |
|               |                 |                                                                            |
| SYSROUTINES   | IOS_PER_INVOC   | estimated number of I/Os per invocation of this routine                    |
|               | INSTS_PER_INVOC | estimated number of instructions per invocation of this routine            |
|               | INITIAL_IOS     | estimated number of I/Os for the first and last time                       |
|               | INITIAL_INSTS   | estimated number of instructions for the first and last time               |
|               | CARDINALITY     | predicted cardinality for a table function                                 |
|               |                 |                                                                            |
| SYSTABSTATS   | CARDF           | number of rows for the partition                                           |
|               | NPAGES          | number of pages on which rows of the partition appear                      |
|               |                 |                                                                            |
| SYSINDEXPART  | LIMITKEY        | the limit key of the partition                                             |
|               |                 |                                                                            |
| SYSCOLDIST    | TYPE            | type of runstats gathered                                                  |
|               | COLVALUE        | non uniform distribution column value                                      |
|               | FREQUENCYF      | percentage of rows that contain the value indicated in the COLVALUE column |
|               | CARDF           | number of distinct values for the column                                   |
|               | STATSTIME       | timestamp when statistics were collected                                   |
|               | NUMCOLUMNS      | number of columns associated with the statistics                           |

a) Running EXPLAIN on QMF or SPUFI

```
EXPLAIN PLAN SET QUERYNO = 1 FOR SELECT * FROM table-name WHERE column_name='D21';
```

b) DB2 also uses DSN\_STATEMENT\_TABLE and DSN\_FUNCTION\_TABLE(UDF queries or plans) for EXPLAIN.

c) Column values

| Column Values                                                                            | Meaning                                                                                                                                    |
|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| ACCESSTYPE = I, I1, N or MX<br>ACCESSNAME = indexname<br>ACCESSCREATOR=creator of the IX | I, MX - Index access to table in column TNAME<br>I1 - one fetch IX scan. When MIN/MAX, one table & NO GROUP BY is used<br>N - IN predicate |
| ACCESSTYPE=M/MI/MU                                                                       | M- Multiple index scan two index of two columns are used<br>MI- intersection of multiple indexes<br>MU- union of multiple IX               |
| ACCESSTYPE=R                                                                             | TS scan                                                                                                                                    |
| MATCHCOLS > 0                                                                            | matching IX scan - predicates are specified for first or all cols of IX for Boolean predicates                                             |
| INDEXONLY=Y                                                                              | index only access                                                                                                                          |
| ACCESS_DEGREE                                                                            | number of parallel tasks involved, 0 if host variable is used                                                                              |
| APPLN                                                                                    | for embedded EXPLAIN statements, the plan name                                                                                             |
| ACCESS_DEGREE                                                                            | number of parallel tasks involved, 0 if host variable is used                                                                              |
| COLUMN_FN_EVAL=S/L/' ' \                                                                 | when col fns are evaluated, S-sorting, L-reading, ' '-after read &sort                                                                     |
| GROUP_MEMBER                                                                             | member name of the DB2 that executed EXPLAIN                                                                                               |
| HINT_USED                                                                                | puts the OPTHINT value in this column if the hint is used                                                                                  |
| JOIN_TYPE=F/L/S/' ' \                                                                    | Full outer/Left outer/star/inner or Nojoin<br>right outer join is converted to left at execution                                           |
| MERGE_JOIN_COLS                                                                          | number of columns merged during a merge scan join                                                                                          |
| METHOD=0/1/2/3/4                                                                         | tableaccess/nested loop join/merge scan join/sort performed/hybrid join                                                                    |
| METHOD=0 or 1 AND join_type=S                                                            | Star join                                                                                                                                  |
| OPTHINT                                                                                  | string that you use to identify this row as an optimization hint                                                                           |
| PARALLELISM_MODE=I/C/X                                                                   | IO/CP/SYSPLEX parallelism                                                                                                                  |
| PARENT_QBLOCK                                                                            | number of parent qblock query                                                                                                              |
| PREFETCH=S, L, ' ' \                                                                     | Sequential prefetch, List prefetch, No prefetch while binding                                                                              |
| PROGNAME                                                                                 | for embedded EXPLAIN statements, the Program or package name                                                                               |
| PRIMARY_ACCESSTYPE=D/' ' \                                                               | db2 will try to use direct row access/db2 won't try                                                                                        |
| QBLOCK_TYPE=CORSUB/NCOSUB/<br>SELECT/INSERT/UPDATE/DELETE/<br>DELCUR/UPDCUR/UNION/UNIOA  | Corelated /non correlated subquery stmt<br>DELCUR - DELETE WHERE CURRENT OF CURSOR                                                         |
| QBLOCKNO                                                                                 |                                                                                                                                            |
| QUERYNO                                                                                  | number of executed query for identification, For FETCH, DECLARE cursor's QUERYNO is used                                                   |
|                                                                                          |                                                                                                                                            |
| SORTC_JOIN(Y/N))                                                                         | composite table sort                                                                                                                       |
| SORTN_JOIN(Y/N)                                                                          | New table sort                                                                                                                             |
| SORTC_UNIQ                                                                               | if DISTINCT is used to remove duplicates - this column is Y                                                                                |
| SORTC_ORDERBY                                                                            | if ORDER BY sort is used                                                                                                                   |
| SORTC_GROUPBY                                                                            | if GROUP BY sort is used                                                                                                                   |
|                                                                                          |                                                                                                                                            |
| TABLE_TYPE=F/Q/T/W                                                                       | type of new table. Function/Temporary result table/Table/Workfile                                                                          |
| TSLOCKMODE=IS/IX/S/U/UX/SIX/N                                                            | BIND time determination                                                                                                                    |
| TSLOCKMODE=NS/NIS/NSS/SS                                                                 | Runtime determination                                                                                                                      |
| WHEN_OPTIMIZE=B/R                                                                        | bind time determination - run time determination                                                                                           |

Samples of Explain:

If you have index on LASTNAME,FIRSTNAME,MIDINIT and below would be the values of EXPLAIN in

| No | WHERE<br>any order of following        | ACCESSTYPE | MATCHCOLS | INDEXONLY | Description                  |
|----|----------------------------------------|------------|-----------|-----------|------------------------------|
| 1  | LASTNAME =<br>FIRSTNAME =<br>MIDINIT = | I          | 3         |           |                              |
| 2  | LASTNAME =<br>FIRSTNAME =              | I          | 2         |           |                              |
| 3  | LASTNAME =<br>MIDINIT =                | I          | 1         |           |                              |
| 4  | FIRSTNAME =<br>MIDINIT =               | I          | 0         |           | I, 0 mean Full<br>index scan |
| 5  | LASTNAME =                             | I          | 1         |           |                              |
| 6  | FIRSTNAME =                            | I          | 0         |           |                              |
| 7  | MIDINIT                                | I          | 0         |           |                              |
| 8  | LASTNAME =<br>FIRSTNAME =<br>MIDINIT > | I          | 3         |           |                              |
| 9  | LASTNAME =<br>FIRSTNAME ><br>MIDINIT = | I          | 2         |           |                              |
| 10 | LASTNAME ><br>FIRSTNAME =<br>MIDINIT = | I          | 1         |           |                              |
| 11 | LASTNAME =<br>FIRSTNAME ><br>MIDINIT > | I          | 2         |           |                              |
| 12 | LASTNAME ><br>FIRSTNAME ><br>MIDINIT > | I          | 1         |           |                              |
| 13 | SELECT EMPNO no WHERE                  | I          | 0         | Y         |                              |
| 14 | SELECT LASTNAME no WHERE               | R          | 0         |           |                              |
| 15 | SELECT FIRSTNAME no WHERE              | R          | 0         |           |                              |
| 16 | SELECT MIDINIT no WHERE                | I          | 0         | Y         |                              |
| 17 | SELECT LN, FN, MI no WHERE             | R          | 0         |           |                              |
| 18 | SELECT FN, LN, MI no Where             | R          | 0         |           |                              |
| 19 | SELECT PHONENO no WHERE                | R          | 0         |           |                              |
| 20 | SELECT LN, PHONENO no WHERE            | R          | 0         |           |                              |
| 21 | SELECT FN, PONENO no WHERE             | R          | 0         |           |                              |
| 22 | SELECT MI, PHONENO no WHERE            | R          | 0         |           |                              |
| 23 | SELECT EMPNO, PHONENO no WHERE         | R          | 0         |           |                              |
| 24 | SELECT LN, FN, MI, PHONENO no WHERE    | R          | 0         |           |                              |
| 25 | SELECT PHONENO, LN, FN, MI no WHERE    | R          | 0         |           |                              |
| 26 | SELECT EMPNO, LN, FN, MI no WHERE      | R          | 0         |           |                              |

Indexes on Variable length columns can be INDEXONLY only when the **ZPARM. RETVLCFK** is set to Yes. If it is set to 'No', it will not be INDEXONLY

1. DB2 System Code , Target Libraries, TAILORED CLISTS and JCL are stored in NEW.SDSN\*
  - 1.1) SS.SDSNLINK - early code
  - 1.2) SS.SDSNLOAD - load modules
  - 1.3) SS.SDSNEXIT - user load modules
  - 1.4) SS.SDSNMACS - macros
  - 1.5) **SS.SDSNSAMP** - **samples, JCL**
  - 1.6) SS.SDSNSPFP - ISPF panels
  - 1.7) SS.SDSNPFPE - English DB2I
  - 1.8) SS.SDSNSPFS - ISPF skeletons
  - 1.9) SS.SDSNSPFT - ISPF tables
  - 1.10) SS.SDSNSPFM - ISPF messages
  - 1.11) SS.SDSNCLST - CLISTS
  - 1.12) SS.SDSNENU - SMP jobs for DB2I panels

## 2. Installation jobs created by the CLIST

|          |                                                                                                                                                                                |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DSNTIJMV | Updates SYS1.PARMLIB(IEFSSNxx)(many installations disable this and will do it manually<br>Creates SYS1.PROCLIB(procedures) like *MSTR, *DBM1, *DIST, *SPAS, DSNUPROC, IRLMPROC |
| DSNTIJCA | optional, Defines ICF catalog                                                                                                                                                  |
| DSNTIJIN | Defines System datasets                                                                                                                                                        |
| DSNTIJID | Initialized system datasets                                                                                                                                                    |
| DSNTIJUZ | Generates DSNZPARM, DSNHDECP                                                                                                                                                   |
| DSNTIJEX | Builds sample auth exits                                                                                                                                                       |
| DSNTIJVC | Builds DSN610.NEW.SDSNCLST                                                                                                                                                     |
| DSNTIJSU | Linkedit CICS LI modules                                                                                                                                                       |
| DSNTIJTM | Defines temp tablespaces, buffer pools                                                                                                                                         |
| DSNTIJSG | Defines default objects                                                                                                                                                        |
| DSNTIJIC | Creates Ics of DB2 catalog and directory                                                                                                                                       |
| DSNTEJxx | IVPs                                                                                                                                                                           |
| DSNTIJDE | Deletes all datasets (CAUTION)                                                                                                                                                 |

## 3. BSDS Boot Strap Dataset

- 3.1) VSAM KSDS dataset utilized by DB2 to control and administer the DB2 log datasets. It is an integral component of DB2, controlling the log datasets and managing and inventory of those logs, which include active and archive logs.
- 3.2) The BSDS is also used to record the image copy backups taken for the SYSIBM.SYSCOPY DB2 Catalog table.

## 4. Log

- 4.1) Can have one or two active log datasets. The active logs must reside on DASD.
- 4.2) When active logs are filled, DB2 uses *log offloading* mechanism to move the log information to archive logs.

- 5 Programs will talk to DB2 by means of threads, which are created upon the first SQL execution by SQLINIT by attaching to Database Services Address Space.

## 6. DSNZPARM

- 6.1) Configurable DB2 parameters are called **DSNZPARMS**. There are about 160+ parms, of which 60+ can be changed on the fly with out the need of recycling the DB2 or an IPL.
- 6.2) Not stored in BOOT STRAP Dataset (BSDS)
- 6.3) Available in SS.\*.SDSNLOAD
- 6.4) Data only module, no instructions
- 6.5) To change the ZPARM value ONLINE(dynamically) without IPL
  - -SET SYSPARM LOAD(your parm name) for current change
  - Update and Reassemble the ZPARM module. For next time DB2 start, otherwise it will start will old values
- 6.4) DSNTIJUZ is the job that updates ZPARMS, DSNTIZL is the step that does in this
- 6.6) Parns
  - PCLOSEN - parameter to mention the DB2 check points
  - PCLOSET - parameter to mention the time  
these two parameters are used by DB2 during VSAM file access to switch from update state to read only state.
  - IDFORE - controls the number of TSO users that can access DB2

- IDBACK - controls the number of Batch users.
- MAXARCH - maximum number of archive logs
- LOGLOAD - check point frequency of logs

*Lock related*

- URCHKTH - to give warning messages for applications with too many locks
- RECURHL - allow DB2 to release the locks that are held by a cursor WITH HOLD
- IRLMRWT - wait time for a application before a timeout
- NUMLKTS - maximum locks on a object, LOCKMAX SYSTEM matches this value
- NUMLKUS - maximum number of page/row locks a single pgm can hold on all TSs

**7. Viewing DB2 Console Messages**

7.1 Select **DSNMSTR** (look for *ssnMSTR*) from SDSF

- DSNZ002I - Starting time of DB2
- DSNJ002I - Time of active dataset full
- DSNJ139I - Message issued when LOG OFFLOAD completed succesfully. Should be little more than a minute
- DSNT501I - Resource unavailable
- DSNT375I - Deadlock message
- DSNT376I - Timeout message

8) -START DB2 PARM(*dsnzparm\_type*) ACCESS(\* /MAINT) → by default *dsnzparm\_type* is DSNZPARM

**11) DB2 Catalog**

- DB2 uses two types of data dictionary-like structures, CATALOG and DIRECTORY
- consists of almost 80 tables.
- Got updated during DDL and DCL execution.
- It has communication information in Communication Database (CDB) tables, which will have VTAM and TCP/IP address, LU names.

**10) DB2 Directory (DSNDB01)**

a) DB2 maintains control information (object dependencies) in the DB2 DIRECTORY (DSNDB01), which describes this hierarchy for each DB. The control information is called Database Descriptor(DBD)

b) SQL can not be used to query from Directory.

c) is composed of five structures

- SPT01 - Holds SKPT(Skeleton Package tables) for application package access paths
- SCTO2 - Holds SKCT(Skeleton Cursor tables) for application plan access paths
- DBD01 - Holds Database Defintions
- SYSUTILX - Holds utility information
- SYSLGRNX - Holds archive and active log information

11) If using Distributed data install, VTAM and optionally TCP/IP

## XVIII

## SS storage pools

Pools are areas in memory where DB2 caches (keeps) application as well as DB2 data. They support fast memory access instead of slow disk access. Key pools in DB2 are:

## a) Bufferpools(BPs)

Amount of memory on the DB server is important factor to determine the size of the DB cache (**Bufferpool**) as well as the number of concurrent users of the DB, - Cache data and IX rows. Data is written back to disk during a checkpoint or a write threshold.

DB2 supports 80 buffer pools

- BP0 -BP49 - 50 No of 4K pages - BP0 is used by DB2 catalog and directory
- BP8K0-BP8K9 - 10 No of 8K pages
- BP16K0-BP16K9 - 10 No of 16K pages
- BP32K0-BP32K9 - 10 No of 32K pages

Don't create other objects in BP0. BPs are Created/Altered by ALTER BUFFERPOOL(ALT BPOOL) command. Change gets effective without bouncing the DB2 subsystem. Parameters are

|         |                                                                                                                                                                         |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VPTYPE  | Type of virtual BP. <b>PRIMARY</b> - allocated in the DB2 database services address space<br><b>DATASPACE</b> - in one or more DB2 associated data spaces               |
| HPSIZE  | Hiper pool size                                                                                                                                                         |
| HPSEQT  | Hiperpool sequential steal threshold                                                                                                                                    |
| VPSIZE  | Changes the virtual pool size 0 - 400000. 0 will delete the BP                                                                                                          |
| VPSEQT  | Sequential steal threshold                                                                                                                                              |
| VPPSEQT | Parallel sequential threshold                                                                                                                                           |
| VXPSEQT | Assisting parallel sequential threshold                                                                                                                                 |
| DWQT    | Deferred write threshold                                                                                                                                                |
| VDWQT   | vertical deferred write threshold                                                                                                                                       |
| CASTOUT | YES - MVS to discard data cached in the HP when a shortage of expanded storage arises<br>NO - MVS to assign a high priority to keeping the data cached in the hiperpool |
| PGSTEAL | LRU - virtual BP buffers should be managed using the Least Recently Used algorithm<br>FIFO - using First in First Out algorithm                                         |

Buffer Manager: BM is responsible for physically transferring data between an external medium and virtual storage. It minimizes the amount of physical I/O performed by using buffering techniques like READ-AHEAD buffering and LOOK-ASIDE buffering. **Latches are part of BM.**

## b) Data spaces

Areas where only BPs may be defined(reserved for **data** use as opposed to program use).

## d) Environmental Descriptor Manager (EDM) pool

Contains internal DB2 objects in order to limit Catalog and Directory access by DB2. Includes

- DBDs **DSNDB01.DBD01**
- SKCTs **DSNDB01.SCT02** and CTs (CURSOR tables or copies of SKCTs)
- SKPTs **DSNDB01.SPT01** and PTs (PACKAGE tables or copies of SKPTs)
- Authorizations for plans, plan information for program execution
- Skeletons for dynamic SQL

Lots of I/O activity on Directory means EDM pool is not big enough. Hit ratio >80% is recommended.

## e) Hiper pool

An extra cache used when data needs to be in-memory longer, for example, when the virtual buffer pools are not big enough (and are therefore paging out data quickly) or when the virtual pools are mainly for sequential access and you need more pools supporting random access. Buffer pool defined in a data space can not have a hiper pool associated with it.

## e) Row Identified (RID) Pool

Stores row identifiers for DB2's internal sorting and storing operations like; List Prefetch, Multiple IX Access, Hybrid Joins, Enforcing unique keys during multiple-row update

## f) Sort Pool

A private area of the DBM1 address space used for sorts. Intermediate sort work files are called runs(use **DSNDB07**) and are later merged to finish the sort. Reducing runs (by doing sorts in memory) is ideal because it is fast. DB2's sorting algorithm is called the tournament sort.

Defined by a DSNZPARM and is currently 240 KB to 64 MB with a 1MB default.

**a) Snapshot Monitor**

Used to determine the status of a DB and its applications at a given time. But not useful when the state changes.

```
GET SNAPSHOT FOR ALL DATABASES/ALL APPLIACATIONS
```

**b) Event Monitor**

b.1) To gather information about state changes regarding many different event types:

- buffer pools
- databases
- tablespaces
- tables
- connections
- transactions
- deadlocks
- statements

b.2) If the event monitor output is directed to a file, the data is written into a number of files up to MAXFILES where each file's size to MAXFILESIZE. If the limit is reached, the event monitor turns off and logs that it did so in the diagnostic log file (db2diag.log).

b.3) Example: `CREATE EVENT MONITOR eventmonitor name FOR`  
           `WHERE eventcondition`  
           `WRITE TO PIPE pipename`  
           `FILE filename`  
           `MAXFILES 25 MAXFILESIZE 1024`  
           `MANUALSTART/AUTOSTART`

b.4) Only 32 event monitors can be active at a given time

b.5) Examining Event monitor output is done using the tool db2evmon

**c) Performance Monitor****d) Resource Limit Facility (RLF) - DB2 Governor**

Manages resources for dynamic SQL **only**. It has

- a) Reactive (stop the query) - 905 Sqlcode
- b) predictive or proactive(prevent the query from running)

**e) Resource limit Tables (RLST)**

- a) CREAT DSNRLSxx tables in DSNRLST database
- b) START RLIMIT ID=xx, is to switch RLST between shifts
- c) Columns are
  - AUTHID - specification applies to this id
  - RLFUNC - blank- row reactively governs dynamic S/I/U/D stmts by plan name
    - 1 - reactively governs bind operations
    - 2 - reactively governs dynamic S/I/U/D stmts by package or collection name
    - 3/4/5 - disables query IO/CP/SYSPLEX parallelisms
    - 6 - predictively governs dynamic S/I/U/D by plan name
    - 7 - predictively governs dynamic S/I/U/D stmts by pkg or collection name
  - PLANNAME
  - ASUTIME
  - LUNAME
  - RLFBIND, RLFCOLLN, RLFPKG, RLFASUERR, RLFASUWARN, RLF\_CATEGORY\_B

## f) Traces (OS/390) → SAAMPG

- START TRACE STAT/ACCTG/AUDIT/MONITOR/PERFM DEST GTF/SF/SRV/OPn/OPX CLASS/AUTHID/LOCATION/PLAN/IFCID
- DB2 provides 6 types of traces - traces are written using GTF or SMF records
- IFC component of DB2 is used to record DB2 data and events
- Traces are further broken down into classes.
- Classes are composed of IFCIDs (Instrumentation Facility Component Identifier).
- An IFCID defines a record that represents a trace event.
- max of 32 traces can go at one time

| No | Name               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | <b>Statistics</b>  | SMF 100 records are called Statistics records. Minimal overhead <ul style="list-style-type: none"> <li>• Class 1 - system services and DB statistics, written for every N mins specified in DSNZPARM</li> <li>• Class 3 - for every Deadlocks and Timeouts</li> <li>• Class 4 - Exceptional Conditions and contain diagnostic information</li> <li>• Class 5 - Data Sharing related information</li> </ul>                                                                                                                                                                                                                                                                                                                                                  |
| 2  | <b>Accounting</b>  | SMF 101 records are Accounting records <ul style="list-style-type: none"> <li>▪ Class 1 - basic accounting information</li> <li>▪ Class 2 - 'in DB2 time'</li> <li>▪ Class 3 - 'Wait time'</li> </ul> DB2 writes data pertaining to the following; <ul style="list-style-type: none"> <li>• CPU and elapsed time of the program</li> <li>• Thread wait times for various events</li> <li>• EDM pool use</li> <li>• Counts Locking events and latches requested for the program</li> <li>• <b>SQL type</b> and no of execution</li> <li>• number of commits and Aborts issued by the program</li> <li>• number of BP requests</li> <li>• Resource Limit Facility Statistics(RLF)</li> <li>• RID pool processing</li> <li>• Distributed Processing</li> </ul> |
| 3  | <b>Audit(AU)</b>   | <ul style="list-style-type: none"> <li>• Authorization failures</li> <li>• <b>Grant and Revoke</b> statements</li> <li>• DDL, DML</li> <li>• Execution of DB2 utilities.</li> <li>• Authid changes using SET CURRENT SQLID</li> <li>• Catalog and Auxiliary table can not be audited</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4  | <b>Monitor</b>     | <ul style="list-style-type: none"> <li>• Class 1 - allows application program to issue and IFI reads REQUEST</li> <li>• Class 2 - processor and elapsed time information</li> <li>• Class 3 - records wait time and resource causing the wait</li> <li>• Class 5 - traces the amount of time spent processing IFI requests</li> <li>• Class 7 - amount of time an agent spent on DB2 to process a package</li> <li>• Class 8 - amount of time an agent was suspended in DB2 for each pkg executed</li> </ul>                                                                                                                                                                                                                                                |
| 5  | <b>Performance</b> | SMF 102 records. Large overhead<br>Cannot be automatically started<br>SQL Text<br>Cursor creation<br>Index access                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 6  | <b>Global</b>      | Entries and exit from internal DB2 modules and DB2 internals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

a) Mnemonic **SDIDSA**

| Name                                                                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>First 3 are Basic Address spaces</b>                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| System Services<br>Address Space<br><br>(DSNMSTR)                                | Coordinates the attachment of DB2 to other SSs(CICS, IMS/TM, TSO).<br>SSAS is responsible for logging, log archival, BSDS, subcomponents are <ul style="list-style-type: none"> <li>▪ <u>SS support</u>, Agent Service Manager, <u>General Command Processors</u></li> <li>▪ <u>Recovery Manager</u>, storage manager, group manager, <u>recovery log manager</u></li> <li>▪ System Parameter Manager, subcomps of Distributed Transaction Manager</li> <li>▪ <u>Message Generator</u>, instrumentation facilities</li> <li>▪ <u>Initilization procedures</u></li> </ul> |
| DataBase Services<br>Address Space<br><br>(DSNDBM1 )<br><br><b>Very critical</b> | Responsible for execution of SQL and management of buffers .Contains ; <ul style="list-style-type: none"> <li>▪ Relational Data System(RDS) for type 2 predicates, sorting, optimizer</li> <li>▪ <u>Data Manager</u> (resp for type 1 predicates, indexable predicates</li> <li>▪ <u>Buffer Manager</u>(resp for Buffer pools), <u>Dataspace manager</u></li> <li>▪ <u>LOB Manager</u>, Service Contoller, <u>Stored Procedure Manager</u></li> </ul>                                                                                                                    |
| Intersystem Resource Lock<br>Manager (IRLM)<br>Address Space<br><br>(IRLMPROC)   | Responsible for the management of all DB2 locks. One per each SS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Distributed Data Facility<br>Address Space<br><br>(DSN1DIST)                     | If your shop wants to enable DB2 SSs to query data between one another,<br>DDF address space must be activated. Supports DRDA. Components include; <ul style="list-style-type: none"> <li>▪ Data Communications Resource Manager (DCRM)</li> <li>▪ Distributed Transaction Manager (DTM)</li> <li>▪ Distributed Relational Data System Manager (DRDS)</li> <li>▪ Distributed Data Interchange Services (DDIS)</li> </ul>                                                                                                                                                 |
| Stored Procedure Address<br>Spaces<br><br>(DSN1SPAS)                             | Multiple address spaces are possible. Devoted to the execution of stored<br>procedures and user-defined function. It uses Catalog information, CPU and size<br>of buffer pools to build optimized access paths. WLM is recommended to manage<br>stored procedures and to support versions. For UDFs, WLMs are required                                                                                                                                                                                                                                                   |
| Allied Address spaces                                                            | For external DB2 attachments, interfaces that communicate with DB2 like<br><br>CICS, IMS, TSO, CAF, RRSAP(Recoverable Resource Services Attachment Facility)<br>message generator(standalone only), standalone utilities                                                                                                                                                                                                                                                                                                                                                 |

16.1.1) Address space priority:

General recommendation list on establishing OS/390 address space dispatching priority is;

MVS monitor → IRLM → DB2 PMs → DBMI → MSTR → CICS

- a) It is IBM's DB2 Replication tool from SOURCE to TARGET and keep them in sync.
- b) CAPTURE on SOURCE and APPLY on TARGET are the two functions of Data Propagator. These two are done after a FULL REFRESH (data transfer from SOURCE to TARGET)
- c) You need Data Joiner tool to define the SOURCE and TARGET. Once they are defined it is DATA PROPAGATOR's duty to replicate.
- d) Three key components of DATA PROPAGATOR are
  - CONTROL TABLES at Target - Stores Replication criteria
  - CAPTURE PROGRAM at source - Captures the changes and stores them temporarily in Change Data (CD) tables
  - APPLY PROGRAM at target - Reads the CD tables and applies changes at specific intervals
- e) More on [Db2 Datapropagator](#)

- 1) **DSNDB01** - DB2 Directory. (OD)
  - DSNDB04** - default DB, not recommended for regular use, REPAIR DROP DATABASE won't work -(FD)
  - DSNDB06** - DB2 Catalog (SC)
  - DSNDB07** - Workfile database for DB2 sorting and temporary storage(SW)
  - SYSDFLT** - default STOGROUP, recommendation is avoid using this.
  - BP0** - For DB2 catalog and directory
- 2) SORT
    - a) DB2 uses **tournament sort**. Utility name is DFSORT and occurs in Relational Data Services (RDS)
    - b) SORTWK\* DD statements must be allocated on the same type of unit
- 3) **Instrumentation Facility Interface(IFI)**, is a feature to gather trace data
- 4) UNION eliminates duplicates thereby invoking sort. UNION ALL keeps duplicates so no invoke sort.
- 5) **Avoid using ambiguous cursors.**  
 If DB2 can not know whether the cursor is for UPDATA OR READ-ONLY purpose then it called a ambiguous cursor. If the cursor appears to be used only for read-only, but dynamic SQL could modify data through the cursor, then the cursor is ambiguous.
- Use **FOR READ ONLY/FOR FETCH ONLY** or **FOR UPDATE OF**, to avoid ambiguity  
 Though FOR READ ONLY and FOR FETCH ONLY do same, FOR READ ONLY is preferred for its ODBC complaincy.
- 6) Work files are intermediate files used by DB2 during program SELECTS, records other than table ORDER, or uses GROUP BY, or JOINS.
  - 7) READ ONLY CURSORS facilitates block reads and can reduce data traffic.
  - 8) Simple predicate is assigned to Data Manager & Complex predicate is assigned to Relational Data System.
  - 9) RID Record Identifier is 4 bytes for simple/segmented TSs & 5 bytes for partition, holds record location in the Data page.
  - 10) For non-unique keys with many duplicates, the index entry will have a long RID chain.
  - 11) Pre formatting during the creation of TSs is writing X'00' on the pages. PREFORMAT format in load improves performance to some extent.
  - 12) Multiple Ids.  
 Before a program begins to start executing its first SQL statement, a connection must have established between the user Task Control Block(TCB) and the DB2 address space.
  - 13) Maximum number of datasets that can be open in MVS at one time is 10,000.
  - 14) DB2 used **Lempel-ZIV algorithm**(same used for PKZIP) for Compression/Decompression. This uses hardware assisted compression.
  - 15) INDEXES, CATALOG/DIRECOTRY, DSNDB07 can not be compressed
  - 16) DB2 objects like TSs, ISs can be created with VCAT option instead of STOGROUP option using IDCAMS, but are difficult to maintain.
17. **To run sqls in batch**  
 DSNNTIAD and DSNTEP2 are strictly the programs, which contain dynamic SQL's, DB2 Commands are not dynamic SQL's. They need DSN prompt to run. The JCL you use to run your cobol-DB2 program in TSO batch should be used. Write the DB2 commands in place of RUN PROGRAM(\*) PLAN(\*)).
18. DB2 does not log SELECT statements
  19. Variable rows are rows with VAR columns and EDITPROCs or compressed rows)
  20. To see the DB2 version and level use -DISPLAY GROUP, which will list under LEVEL



### 8.3) System-directed access

Using three-part names (**Location-id.owner.table-name**)

Prior to Version 6, this used private protocol and not DRDA protocol, but, as of version 6, three-part names can use DRDA.

For this BIND the package at each location that is specified in a three part names and then BIND a package or plan at the local location specifying the DBPROTOCOL(DRDA) bind option.

Private protocol will eventually go way.

9. Can have application driven access and system driven access with in single unit of work

E.g.,

```
CONNECT TO CHICAGO;
```

```
SELECT COL1, COL2 FROM owner.table1 (Application directed)
```

```
SELECT COL1.COL2 FROM newyork.owner.table2 (System directed)
```

```
Commit;
```

g) Application directed access is IBM's strategic direction

h) Two-phase commit phases are

11.1) Preparation

11.2) Actual commit

12. For work stations DRDA is supported using DB2 CONNECT. DB2 Connect supports both TCPIP and DRDA protocols.

**a) Commit guidelines (only suggestions)**

- Bind with `CURRENTDATA(NO)` for read-only processing.
- Bind with `RELEASE(DEALLOCATE)` to reduce TS locking activity. There is system overhead when `release(commit)` is used (i.e. allocating resources, un-allocating, and reallocating, etc.). This also prevents concurrency.
- **ISOLATION(UR)** for read-only processing of decision support systems.
- Alternative to **ISOLATION(UR)** is **WITH UR** clause in SELECT statement within the program.
- Coding **COMMITs** in all DB2 programs.

b) Non-Datasharing use Implicit Hierarchical Locking. Datasharing use Hierarchical Locking

c) P-locks are Page set P-locks and Page P-locks - negotiable

d) L-locks are logical locks

- non negotiable
- program or transaction owned
- controlled by IRLM
- held till COMMIT occurs
- Two types Parent L-locks, Child L-locks

f) Modify Locks -

g) Retained Locks - at the time failures, can be accessed only by one member of the DS group.

h) Lock Contention

- Global Lock Contention - real contention against two resources
- False Lock Contention -
- XES Contention

i) TABLE Locks are possible only for segmented table space

j) page level and row level locks are same level. Row locks never escalate to page locks

k) Code **LOCK TABLE** statements when scanning the entire table with update intent (delete pgm) or if the table is large. **LOCK TABLE IN EXCLUSIVE MODE** is recommended along with the **release(deallocate)** bind parameter, **LOCK TABLE IN SHARE MODE** is available.

l) Commit/Rollback put the LOCK TABLE resource into page lock. Another LOCK TABLE should be issued

m) No concept of Page or Row lock for LOB.

n) INTENT lock is on a TS or Table. I Means a row/page level locks are used on the objects.

TS locks can be S, U, X, IS, IX, SIX

o) Page or Row locks can be only S, U, X

p) Lock duration

TS, Table and Partition duration - controlled by ACQUIRE, RELEASE

Page, Row level lock - controlled by ISOLATION

**q) Claims**

- Is a notification to DB2 that an object is being accessed
- Claims are released at COMMIT
- Prevents Drain to occur till Commit
- a) Write b) Repeatable Read c) Cursor Stability Read - Three types
- Application programs, some utilities, make claims when they first access them

**Drains**

- Access to an object by preventing new claims & waiting the existing claims to be released
- Utilities, commands and some SQL act as drainers

h) **LOCKINFO** on DISPLAY DATABASE LOCKS

Describes the type and duration used by corresponding agents identified by CONNECTION and CORRELATION IDS for transaction locks - L locks or used by corresponding subsystems identified by datasharing member names for physical locks, P locks and retained locks. Multiple locks held by an agent or listed on multiple lines. LOCKINFO column consists of:

**"lock status"- "lock state" , "lock type" , "lock duration"**

1) **"lock status"** can be ;

|          |   |                                             |
|----------|---|---------------------------------------------|
| <b>H</b> | - | lock is held by the agent or the DB2 member |
| <b>W</b> | - | agent or the member is awaiting the lock    |
| <b>R</b> | - | lock is retained                            |

2) **"lock state"** describes the mode of locks and can be;

For L-locks and drain locks:

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>IS</b>  | lock with read intentions                                                                                             |
| <b>IX</b>  | lock with update intentions                                                                                           |
| <b>S</b>   | lock with read-only capability                                                                                        |
| <b>U</b>   | lock with update capability                                                                                           |
| <b>X</b>   | exclusive lock                                                                                                        |
| <b>SIX</b> | locks with a protocol that doesn't lock a page while reading, but locks the page with update intention while updating |

For P-locks:

|            |                                                                              |
|------------|------------------------------------------------------------------------------|
| <b>IS</b>  | DB2 member has R/O interest. The page set or partition is GBP dependent.     |
| <b>IX</b>  | DB2 member has R/W interest. The page set or partition is GBP-dependent.     |
| <b>S</b>   | DB2 member has R/O interest. The page set or partition is not GBP-dependent. |
| <b>SIX</b> | DB2 member has R/W interest. The page set or partition is GBP-dependent.     |
| <b>NSU</b> | DB2 member has R/W interest. The page set or partition is GBP-dependent.     |
| <b>X</b>   | DB2 member has R/W interest. The page set or partition is not GBP-dependent. |

3) **'lock type'** describes the type of locking and can be;

|           |                                     |
|-----------|-------------------------------------|
| <b>S</b>  | A table space L-lock.               |
| <b>T</b>  | A table L-lock.                     |
| <b>C</b>  | A cursor-stability read drain lock. |
| <b>R</b>  | A repeatable-read drain lock.       |
| <b>W</b>  | A write drain lock.                 |
| <b>P</b>  | A partition L-lock.                 |
| <b>PP</b> | A page set or partition P-lock.     |

4) **'lock duration'**

For **'lock status' H,**

|          |                                                                                                           |
|----------|-----------------------------------------------------------------------------------------------------------|
| <b>A</b> | lock is freed at deallocation.                                                                            |
| <b>C</b> | lock is freed at commit.                                                                                  |
| <b>H</b> | lock is freed when all cursors are closed.                                                                |
| <b>M</b> | lock is freed by the system.                                                                              |
| <b>P</b> | lock is freed when the plan is complete.                                                                  |
| <b>I</b> | lock is a page set or partition P-lock. It is released when the page set or partition data set is closed. |

For **'lock status' W,** - a 2-digit number of waiter's position in the DB2 system's lock

For **'lock status' R** - do not have a lock duration.

For **P-lock,** the lock is owned by the system, not the user, and its duration is not related to the duration of the locks that are owned by the user.

There are no explicit index space locks. However, all index spaces on tables are implicitly locked at the same level as the table spaces containing those tables. P-locks are acquired by DB2 on index spaces as well as on table spaces.

**1) Federated database system or federated system**

- a) Is a database management system (DBMS) that supports applications and users submitting SQL statements referencing two or more DBMSs or databases in a single statement.
- b) Only read-only operations
- c) Utilities (LOAD, REORG, REORGCHK, IMPORT, RUNSTATS etc.,) against nicknames, aren't allowed

**2) DB2 Connect related**

- a. Applications that run on a non S/390 require DB2 Connect & CAE to access DB2 for OS/390 data.
- b. ODBC Application calls CAE, which in turn sends the request to the DB2 Connect gateway.
- c. Gateway is the machine which runs DB2 Connect. It is also called DB2 Connect server
- d. DB2 Connect supports both TCPIP and DRDA. It supports ODBCS, OLE DB, CLI, JDBC, SQLJ appls.
- e. DB2 Connect passes the call to DB2 for OS/390 in the form of a DRDA request
- f. Connect Personal Edition on the client machine or Connect Enterprise Edition for server machine. If connect enterprise edition is used, client machines need only CAE. CAE is connected to server machines through NetBIOS, IPX or TCP/IP
- g. Regardless of which option is used, DB2 for OS/390 location name must be defined in CAE
- h. Similar to CONNECT other gateway products exist such as NEON System's **Shadow Direct**
- i. CLIENT packages should use BLOCKING ALL
- j. To know the TCP/IP address of your OS/390 system . Type **NETSTAT HOME** in READY promp
- k. EXPORT from Mainframe DB2 and Import into PC Db2

Export Sample: Store this in a .bat file and run this in db2 Command Line Processor

```
:EXPORT
DB2 CONNECT TO db2_subsystem_name USER mainframe_userid
IF %ERRORLEVEL% NEQ 0 GOTO :ERROR
DB2 EXPORT TO C:\MRK\TESTEXP\TB1.IXF OF IXF SELECT * FROM MRKADU1.EMP
:PAUSE
DB2 TERMINATE
:ERROR
END
```

Import Sample: Store this in a .bat file and run this in db2 Command Line Processor

```
:IMPORT
DB2 CONNECT TO db2_subsystem_name USER mainframe_userid USING *****
```

```
IF %ERRORLEVEL% NEQ 0 GOTO :ERROR
DB2 IMPORT FROM C:\MRK\TESTEXP\TB1.IXF OF IXF COMMITCOUNT 100 INSERT_UPDATE INTO
CSE.EVENT_LOG >>C:\MRK\TESTEXP\kk2.TXT
:PAUSE
DB2 IMPORT FROM C:\MRK\TESTEXP\TB2.IXF OF IXF COMMITCOUNT 100 INSERT_UPDATE INTO
CSE.TICKLER_LOG >>C:\MRK\TESTEXP\kk2.TXT
:PAUSE
DB2 IMPORT FROM C:\MRK\TESTEXP\TB3.IXF OF IXF COMMITCOUNT 100 INSERT INTO CSE.ACTY_LOG
>>C:\MRK\TESTEXP\kk2.TXT
:PAUSE

:ERROR
:PAUSE
```

```
DB2 TERMINATE
```

**1. Audit related**

- a) To configure auditing : db2 audit configure
- b) Starting/Stopping audit : db2 audit start/stop
- c) flushing before viewing the file : db2 audit flush

1. Must use C or C++ specifically.
2. Must use Language Environment for language run time support
3. AMODE(31) to indicate 31-bit Addressing mode
4. An API for data manipulation
5. Does not require explicit CURSOR declaration and OPEN statements
6. SQLTransact() is the equivalent function call for COMMIT and ROLLBACK statements
7. DSNACLI is the plan name in OS/390 used for functions that are called for ODBC

1. JDBC is an API , uses dynamic SQL
2. JDBC applications do not require precompiles and bind
3. SQLJ applications can have embedded SQLs, there by need precompile and bind. No dynamic SQL is allowed.
4. Mixing of SQLJ and JDBC in a single application is possible
5. SQLJ equivalent of a cursor is a result set iterator

**JDBC Example**

```
// Create the connection.
// Change the following URL to match the location name of your local DB2 for OS/390.
// The URL format is: "jdbc:db2os390:location_name"

String url = "jdbc:db2os390:st11db2g";
Connection con = DriverManager.getConnection(url);

// Create the Statement
Statement stmt = con.createStatement();
System.out.println("**** JDBC Statement Created");

// Execute the query and generate a ResultSet instance
ResultSet rs = stmt.executeQuery("SELECT LASTNAME, HIREDATE FROM EMP");
System.out.println("**** JDBC Result Set Created");

// Close the statement
stmt.close();

// Close the connection
con.close();
```

**SQLJ Example**

```
{
#sql public iterator ByPos(String,Date);
// Declare positioned iterator class ByPos
ByPos positer; // Declare object of ByPos class
String name = null;
Date hrdate;
#sql positer = { SELECT LASTNAME, HIREDATE FROM EMP };
#sql { FETCH :positer INTO :name, :hrdate };
// Retrieve the first row from the result table
while (!positer.endFetch())
{ System.out.println(name + " was hired in " + hrdate);
#sql { FETCH :positer INTO :name, :hrdate };
// Retrieve the rest of the rows
}
}
```

6. Recommended Web sites <http://www.ibm.com/developer/java/>  
<http://www-4.ibm.com/software/data/db2/java>

|      |                                                                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -109 | Attempt to use Order by while creating VIEW                                                                                                                                   |
| -199 | Attempt to ALTER a trigger                                                                                                                                                    |
| -222 | In STATIC SENSITIVE cursors, if DELETE/UPDATE could not find a row                                                                                                            |
| -224 | In STATIC SENSITIVE cursors, if DELETE/UPDATE could not find a matching contents                                                                                              |
| -372 | Attempt to create Two ROWIDs or Two IDENTITY cols in one table                                                                                                                |
| -438 | Trigger SIGNAL state occurred, SQLSTATE, SQLERRM will have respective values                                                                                                  |
| -454 | If <i>schema.udf</i> and the signature matches with an existing UDF                                                                                                           |
| -456 | If specific name of the function already exists                                                                                                                               |
| -530 | Attempt to insert a value in the foreign key column that is not available in Parent table                                                                                     |
| -532 | Deleting a primary key when child exists                                                                                                                                      |
| -542 | Attempting to include a NULL column as a primary key or part of a primary key                                                                                                 |
| -553 | If tried to SET CURRENTSQLID to an invalid id                                                                                                                                 |
| -601 | If owner.table, owner.view, owner.synonym object already exists as another type                                                                                               |
| -623 | Attempt to create a second CLUSTER index for a table                                                                                                                          |
| -624 | Attempt to create a second or duplicating a primary key                                                                                                                       |
| -628 | Mutually exclusive clauses are used like, NOT NULL and DEFAULT NULL, SEGSIZE and LARGE FIELDPROC and DEFAULT, LOCKPAR YES and LOCKSIZE TABLESPACE, SEGSIZE and MEMBER CLUSTER |
|      | <b>Partition Related</b>                                                                                                                                                      |
| -636 | VALUES for PART IX are not in ascending(for ASC) or descending(for DESC) order                                                                                                |
| -646 | Attempt to create Second Partition table in a PTS                                                                                                                             |
| -667 | Attempt to drop a CLUSTERING PART IX. PTS should be dropped                                                                                                                   |
| -669 | Attempt to drop a partition table. PTS should be dropped                                                                                                                      |
| -747 | Attempt to issue a DML on LOB column table before creating AUX tables/IX                                                                                                      |
| -750 | Attempt to RENAME a table used in VIEW or TRIGGER.                                                                                                                            |
| -763 | Attempt to create LOB Table in non LOB TS or Regular table in LOB TS                                                                                                          |
| -767 | Attempt to CREATE AUX table by giving columns. No cols should be specified.                                                                                                   |
| -770 | Attempt to create a LOB column base table without ROWID                                                                                                                       |
| -867 | Attempt to include a ROWID column in to a PRIMARY key                                                                                                                         |
| -771 |                                                                                                                                                                               |
| -846 | Attempt to create IDENTITY for ROWID                                                                                                                                          |
| -905 | Resource limit exceeded                                                                                                                                                       |
| +562 | Duplicate GRANT for an object                                                                                                                                                 |
| +222 | Scrollable cursor hole during FETCH                                                                                                                                           |
|      | <b>Stored procedure related</b>                                                                                                                                               |
| -471 | stored procedure is stopped or in STOP abend status when CALLED                                                                                                               |
| -480 | trying to ASSOCIATE when CALL itself failed                                                                                                                                   |
| -423 | trying to ALLOCATE when CALL itself failed                                                                                                                                    |
| -504 | trying to FETCH when ALLOCATE failed                                                                                                                                          |
| +466 | after stored procedure call is if the call ends normally.                                                                                                                     |
| -430 | is when there is problem in the call                                                                                                                                          |
| -440 | if the stored procedure could not be found or if not authorized                                                                                                               |
| -444 | if the routine is found in DB2 catalog but the LOADMODULE is not found                                                                                                        |
| -480 | if the procedure isn't called but trying to associate a variable to the cursor                                                                                                |

| Type                     | Updateable Views      | Read only Views | Updateable Cursors         | Read only Cursors |
|--------------------------|-----------------------|-----------------|----------------------------|-------------------|
| <b>DISTINCT</b>          | N                     | Y               | N                          | Y                 |
| <b>GROUP BY...HAVING</b> | N                     | Y               | N                          | Y                 |
| <b>JOIN</b>              | N                     | Y               | N                          | Y                 |
| <b>ORDER BY</b>          | N                     | N               | N(except sensitive static) | Y                 |
| <b>UNION...UNION ALL</b> | N                     | Y               | N                          | Y                 |
| <b>Column function</b>   | N, DELETE is possible | Y               | N                          | Y                 |
| <b>Table function</b>    |                       |                 | N                          | Y                 |
| <b>UR</b>                | NA                    | NA              | UR with no FOR UPDATE OF   | Y                 |
| <b>Constant</b>          | Y but No Insert       | Y               |                            |                   |
| <b>Special Register</b>  | Y but No Insert       | Y               |                            |                   |

## 1) SG

## a) When a new volume is added to Storage group

- i) find out the TS and IS that are used in the STORAGE group
- ii) After the volume is added use REORG (**preferred**) or RECOVER (least preferred)

## 2) TS

## a) When a TS is dropped and recreated with new parameters

OR

## When a Table is moved to new Table Space

- i) Create the intermediate TS with new specifications
- ii) Create the objects of OLD TS on intermediate TS
- iii) Insert or LOAD the new objects of intermediate TS
- iv) if there are ROWID columns and if you want to generate new values

CREATE the new table           with   GENERATE ALWAYS  
and specify                            OVERRIDING USER VALUE on the INSERT

or if you want to use the old values

CREATE the new table           with   GENERATED BY DEFAULT

- v) DROP THE OLD TS
- vi) COMMIT
- vii) CREATE the NEW TS with new SPECIFICATIONS
- viii) repeat the above steps on the NEW TS
- ix) RECREATE indexes
- x) DROP intermediate TS
- xi) Recreate the Dependents of **step I** and ask users to re-create their synonyms

## b) When a TS is ALTERed for PRIQTY or SECQTY.

- i) NO need to STOP TS for ALTERing, it can be done with out STOPing
- ii) REORG is needed for this change to be effective

## 3) Table

## a) When a new column is ADDED

- i) ALTER ADD the column, this will make the column Variable length, though the column is fixed length
- ii) REORG will make the row fixed length
- iii) Take a NEW image copy
- iv) RUN MODIFY utility to delete previous image copies

## b) When then length of the existing column need to be changed.

- i) Find Dependents; Views, IXS, Synonyms, Triggers, Pkgs, Plns & authorization
- ii) Create a new table T2
- iii) Insert into T2 select \* from T1
- iv) DROP T1 and COMMIT
- v) RENAME T2 to T1
- vi) REORG TS
- vii) Recreate the Dependents of **step I** and ask users to re-create their synonyms

## c) When a identity column is Altered

- i) Find Dependents; Views, IXS, Synonyms, Triggers, Pkgs, Plns & authorization
- ii) Unload the old table
- iii) Drop the old table and Commit
- iv) Create the new Table with NEW attributes on IDENTIY, GENERATED BY DEFAULT to reload existing values

Appropriate START WITH - that allows the sequence to continue from the value where it ended in the unloaded table

- v) Recreate the Dependents of **step I** and ask users to re-create their synonyms

---

**4) SQL****a) Checklist to check a query performance problem**

- i) Any Unused cols are selected
- ii) Unneeded Order By or Group by is used
- iii) Remove redundant predicates
- iv) Check the predicates order so that the most filtering predicate are first
- v) Subquery predicates order so that the most filtering predicate are first
- vi) Check whether stage2 is involved- try to change to stage1
- vii) Indexes are used by predicates or any new indexes are needed
- viii) See when the COLUMN\_FN\_EVAL (column function is evaluated)
- ix) See whether view merge or view materialization occurred

XXXXI

References and Links

- 1) The Practical Guide to DB2 Data Replication V8  
<http://publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg246828.html?Open>
- 2) Universal Database for OS/390 Version 7.1 Certification Guide Richard Yevich, Susan Lawson
4. DB2 UDB v7.1 for UNIX, Linux, Windows and OS/2 Database Administration Certification Guide (4th Edition) by George Baklarz, Bill Wong, Jonathan cook
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6. IBM DB2 for Z/OS online library <http://www-306.ibm.com/software/data/db2/zos/library.html>
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