DB2® UDB Version 8 for z/OS SQL Enhancements

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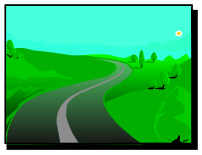
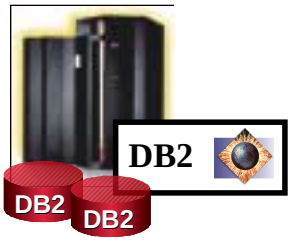
Version 8 themes in DB2® for z/OS

- ✓ **Reengineering & Renaissance**
- ✓ **Breaking through Limitations**
- ✓ **SQL Function & DB2 family**
- ✓ **Performance Enhancements**
- ✓ **Continuous Availability**
- ✓ **Indexing Improvements**
- ✓ **Very Large Database**
- ✓ **WebSphere & Java**
- ✓ **SAP, PeopleSoft & Siebel**

Reengineered for e-business



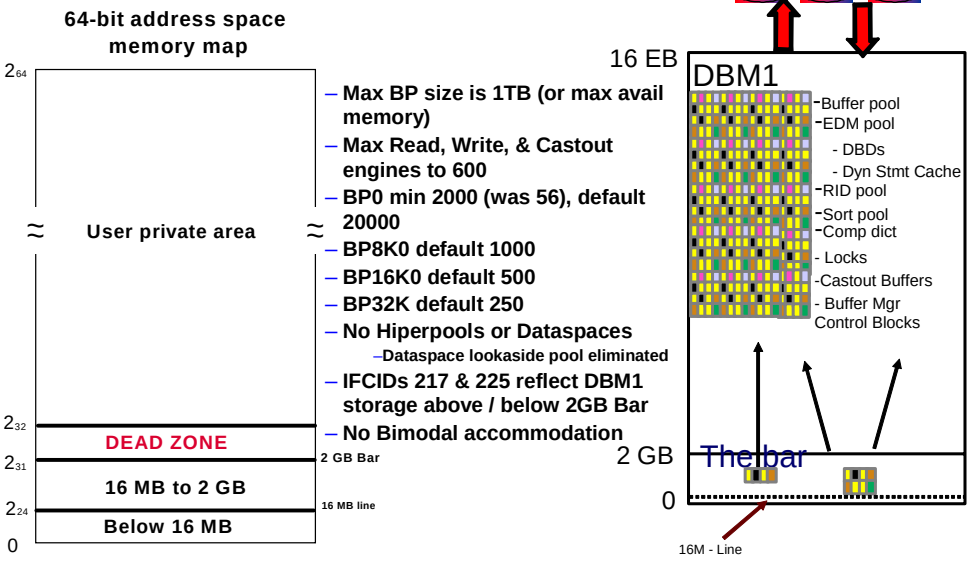


DB2 for z/OS limits: Breaking through limitations

Image of Earth from Moon,
Source: NASA (Public Domain)

– Virtual storage 2 GB	2^{31}	to	2^{64}
– Table, view, alias names	18	to	128
– Column names	18	to	30
– Partitions	254	to	4096
– SQL statement length	32 KB	to	2 MB
– Index key size	255	to	2000
– Character literals, hex	255	to	32704
– Tables in a join	15	to	225
– Active logs	31	to	93
– Archive logs	1000	to	10,000
– Special registers	Varying		
– ...			

64 bit Evolution (Virtual Storage Relief)



- Max BP size is 1TB (or max avail memory)
- Max Read, Write, & Castout engines to 600
- BP0 min 2000 (was 56), default 20000
- BP8K0 default 1000
- BP16K0 default 500
- BP32K default 250
- No Hiperpools or Dataspaces
  - Dataspace lookaside pool eliminated
- IFCIDs 217 & 225 reflect DBM1 storage above / below 2GB Bar
- No Bimodal accommodation

SQL function and DB2 Family

- Support for long names
- Multi-row INSERT and FETCH
- GET DIAGNOSTICS
- INSERT within SELECT
- IDENTITY column enhancements
- SEQUENCES
- Dynamic scrollable cursors
- CURRENT PACKAGE PATH
- Common table expressions
- SCALAR fullselect
- SQL statements can be up to 2 MB
- ... and much more

Image of Earth from Moon,
Source: NASA (Public Domain)

Multi-row INSERT - 1

- **Inserts multiple rows on one API call**
- **Can be**
  - ATOMIC or
  - NOT ATOMIC CONTINUE ON SQLEXCEPTION
- **Can be static or dynamic SQL**
- **Significant performance boost**

```
INSERT INTO T1 FOR :hv ROWS
    VALUES (:ARRAY1, :ARRAY2) ATOMIC;
```


Multi-row INSERT - 2

- **Multi-row INSERT in dynamic SQL**

```
STMT = 'INSERT INTO T1
            VALUES ( ?, ?)
            FOR MULTIPLE ROWS ATOMIC;

PREPARE S1 FROM STMT;

EXECUTE S1 FOR :HV ROWS
            USING :ARRAY1, :ARRAY2;
```

Multi-row FETCH - 1

- **Returns multiple rows on one API crossing**
- **"wide" cursor with potentially locks on multiple rows**
- **Supports scrollable and non-scrollable, static and dynamic SQL**
- **Supports positioned UPDATE/DELETE of multi-row FETCH**
- **Significant performance boost**

```
DECLARE C1 CURSOR
    WITH ROWSET POSITIONING
    FOR SELECT COL1, COL2 FROM T1;
OPEN C1;
FETCH FROM C1
    FOR :hv ROWS  INTO  :ARRAY1, :ARRAY2;
```


Multi-row FETCH - 2

- **Allows positioned UPDATE or DELETE (of a single row) on a "wide" cursor**

```
UPDATE T1 SET COL1='ABC'
    WHERE CURRENT OF  C1
    FOR ROW  :hv  OF ROWSET
```

- **Using the WHERE CURRENT OF clause on a cursor with an "active" ROWSET, updates all rows in the ROWSET**

GET DIAGNOSTICS

- **Returns SQL error information**
  - For overall statement
  - For each condition (when multiple errors occur)
- **Supports SQL error message tokens greater than 70 bytes (SQLCA limitation)**

```
INSERT INTO T1 FOR 5 ROWS VALUES(:ARRAY);
GET DIAGNOSTICS :ERR_COUNT = NUMBER;
   DO II = 1 TO ERR_COUNT;
      GET DIAGNOSTICS CONDITION :II
           :RC = RETURNED_SQLSTATE;
   END;
```

- **Supports retrieving individual errors from NOT ATOMIC multi-row INSERT statements**

SELECT from INSERT

- **Elegant technique for retrieving values created/modified by DB2 during INSERT**
  - Identity columns, sequence values
  - User-defined defaults, expressions
  - Columns modified by triggers
  - ROWIDs, CURRENT TIMESTAMP

```
SELECT C1, C2, C3, C4, C5
   FROM FINAL TABLE
      (INSERT (C1, C5) INTO T1
           VALUES('ABC', CURRENT DATE)
      );
```

Identity Column Improvements

- **ALTER support for identity columns, eg.**

```
ALTER TABLE ALTER COLUMN idencol
                         RESTART WITH 500
```

  - GENERATED ALWAYS | BY DEFAULT
  - START WITH value
  - **RESTART WITH value**
  - INCREMENT BY
  - MINVALUE | **NO MINVALUE**
  - MAXVALUE | **NO MAXVALUE**
  - CYCLE | NO CYCLE
  - CACHE | NO CACHE
  - **ORDER | NO ORDER** (**Bold** keywords are new in V8)

SEQUENCES - 1

- **Useful for porting Oracle applications**
- **New SQL support:**
  - CREATE SEQUENCE
  - ALTER SEQUENCE
    - RESTART WITH value
    - INCREMENT BY
    - MINVALUE
    - MAXVALUE
    - CYCLE/NO CYCLE
    - CACHE/NO CACHE
    - ORDER/NO ORDER
  - GRANT/REVOKE privileges for the sequence object
  - NEXT VALUE FOR sequence-name
  - PREVIOUS VALUE FOR sequence-name

SEQUENCES - 2

- **An example:**

```
CREATE SEQUENCE order_seq
          START WITH 1 INCREMENT BY 1
          NOMAXVALUE
          NOCYCLE CACHE 2
```

```
INSERT INTO orders (orderno,custno)
  VALUES (NEXT VALUE FOR order_seq,123456);
```

- **or**

```
UPDATE orders
     SET orderno =NEXT VALUE FOR order_seq
     WHERE custno =123456;
```

- **or**

```
SELECT NEXT VALUE FOR order_seq
  INTO :hv_seq from sysibm.sysdummy1;
```


Dynamic Scrollable Cursors

- **Scrollable cursor that provides access to base table rather than temp tables -- allows viewing of updates (and inserts) by other users as well as your own.**
- **Defaults to single row fetch, so DDF applications should use:**
  - Multi-row FETCH
  - Positioned update/delete for multi-row FETCH

```
DECLARE C1 SENSITIVE DYNAMIC SCROLL
CURSOR  FOR SELECT C1, C2 FROM T1;
```

CURRENT PACKAGE PATH

- **Important for SQLJ and DDF applications**
  - Less need for SET CURRENT PACKAGESET
  - Less network traffic for multiple PKLIST values
  - Easier to switch to/from JDBC and SQLJ
  - Better handling of nested stored procedure packages
- **Allows application to specify search list of package schemas (similar to PKLIST)**

```
SET CURRENT PACKAGE PATH
      =     ALPHA,
            BETA,
            PROD
```

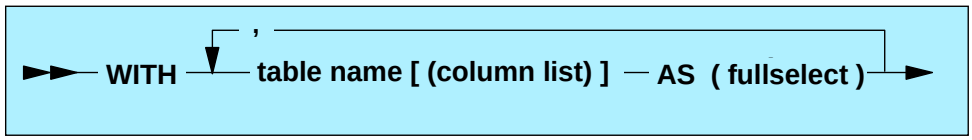

SET [CURRENT] SCHEMA

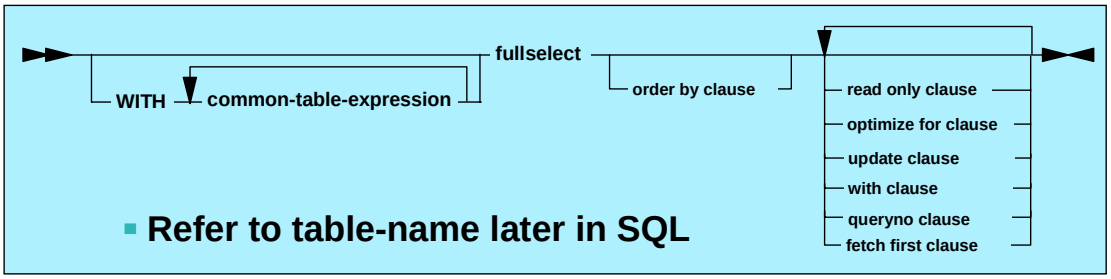
- **Set qualifier for unqualified dynamic SQL**
  - Can use SET CURRENT SQLID today
  - CURRENT SQLID has authorization implications
    - Can only be your primary or secondary auth ID
  - SET CURRENT SCHEMA is not tied to authorization
  - Improves DB2 Family compatibility

```
SET CURRENT SCHEMA  = 'MYQUAL' ;
SET SCHEMA  = 'MYQUAL' ;
```

Common Table Expressions (CTE) - 1

- **Allowed in SELECT, CREATE VIEW, INSERT**
- **Syntax:**





- **Refer to table-name later in SQL**

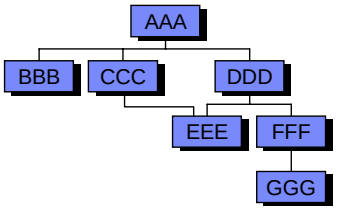
Common Table Expressions (CTE) - 2

```
WITH RPL (PART, SUBPART, QUANTITY) AS
   ( SELECT R.PART, R.SUBPART, R.QUANTITY
       FROM PARTLIST AS R
       WHERE R.PART = '01'
   )

SELECT DISTINCT PART, SUBPART, QUANTITY
  FROM RPL
  ORDER BY PART, SUBPART, QUANTITY;
```

Common Table Expressions (CTE) - 3

- **Allows for recursive SQL coding**
  - fullselect of CTE refers to itself
  - fullselect that does not refer to CTE
    UNION ALL
    fullselect that refers to CTE




```
WITH PARENT (PKEY, CKEY) AS
   ( SELECT PKEY, CKEY
        FROM HIERARCHY
        WHERE PKEY = 'AAA'
     UNION ALL
     SELECT C.PKEY, C.CKEY
        FROM HIERARCHY C ,PARENT P

        WHERE P.CKEY = C.PKEY
   )
SELECT PKEY, CKEY
  FROM PARENT;
```

PKEY	CKEY
AAA	BBB
AAA	CCC
AAA	DDD
CCC	EEE
DDD	EEE
DDD	FFF
FFF	GGG

Scalar fullselect - 1

- **Allows scalar fullselect where expressions were previously supported**

```
SELECT C1
  FROM T1
  WHERE
     T2 >  (SELECT COL1 FROM T2 ...)

SELECT C1,
            (SELECT COL1 FROM T2...),
            C3
       FROM T1
```

Scalar fullselect - 2

```
UPDATE NEW_PARTPRICE N
  SET PRICE =
    CASE
      WHEN(  (SELECT ONHAND#
                FROM INVENTORY
                WHERE PART=N.PART)  < 7  )
            THEN 1.1 * PRICE
      WHEN(  (SELECT ONHAND#
                FROM INVENTORY
                WHERE PART=N.PART) > 20  )
           THEN .8 * PRICE
      ELSE PRICE
    END;
```


SQL statements up to 2 MB

- **SQL statements can now be up to 2 MB in length**
- **Parse tree has been completely re-architected to reduce the number of cases of SQLCODE -101 (SQL too complex) due to SQL statement length**
- **Important for SQL procedure language applications**

IS NOT DISTINCT FROM

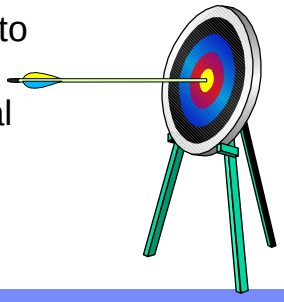
- **SQL uses three-valued logic where any given comparison can return: TRUE, FALSE, or NULL**
- **Applications can use IS NOT DISTINCT FROM to obtain a TRUE result instead of NULL when a comparing NULL values**

```
SELECT C1 FROM T1 WHERE
C1 IS NOT DISTINCT FROM :hv;
```

C1 value	:hv value	RESULT
NULL	'ABC'	FALSE
NULL	NULL	TRUE
'ABC'	'ABC'	TRUE
'ABC'	NULL	FALSE
'ABC'	'DEF'	FALSE

REOPT(ONCE)

- **Bind option that controls when the optimizer builds the access path information for dynamic SQL applications**
  - By default, access path is calculated at PREPARE
  - Using REOPT(ONCE)
    - Defers access path selection until OPEN
    - Values of host variables on OPEN are used to calculate access path
    - Resulting access path is cached in the global (prepared) statement cache

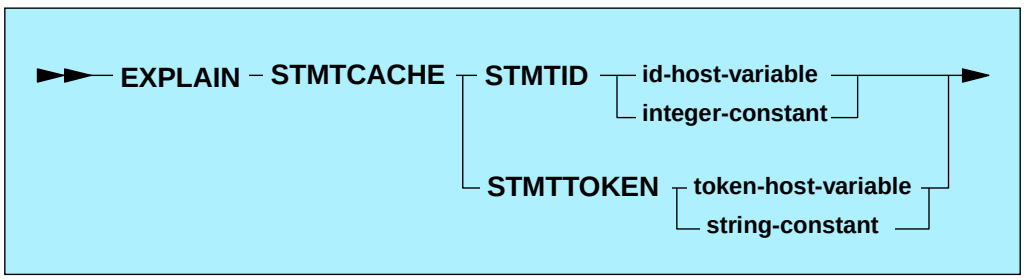


Other SQL Improvements

- **SQL procedures language extensions (see later)**
- **GROUP BY expression**
  - SELECT A+B,C
    FROM T
    ORDER BY A+B
    GROUP BY **A+B**
- **Qualified column names on SET clause**
  - UPDATE T1 SET **T1.**COL1...
- **Qualified column names on INSERT**
  - INSERT **T1.**COL1 INTO T1 VALUES...
- **Multiple DISTINCT clauses**
  - SELECT COUNT(**DISTINCT(A1)**), AVG(**DISTINCT(A2)**)
    FROM T2

Other SQL Improvements -2

- **Enhancements to the EXPLAIN statement allow you to obtain EXPLAIN information for entries in the DB2 global statement cache.**
- **Visual Explain is enhanced to exploit this new function.**



Other SQL Improvements -3

- **READ ONLY USING UPDATE LOCKS**
  - Allows WebSphere persistence layer to minimize network traffic when using searched update and pessimistic locking

```
PREPARE stmt 1 FROM
  "SELECT C1, C2, C3 FROM T1 WHERE C1=? AND C2=?
     FOR READ ONLY KEEP UPDATE LOCKS"
```

- **VOLATILE table support (see performance section for details)**

```
CREATE TABLE  TAB 1 ...  VOLATILE
```

- **Transparent ROWID column**
  - Eliminates the need to explicitly declare a ROWID column in tables that include LOBs
  - DB2 will generate a "hidden" ROWID column, which is not visible on SELECT *
  - Simplifies porting of LOB applications from other platforms

New Built-in Functions

- **ENCRYPT: encrypt a column in a table with a user-provided encryption password**
  - ENCRYPTION PASSWORD special register
- **DECRYPT_BIN**
- **DECRYPT_CHAR**
- **GET_HINT: obtain hint to help remember ENCRYPTION PASSWORD**
- **GENERATE_UNIQUE creates a CHAR(13) FOR BIT DATA value,unique across a sysplex**
- **Character-based string functions**

```
SELECT SUBSTRING(COLB,1,3,CODEUNITS32)
       AS  RESULT FROM TESTB
```

New Special Registers

- Client information for this connection
  Provided by sqleseti, Java, RRS SIGNON
  - CURRENT CLIENT_ACCTNG : accounting string
  - CURRENT CLIENT_APPLNAME : application name
  - CURRENT CLIENT_USERID : client user ID
  - CURRENT CLIENT_WRKSTNNAME : workstation name
- MQT related special registers
  - CURRENT MAINTAINED TABLE TYPES FOR OPTIMIZATION
  - CURRENT REFRESH AGE
- Application enablement related special register
  - CURRENT PACKAGE PATH
  - CURRENT SCHEMA

Session variables

- **Variables set by DB2, connection or signon exit**
- **Built in function to retrieve value for a variable**
  - Use function in views, triggers, stored procedures & constraints to enforce security policy
- **Can have more general, flexible access checks**
  - Multiple columns, AND/OR logic, ...
- **Complements other security mechanism**

```
CREATE VIEW V1 AS SELECT * FROM T1
WHERE
COL5 = GETVARIABLE(SYSIBM.SECLABEL);
```

Key Java Improvements

- **DB2 Universal Driver for SQLJ and JDBC**
- **Type 2 and type 4 driver**
  - Updated to support JDBC/SQLJ 3.0 standard
    - Savepoint support
    - Connection pooling improvements
    - New metadata for PreparedStatements
    - Return autogenerated keys
    - Multiple open ResultSets for a single stored procedure
    - WITH HOLD cursors
    - Improved BLOB/CLOB support
    - More to come ...
- **SQLJ tooling support in WSAD V5.1**

UNICODE Evolution

- **UNICODE encoding scheme can represent codepoints of characters of many different geographies and languages**
  - Sometimes more than one byte to represent a single characters
  - Different languages in the same table
  - CCSID UNICODE
- **V5 ASCII data and Unicode for Java**
- **V7 UNICODE data storage and manipulation**
- **OS/390, z/OS, z/Architecture and zSeries**

WebSphere. software

Unicode Enhancements in Version 8

- **Able to join Unicode with EBCDIC or ASCII**
- **SQL in Unicode, statements, literals, object names, mixed CCSIDs / Utility statements can be in Unicode**
- **Most DB2 character catalog columns in Unicode (Unicode catalog)**
- **Collating sequence change**
- **Lengths and maximum lengths can change**
- **DB2 itself works in Unicode (eg. SQL statement parsing)**

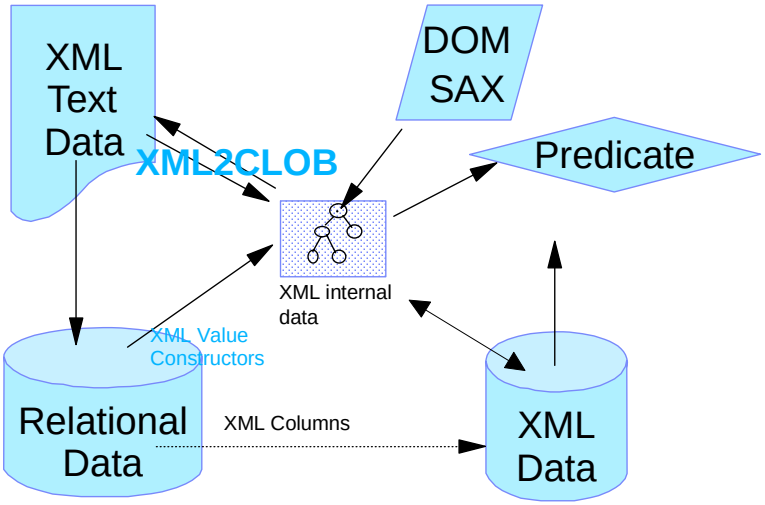
www.unicode.org

Multiple CCSIDs per SQL statement

- **A single SQL statement can now intermix EBCDIC, ASCII and Unicode tables and host variables**
- **Unlike host variables are translated to column CCSID**
- **Unlike column CCSIDs are "promoted" to Unicode**
  - May require query to be materialized/sorted

```
SELECT T1.COL_EBCDIC ,
       T2.COL_ASCII  ,
       T3.COL_UNICODE
  FROM T1,T2,T3 WHERE ...;
```

SQL/XML - XML extensions to SQL



XML value constructors:

XMLELEMENT (xmlattributes), XMLFOREST, XMLCONCAT, XMLAGG, XMLNAMESPACES

XML Publishing Functions SQL/XML

- **New built-in functions for generating XML from relational data**
  - **XMLELEMENT** generates XML element from arguments
  - **XMLATTRIBUTES** specify attributes for the XML element within XMLELEMENT
  - **XMLFOREST** creates forest of XML elements that share a specific pattern
  - **XMLCONCAT** returns a forest of XML elements that are generated from a concatenation of two or more arguments
  - **XMLAGG** returns a concatenation of XML elements from a collection of XML elements
  - **XML2CLOB** converts the new transient XML data type into UTF-8 CLOB
  - **XMLNAMESPACES** is used to declare XML Namespaces
- **Alternative to XML composition function of XML Extender**

Query Example

Query:

```
SELECT
  XML2CLOB(
    XMLELEMENT
     ( "Dept",
       XMLATTRIBUTES ( D.DEPTNO AS "deptno",
                       D.DEPTNAME AS "name" ),
      ( SELECT XMLAGG (
              XMLELEMENT (
                "Proj",
                XMLATTRIBUTES (P.PROJNO AS "projno",
                        P.PROJNAME AS "name"),
                ( SELECT XMLAGG (
                        XMLELEMENT (
                          "Emp",
                          XMLATTRIBUTES
                           (E.EMPNO as "empno"),
                        E.FIRSTNME || ' ' || E.LASTNAME
                              )
                        )
                  FROM DSN8810.EMPPROJACT EP,
                     DSN8810.EMP E
                  WHERE EP.PROJNO = P.PROJNO AND
                     EP.EMPNO = E.EMPNO
                ) )
              )
        FROM DSN8810.PROJ P
        WHERE P.DEPTNO = D.DEPTNO
      )
     ) )
FROM DSN8810.DEPT D
WHERE D.DEPTNO = 'D01';
```

Result: (formatted for easy viewing)

```
<Dept deptno="D01" name="DEVELOPMENT CENTER">
  <Proj projno="AD3100" name="ADMIN SERVICES">
    <Emp empno="000010">CHRISTINE HAAS</Emp>
  </Proj>
  <Proj projno="MA2100" name="WELD LINE AUTOMATION">
    <Emp empno="000010">CHRISTINE HAAS</Emp>
    <Emp empno="000110">VINCENZO LUCCHESI</Emp>
  </Proj>
</Dept>
```


ON COMMIT DROP enhancement

- **Declared Temporary Table improvement that causes temp table to be dropped automatically at commit:**
  - When no HELD cursors are open against the temp table
- **Significant improvement for DDF threads that use CMTSTAT=INACTIVE**
  - Stops declared temp tables from preventing thread from going INACTIVE

```
DECLARE  GLOBAL TEMPORARY TABLE
      DTT1 (COL1 CHAR (20))
      ON COMMIT DROP TABLE
```

Stored Procedures and RRS

- **Stored procedures improvements**
  - WLM management of TCBs
    - TCBs are added/removed based on WLM recommendations
  - MAX FAILURES on CREATE PROCEDURE and UDF
  - COMPJAVA (HPJ) is replaced by interpretive Java
  - No creation of, or altering to, DB2-managed SP in V8
    - Migrate to WLM-managed SP
- **RRS "implicit" connection support**
  - Similar to CAF-style implicit connections

DB2 UDB for z/OS Version 8 is

- ✓ **SQL OLTP Leadership: Multi-row Fetch & Insert, Select within Insert, Dynamic Scrollable Cursors, ...**
- ✓ **Breaking through limitations: storage, name lengths, SQL statements, partitions, logging**
- ✓ **Performance Enhancements: MQTs, index use**
- ✓ **Database changes without an outage: add partition, rotate partitions, alter cluster**
- ✓ **Integration: applications, middleware, platform**
- ✓ SAP PEOPLESOFT SIEBEL ...

Reengineered for e-business

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- SAP on DB2 for z/OS: High Availability Using System Automation, SG24-6836
- Squeezing the Most Out of Dynamic SQL, SG24-6418
- Large Objects with DB2 for z/OS and OS/390, SG24-6571

DB2 for z/OS on the Web

ibm.com/software/db2zos

- Full URL for DB2 for z/OS page
  http://www.ibm.com/software/data/db2/zos/index.html
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  http://www.ibm.com/software/db2/zos/db2zosv8.html
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