SQL on iSeries:

Concepts and Implementations

Higher Productivity iSeries Programming Using SQL

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This Presentation

- SQL Data Definition Language: DDL
- Data Manipulation Techniques with SQL
- Implementing SQL
  - Interpreted SQL
  - Compiled SQL
    - SQL Stored Procedures
    - SQL Functions
- SQL Performance Considerations

DDL: SQL Terminology

iSeries	**SQL**
Library	Collection or Schema
Physical File	Table
Record	Row
Field	Column
Logical File	View or Index

DDL: Data Definition Language - Used to:

- Define Tables
- Alter Tables
- Tables defined with DDL can be accessed with both SQL and Traditional languages like RPG/C/COBOL

DDL Limitations:

- Tables created with DDL can support ONE MEMBER ONLY
- Tables or Views using long names (up to 128 characters) will not be visible with iSeries commands DSPOBJD and DSPFD

A Word about NULLs

- The NULL value is effectively equivalent to "UNKNOWN"
- NULL is DIFFERENT BLANK

- Assigning a value of NULL:

```
UPDATE TABLE_A SET USER_NAME = NULL
```

- Comparing a value with NULL:

```
UPDATE TABLE_A SET COLUMN_A =‘NOT
   FILLED’
WHERE LAST_NAME IS NULL
```

DDL Coding Example: A SIMPLE TABLE

```
CREATE TABLE ER100F
(
 BATCH_ID            FOR BTCHID NUMERIC(10)   NOT NULL,
 SOURCE_FACILITY     FOR SRCFAL CHAR(30)      NOT NULL,
 SOURCE_DESCRIPTION  FOR SRCDSC VARCHAR(100)  NOT NULL,
 LOAD_TIMESTAMP      FOR LDTMSP TIMESTAMP     NOT NULL
) ;
LABEL ON ER100F (SOURCE_FACILITY  TEXT IS
                 'Source Facility ');
LABEL ON ER100F (BATCH_ID         TEXT IS
                 'Batch ID        ');
LABEL ON ER100F (LOAD_TIMESTAMP   TEXT IS
                 'Load Timestamp');

LABEL ON TABLE ER100F IS 'Test Data Fact Table'  ;
```

- Equivalent of a Physical File

DDL Coding Example: A UNIQUE Index

```
CREATE UNIQUE INDEX  ER100FIDX  ON ER100F
 (
    BATCH_DATE,
    BATCH_ID
 )
```

- Equivalent of a Logical File
- Visible with DSPDBR Command

Creating a VIEW : DDL Coding Example

```
CREATE VIEW MA_PROJ
    AS SELECT * FROM PROJECT
          WHERE SUBSTR(PROJNO, 1, 2) =
  'MA'
```

- Equivalent of a Logical File with a SELECT
- Visible with DSPDBR Command IF the VIEW name is 10 characters or less

DDL Coding Examples : A more complex view

```
CREATE VIEW RSLTS_ABOVE_AVG AS
SELECT MR.SOURCE_FACILITY, MR.BATCH_ID,
MR.MATERIAL_TYPE, MR.MATERIAL_NAME,
MR.COMPONENT_NAME, MR.ACTUAL_RESULTS
FROM MAT_RESULTS MR
WHERE MR.ACTUAL_RESULTS >
(SELECT AVG(AV.ACTUAL_RESULTS) FROM MAT_RESULTS AV)
```

Refining a data selection from a VIEW:

```
SELECT * FROM RSLTS_ABOVE_AVG ORDER BY SOURCE_FACILITY
```

Altering Existing Tables with DDL

- Adding a new column

```
ALTER TABLE EQP_TABLE ADD COLUMN
EQUIPMENT_CATEGORY FOR EQPCAT CHAR(10)
```

- Removing a column

```
ALTER TABLE EQP_TABLE
DROP COLUMN EQUIPMENT_CATEGORY
```

Setting up Constraints in SQL

- Setting up a Primary Key with existing tables

```
CREATE TABLE
   DEPT_TABLE
(
 DEPT_ID    CHAR(2),
 DEPT_NAME VARCHAR(20),
 PRIMARY KEY(DEPT_ID))
```

- Setting up a Primary Key and Parent/Child Constraint (when creating parent/child tables)

```
ALTER TABLE
   EMPLOYEE_TABLE ADD
   CONSTRAINT CSTEMPDPT
   FOREIGN KEY DEPT_ID
   REFERENCES
   DEPT_TABLE(DEPT_ID)
```

```
CREATE TABLE
   EMPLOYEE_TABLE
(
EMP_NUMBER INT,
EMP_NAME VARCHAR(20),
DEPT_ID CHAR(2),
PRIMARY
   KEY(EMP_NUMBER),
FOREIGN KEY(DEPT_ID)
   REFERENCES
   DEPT_TABLE(DEPT_ID))
```

Dealing with SQL Object Names Longer than 10 Characters

- DDL allows for table names longer than 10 characters
- DSPFD CANNOT see these tables
- DSPOBJD CANNOT see these tables
- Keeping track of these tables can only be done through the SQL CATALOG
- SQL CATALOG Files are stored in
- QSYS2/SYS* system table objects

Most Used Catalog Tables

Catalog Table	Description
SYSCOLUMNS	Columns
SYSCST	Constraints
SYSFUNCS	Functions
SYSINDEXES	Indexes
SYSKEYS	Keys
SYSPROCS	Procedures
SYSTABLES	Tables
SYSTRIGGER	Triggers
SYSVIEWS	Views

Finding SQL Object Names Longer than 10 Characters

- To find a table with a long name
- ```
  SELECT TABLE_NAME, TABLE_SCHEMA
  FROM QSYS2/SYSTABLES WHERE
  TABLE_NAME = 'MONTH_TO_DATE_SALES'
  ```

- To find the columns in a long file name:
- ```
  SELECT * FROM QSYS2/SYSCOLUMNS
  WHERE TABLE_NAME =
  'MONTH_TO_DATE_SALES'
  ```

Real Life Use for Catalog Tables

- Where is this column (field) name used?
- **SELECT * FROM QSYS2/SYSCOLUMNS WHERE COLUMN_NAME = 'GLMCU'**

- Are the number of columns (fields) for this table the same in all schemas (libraries)?
- **SELECT TABLE_NAME, TABLE_SCHEMA, COUNT(*) FROM QSYS2/SYSCOLUMNS WHERE TABLE_NAME = 'F0911' GROUP BY TABLE_NAME, TABLE_SCHEMA**

DDL Summary

- With DDL, you can create or alter tables
- DDL allows table and column names to be longer than 10 characters
- All DDL Objects can be found in the SQL Catalog Tables
- All SQL Catalog files start with SYS* and can be found in library QSYS2

Part 2
CODING in SQL: MAKE IT HAPPEN!

- SQL JOIN
- SQL Update
- Group BY
- Casting
- Date & Time Manipulation

SQL Joins

- Join or Inner Join
- Left/Right Join or Left/Right Outer Join
- Left/Right Exception Join
- Cross Join

JOIN or INNER JOIN

- Most commonly used join
- Returns as many rows as there are matches, no more, no less
- Returns values for all columns

INNER Join Example: Getting only the exact key matches

```
SELECT
EM.EMPLOYEE_NBR,
EM.EMPLOYEE_NAME,
BM.EMPLOYEE_BENEFITS_DESC

FROM EMPLOYEE_MASTER EM
INNER JOIN BENEFITS_MASTER BM
ON EM.EMPLOYEE_NBR = BM.EMPLOYEE_NBR
```

EM.EMPLOYEE_NBR	EM.EMPLOYEE_NAME	BM.EMPLOYEE_BENEFITS_DESC
1234	John Smith	TOP DENTAL
4567	Garth Johnson	BOTTOM DENTAL
7342	Gene Lockhart	FULL MEDICAL
121	Steve Carson	FULL MEDICAL

LEFT JOIN or LEFT OUTER JOIN (1 of 2)

- Returns values for ALL the rows on the left table and values from the joined table that match
- When a match is not found in the joined file (to the right), NULLs are returned
- NULL values can be overridden with the IFNULL operand

LOJ Example: Getting the matches, the data from the left table and defaults from the right table if no values found

```
SELECT
EM.EMPLOYEE_NBR,
EM.EMPLOYEE_NAME,
IFNULL(BM.EMPLOYEE_BENEFITS_DESC,
  'Benefits not yet allocated')
FROM EMPLOYEE_MASTER EM
LEFT OUTER JOIN BENEFITS_MASTER BM ON
  EM.EMPLOYEE_NBR = BM.EMPLOYEE_NBR
```

LEFT JOIN or LEFT OUTER JOIN Results

LOJ Results **WITHOUT** IFNULL default override

EM.EMPLOYEE_NBR	EM.EMPLOYEE_NAME	EM.EMPLOYEE_BENEFITS_DESC
1234	John Smith	TOP DENTAL
4567	Garth Johnson	BOTTOM DENTAL
852	Brian Evans	-
121	Steve McPhearson	-

LOJ Results **WITH** IFNULL default override

EM.EMPLOYEE_NBR	EM.EMPLOYEE_NAME	EM.EMPLOYEE_BENEFITS_DESC
1234	John Smith	TOP DENTAL
4567	Garth Johnson	BOTTOM DENTAL
852	Brian Evans	BENEFITS NOT YET ALLOCATED
121	Steve McPhearson	BENEFITS NOT YET ALLOCATED

USING MORE THAN ONE LOJ Table

```
INSERT INTO EMPLOYEE_DATA
 (
EMPLOYEE_NBR,
EMPLOYEE_NAME,
EMPLOYEE_BENEFITS_DESC,
EMPLOYEE_SALARY,
SALARY_CATEGORY
)

SELECT
EM.EMPLOYEE_NBR,
EM.EMPLOYEE_FIRST_NAME || ' ' || EM.EMPLOYEE_LAST_NAME,
IFNULL(BM.EMPLOYEE_BENEFITS_DESC, 'New Employee – Benefits not yet allocated'),
IFNULL(PM.YEARLY_SALARY, 0),
CASE
   WHEN PM.YEARLY_SALARY<100000 THEN 'REGULAR EMPLOYEE'
   WHEN PM.YEARLY_SALARY<=100000 THEN 'EXECUTIVE EMPLOYEE'
   WHEN PM.YEARLY_SALARY IS NULL THEN 'UNKNOWN - INVESTIGATE'
   ELSE 'DA BOSS'
END

FROM EMPLOYEE_MASTER EM
LEFT OUTER JOIN BENEFITS_MASTER BM ON EM.EMPLOYEE_NBR = BM.EMPLOYEE_NBR
LEFT OUTER JOIN PAYROLL_MASTER PM  ON EM.EMPLOYEE_NBR = PM.EMPLOYEE_NBR;
```

LEFT EXCEPTION JOIN

- Returns only the rows from the left table that do not have a match in the right table

```
SELECT EM.EMPNO, EM.LASTNAME,
    EM.PROJNO FROM EMPLOYEE EM
EXCEPTION JOIN PROJECT PJ
ON EM.PROJNO = PJ.PROJ#
```

CROSS JOIN

- Also known as "CARTESIAN PRODUCT"
- Can be specified with the CROSS JOIN syntax or by listing two tables without a WHERE clause
- Returns a row in the result table for each combination of rows from the tables being joined

```
SELECT * FROM FILEA CROSS JOIN FILEB
```

```
SELECT * FROM FILEA, FILEB
```

CROSS JOIN EXAMPLE

EM.EMPNBR	EM.EMPNAME
1234	John Smith
4567	Garth Johnson
852	Brian Evans
121	Steve McPhearson

BEN_NBR	EM.EMPLOYEE_BENEFITS_DESC
1111	TOP DENTAL
2222	BOTTOM DENTAL

CROSS JOIN Results

EM.EMPNBR	EM.EMPNAME		
121	Steve McPhearson	1111	TOP DENTAL
121	Steve McPhearson	2222	BOTTOM DENTAL
852	Brian Evans	1111	TOP DENTAL
852	Brian Evans	2222	BOTTOM DENTAL
1234	John Smith	1111	TOP DENTAL
1234	John Smith	2222	BOTTOM DENTAL
4567	Garth Johnson	1111	TOP DENTAL
4567	Garth Johnson	2222	BOTTOM DENTAL

CASTING and Joining Tables With Incompatible Keys using CAST

```
SELECT CAST(ZIP_NUMBER AS CHAR(5)) FROM FILEB

SELECT INT(SUBSTRING(TELEPHONE, 1, 3) ) AREA_CODE
    FROM FILEA
```

- Tips & Techniques

Joining with Cast Values:

```
SELECT * FROM FILE_A, FILE_C
WHERE       FILEA.INT_KEY
     =      CAST(SUBSTRING(TELEPHONE, 1, 3) as INT )
```

Join Summary

- Inner Join
- Left or Right Outer Join
- Left or Right Exception Join
- Cross Join

Update/Delete with SQL

- Use of SQL for UPDATE or DELETE

Updating Data in a Table Using a Correlated Query

```
UPDATE EMPLOYEE_TABLE EM
SET (EM.FIRST_NAME, EM.LAST_NAME) =
(SELECT UPDT.FIRST_NAME,UPDT.LAST_NAME
   FROM NEW_NAMES UPDT )
WHERE EXISTS
    (SELECT *
  FROM NEW_NAMES UPDT WHERE UPDT.ID =
   EM.ID )
```

- Note the use of TWO WHERE clauses
- **WARNING:** Will crash if the second select yields more than one row!

Updating Data in a Table Using MAX() value to avoid possible duplicates

```
UPDATE EMPLOYEE_TABLE EM
SET (EM.ID) =
(SELECT MAX(UPD0.ID) FROM UPDATE_TABLE UPD0)
   WHERE EXISTS
(SELECT * FROM UPDATE_TABLE UPD1
WHERE
    UPD1.FIRST_NAME = EM.FIRST_NAME
AND UPD1.LAST_NAME  = EM.LAST_NAME
AND UPD1.ADDRESS_1  = EM.ADDRESS_1
AND UPD1.ADDRESS_2  = EM.ADDRESS_2
AND UPD1.ADDRESS_3  = EM.ADDRESS_3
);
```

Updating Data in a Table Using a Correlated Query with a pre-selection Note the THREE WHERE CLAUSES

```
UPDATE FGLDETOS  FGL
     SET
          (
            FGL.ADDRESS_BOOK_NUMBER ,
            FGL.DW_STS_ADDRESS_BOOK_NUMBER  )=
             (SELECT    A.Q1AN8R,'O'
                FROM  F590101A A
               WHERE  A.Q1AN8 =  FGL.ADDRESS_BOOK_NUMBER
                 AND  A.Q1AN8 !=  A.Q1AN8R
                 AND  A.Q1AN8R > 0
                 AND  FGL.ROW_SOURCE='A'
                 )
WHERE EXISTS
     ( SELECT    *
                FROM  F590101A A1
               WHERE  A1.Q1AN8 =  FGL.ADDRESS_BOOK_NUMBER
                 AND  A1.Q1AN8 !=  Q1AN8R
                 AND  A1.Q1AN8R > 0
                 AND  FGL.ROW_SOURCE='A'
                );
```

Deleting Data in a Table Using a Correlated Query

```
(DELETE FROM EMPLOYEE_TABLE EM
WHERE EXISTS
(SELECT * FROM UPDATE_TABLE UPDT WHERE
   UPDT.ID = EM.ID);
```

- Note again the use of TWO WHERE clauses

Update/Delete Summary

- UPDATE or DELETE in SQL is done with correlated sub-queries
- Ensure you have unique values to update with in an update SQL statement

Value-Added Data using SQL: Using the GROUP BY function

- Using the keyword GROUP BY
  - HAVING vs. WHERE
- Using DISTINCT
- Dealing with Duplicate Values
- Date/Time Manipulations

Aggregating Data with GROUP BY

- Find distinct values, regardless of how many rows in a table – AND sum or count of values

```
SELECT CITY_NAME,
    COUNT(*) ORDERS_COUNT,
     SUM(ORDER_VALUE) ORDERS_VALUE,
     AVG(ORDER_VALUE) AVERAGE,
     MIN(ORDER_VALUE) MIN_ORDER,
     MAX(ORDER_VALUE) MAX_ORDER FROM ORDERS
     GROUP BY CITY_NAME ORDER BY 4
```

CITY_NAME	ORDERS_ COUNT	ORDERS_VALUE	AVERAGE	MIN_ORDER	MAX_ORDER
New York	2324.00	45646546.00	19641.37	123.00	852.00
Phoenix	3434.00	544696445.00	158618.65	1822.00	5236.00
Chicago	4553.00	834098534.00	183197.56	268.00	7411.00
Houston	2.00	554556.00	277278.00	965.00	1258.00

Aggregating Data – HAVING Clause

- For comparing individual rows, use WHERE
- For aggregated values, use HAVING

```
SELECT STORE_NAME, STORE_STATE, SUM(SALES)
    STORE_SALES
    FROM STORE_INFORMATION
    WHERE STORE_STATE = 'IL'
    GROUP BY STORE_NAME, STORE_STATE
    HAVING SUM(SALES) > 1500
```

STORE_NAME	STORE_STATE	STORE_SALES
Ontario Street	IL	3434
Michigan Avenue	IL	4553

Finding Distinct Values in a Table with SQL

- Find distinct values, regardless of how many rows in a table

```
SELECT DISTINCT CITY_NAME, ZIP_CODE FROM
    ORDERS WHERE CITY_NAME = 'CHICAGO'
    ORDER BY ZIP_CODE
```

CITY	Zip Code
CHICAGO	60606
CHICAGO	60607
CHICAGO	60608
CHICAGO	60609
CHICAGO	60610
CHICAGO	60611
CHICAGO	60612

Finding Duplicate Keys in a Table

```
(SELECT ADDRESS_1, ADDRESS_2,
   ADDRESS_3, COUNT(*)
   FROM CONTACT_TABLE
   HAVING COUNT(*) > 1
   GROUP BY ADDRESS_1, ADDRESS_2,
   ADDRESS_3
```

- Very Common SQL Example
- Note the use of the GROUP BY clause
- Unique Keys still best to keep duplicates out when possible!
- Useful to clean up raw data

Removing Duplicate Rows In A Table (Address Example)

```
(DELETE FROM CONTACT_TABLE AD1
WHERE AD1.ID_NUMBER <
(
 SELECT MAX(AD2.ID_NUMBER)
 FROM CONTACT_TABLE AD2
 WHERE ( AD1.ADDRESS_1 = AD2.ADDRESS_1 AND
         AD1.ADDRESS_2 = AD2.ADDRESS_2 AND
         AD1.ADDRESS_3 = AD2.ADDRESS_3 )
)
```

- Note the use of the MAX clause
- Note the use of Correlation Names AD1 and AD2 - attacking the same table twice with two different correlated names

Extracting ONLY UNIQUE (no duplicate) Values USING DISTINCT with ALL the columns in the table

```
SELECT DISTINCT
PT1.CLERK,
PT1.TRANS_NUMBER,
PT1.ITEM,
PT1.SIZE,
PT1.COLOUR,
PT1.DOLLAR_AMT,
PT1.POLLING_TIME
FROM POLLING_TABLE PT1
```

Time & Date Values on iSeries: a Very useful Data Type

- The TIMESTAMP value on iSeries records time to ONE MILLIONTH of a SECOND
- Measure time values conveniently with SQL, from dates to seconds with very little effort

Date & Time Data Manipulations

- DATE and TIMESTAMP data types allow easy date and time calculations

```
SELECT CURRENT TIMESTAMP
       + 7 hours - 5 minutes - 10 seconds
       FROM SYSIBM/SYSDUMMY1
2005-06-21-09.07.10.553453

SELECT CURRENT DATE + 30 DAYS FROM SYSIBM/SYSDUMMY1
    05/07/21

SELECT
CHAR(DATE(TIMESTAMP('2005-06-21-09.07.10.553453')
     +7 DAYS)) FROM SYSIBM/SYSDUMMY1
05/06/28

SELECT * from ORDER_TABLE WHERE
       CURRENT_TIMEATAMP - ORDER_DATE < 30 DAYS
```

SYSTEM Date & Time RETRIEVAL

- TIME Retrieval using CURTIME function

```
SELECT curtime() FROM sysibm/sysdummy1
```

- DATE Retrieval using CURDATE function

```
SELECT curdate() FROM sysibm/sysdummy1
```

- CURRENT TIMESTAMP Retrieval using NOW function

```
SELECT now() FROM sysibm/sysdummy1
```

- GMT TIMESTAMP using NOW and TIMEZONE
- `select now()- current timezone from sysibm/sysdummy1`

Value Added DATA Recap

- Group BY
- Casting
- Date & Time Data Type
- Using the keyword GROUP BY
  - HAVING vs. WHERE
- Using DISTINCT
- Dealing with Duplicate Values

Part 3
SQL Implementation

- Interpreted SQL
- SQL Stored Procedures

Interpreted SQL

- Used with the RUNSQLSTM CL Command
- SQL commands are stored in a Source Member
- Format:

```
RUNSQLSTM

SOURCELIB/SOURCEFILE SOURCEMBR
```

Interpreted SQL Characteristics

- Must have an output if there is a select
- Can be used for Set Processing ONLY (as opposed to individual rows)
- Cannot receive parameters
- Cannot use loops
- Can use CASE Statements but not IF/Then/Else

Running Interpreted SQL

Can be run with the RUNSQLSTM CL command

RUNSQLSTM LIBRARY/FILE MEMBER

Sample Source:

```
INSERT INTO EXTRACT
SELECT INPUT.FIRST_NAME,
    INPUT.LAST_NAME, INPUT.SALARY
    FROM PAYROLL INPUT
    WHERE (INPUT.SALARY IS > 1000000);
```

SQL Stored Procedures Characteristics

- Compile into Executable CLE type *PGM objects
- Faster than interpreted code – MOST TIMES
- Can be debugged like any CLE program
- Debug to retrieve SQL Optimizer messages

  - Can use Parameters, Variables
  - Logic constructs (if/then/else, do/for loops)
  - The ability to take advantage of compiled functions

Stored Procedure Example 1: A simple Update

```
CREATE PROCEDURE PROC_NAME
 LANGUAGE SQL

 -- START PROCEDURE
 -- This procedure will, for each
 row of table ER400SX, retrieve the
 current timestamp
 -- and update the column
 PUBLISH_TMS within ER400SX

 BEGIN

 -- DECLARE CURSOR VARIABLES
 DECLARE PUBLISH_TMS    TIMESTAMP ;
 DECLARE WORK_TIMESTAMP TIMESTAMP ;
 DECLARE SQLSTATE CHAR(5) DEFAULT
 '00000' ;
 DECLARE AT_END  INT DEFAULT 0 ;
 DECLARE SQLCODE INT DEFAULT 0 ;

 DECLARE CURSOR_UPD CURSOR FOR
 SELECT PUBLISH_TMS FROM ER400SX
 MAIN;
 SET AT_END = 0;
```

```
OPEN  CURSOR_UPD ;

 WHILE (SQLCODE = 0)

     FETCH CURSOR_UPD INTO WORK_TIMESTAMP ;


        UPDATE ER400SX
        SET PUBLISH_TMS  = CURRENT TIMESTAMP,
            TIME_ELAPSED = DAY(CURRENT_TIME_STAMP
              - WORK_TIMESTAMP)
        WHERE CURRENT OF CURSOR_UPD ;

 END WHILE  ;

 CLOSE CURSOR_UPD ;

 -- END PROCEDURE
 END
```

SQL Stored Procedure Tips

- The code begins with

  `CREATE PROCEDURE PROC_NAME`

  where PROC_NAME will be the name of the procedure name – NOT the MEMBER NAME
- The procedure will be created in the Current Library
- The CREATE PROCEDURE statement will not replace an existing procedure

Stored Procedure Example (2) – a Correlated Update

```
 CREATE PROCEDURE DWCVGDOS01

  LANGUAGE SQL
  SET OPTION OUTPUT = *PRINT, DBGVIEW = *SOURCE

  -- START PROCEDURE

  BEGIN

-- DECLARE CURSOR VARIABLES
DECLARE SQLSTATE                      CHAR(5) DEFAULT '00000' ;
DECLARE SQLCODE                       INT DEFAULT 0 ;
DECLARE AT_END                        INT DEFAULT 0 ;
DECLARE CURRENT_ADDRESS_BOOK_VALUE    INT     ;
DECLARE NEW_ADDRESS_BOOK_VALUE        INT     ;
DECLARE CURRENT_SUR_KEY               INT     ;

-------------------------------------------------------------
          ------------------
-- CURSOR 1 - FGLDET BEING UPDATED
-------------------------------------------------------------
          ------------------
DECLARE CURSOR_MAIN  CURSOR FOR
         SELECT
       GLAN8,
       Q1AN8R,
       DW_SURROGATE_KEY
       FROM FGLDETOS  AA
       JOIN  F590101A BB
       ON    BB.Q1AN8  = AA.GLAN8
       AND   BB.Q1AN8 <> BB.Q1AN8R
       AND   BB.Q1AN8R > 0
       AND   AA.ROW_SOURCE = 'A' ;

-------------------------------------------------------------
          -------------
-- SET VARIABLES FOR PROCESSING
-------------------------------------------------------------
          -------------
OPEN  CURSOR_MAIN ;
SET AT_END = 0;

-------------------------------------------------------------------------
-- MAIN UPDATE LOOP. UPDATE THE MAIN FILE USING THE SECONDARY FILE.
-------------------------------------------------------------------------
WHILE (SQLCODE = 0) DO

    FETCH CURSOR_MAIN  INTO
                          CURRENT_ADDRESS_BOOK_VALUE,
                          NEW_ADDRESS_BOOK_VALUE,
                          CURRENT_SUR_KEY ;

     UPDATE FGLDETOS  FGL
       SET
           (
             FGL.ADDRESS_BOOK_NUMBER ,
             FGL.DW_STS_ADDRESS_BOOK_NUMBER
           )
       =
           (
                  NEW_ADDRESS_BOOK_VALUE ,     -- REPLACE WITH NEW VALUE
                  'O'                          -- CHANGE TO OPEN
           )
           WHERE FGL.DW_SURROGATE_KEY  = CURRENT_SUR_KEY    ;


END WHILE ;

CLOSE CURSOR_MAIN ;

END


-- END OF PROCEDURE --
```

Steps to Create and Run a Stored Procedure

- Code the stored procedure in a source member
- Create the stored procedure in your current library (CURLIB) using RUNSQLSTM
  - This will result in the stored procedure to be created as an ILE C pgm, with your SQL code embedded within
- Syntax: CALL PROCEDURE_NAME
- NOTE: SQL procedure objects have to be called in an SQL environment

4 Ways to call an SQL Stored Procedure

- Interactively – from the STRSQL command prompt
- In Batch – using the RUNSQLSTM with an SQL source member containing the CALL to the SQL procedure
- Using the QMQRY (Query Manager Query) – The instruction is STRQMQRY and the QMQRY member should contain the call
- Using Dan Riehl's EXCSQL

Debugging an SQL Stored Procedure

- To be debuggable, the procedure has to be created in a debuggable mode
- RUNSQLSTM with DBGVIEW(*LIST) or DBGVIEW(*SOURCE)
- DBGVIEW(*LIST) provides a C view of the code
- DBGVIEW(*SOURCE) provides an SQL view of the code
- Once the procedure is compiled, use STRDBG PGM(PROC_NAME) UPDPROD(*YES)

SQL Stored Procedure File Operation Debugging – SQLCODE

- SQLCODE is a results indicator variable affected by each database operation
- - Zero value in the SQLCODE indicates success
- - To see the value of the SQLCODE variable, use EVAL SQLCODE
- - SQLCODE is actually part of a larger system data structure. To see it, use
- **`EVAL sqlca`**

SQL Modular Programming with Functions – Recycle that code!

- - SQL FUNCTIONS
  - Allow creation of your own functions in the same way that you can create your own commands
- Are Different from SQL Procedures:
  - - procedures can receive and return many parameter values
  - - functions can receive many but will only return a single parameter value.

The Mechanics of SQL Functions

- To compile a function, use the RUNSQLSTM command, just like creating a Stored procedure
- SQL functions compile into objects of type *SRVPGM
- This means the function cannot be called on its own

SQL Functions – A simple Example

```
CREATE FUNCTION HOW_OLD (INDATE DATE)
  RETURNS CHAR(8)
  LANGUAGE SQL
     BEGIN
   DECLARE  HOW_OLD CHAR(8);
   DECLARE  RETVAL CHAR(8);
    CASE
      WHEN INDATE < CURRENT_DATE - 60 DAYS THEN
             SET RETVAL = 'VERY OLD';
      WHEN INDATE < CURRENT_DATE - 30 DAYS THEN
             SET RETVAL = 'OLD';
      ELSE
             SET RETVAL = 'FRESH';
    END CASE;
   RETURN(RETVAL);
  END
```

```
SELECT HOW_OLD(CURRENT DATE - 33 DAYS) FROM SYSIBM/SYSDUMMY1
```

SQL Functions – A simple Example Translating a JDE Julian Date to MDY

SQL Function Code:

```
CREATE FUNCTION XJDETOMDY (IN_JDE_DATE INT)
RETURNS DATE
LANGUAGE SQL
BEGIN
   DECLARE  OUT_YMD DATE ;
   SET OUT_YMD = DATE(CHAR(1900000+IN_JDE_DATE)) ;
   RETURN (OUT_YMD);

END
```

Execution:

```
                    CYYJJJ
SELECT XJDETOMDY(105144) FROM SYSIBM/SYSDUMMY1
05/24/05
```

SQL Functions – A simple Example
Translating a MDY Date to a JDE Julian Date

SQL Function Code:

```
CREATE FUNCTION XMDYTOJDE
        (IN_YMD_DATE DATE)
RETURNS  INT
LANGUAGE SQL
BEGIN
  DECLARE  OUT_JDE_DATE   INT    ;
  DECLARE  OUT_JDE_PART1  CHAR(1) ;
  DECLARE  OUT_JDE_PART2  CHAR(2) ;
  DECLARE  OUT_JDE_PART3I INT    ;
  DECLARE  OUT_JDE_PART3C CHAR(3) ;

CASE
    WHEN IN_YMD_DATE <
         DATE('01/01/2000')
     THEN SET OUT_JDE_PART1 = '0'   ;
    ELSE
     SET OUT_JDE_PART1 = '1'   ;
END CASE  ;
```

```
SET  OUT_JDE_PART2  =  SUBSTR(CHAR(IN_YMD_DATE),
        7,2) ;

SET  OUT_JDE_PART3I  =   DAYS(IN_YMD_DATE) -
    DAYS( DATE('01/01/' || OUT_JDE_PART2  ) )U  ;
CASE
    WHEN OUT_JDE_PART3I < 10
     THEN SET OUT_JDE_PART3C = '00' ||
         CHAR(OUT_JDE_PART3I) ;

    WHEN OUT_JDE_PART3I < 100
     THEN SET OUT_JDE_PART3C = '0' ||
         CHAR(OUT_JDE_PART3I) ;
    ELSE
        SET OUT_JDE_PART3C = CHAR(OUT_JDE_PART3I) ;
END CASE  ;
 SET OUT_JDE_DATE = INT(OUT_JDE_PART1 ||
        OUT_JDE_PART2 || OUT_JDE_PART3C ) ;
RETURN (OUT_JDE_DATE) ;
END
```

Execution:

```
SELECT XMDYTOJDE(DATE('05/24/05')) FROM SYSIBM/SYSDUMMY1

105144
```

Implementing SQL Recap

- Interpreted SQL
- SQL Stored Procedures
  - Debugging
- SQL Functions

Part 4
Performance & Security

- Performance
- Data Retrieval Tips
- Security

Real life SQL Rule Number 1: Indexes, Indexes, Indexes

- SQL performance can be fantastic, but it can also be terribly slow if not coded properly or if no index is recognized by the DB2 SQL Optimizer
- Code your SQL join statements with keys that match the order of the indexes
- Look for Optimizer Suggestions

Make the most out of your indexes: The Cardinality Rule

- Most efficient indexes for SQL processing are ones that are created in order of cardinality
  - For example: in a table containing 10,000 rows with an index composed of 3 keys:
  - First key, Company Division has 4 possible values
  - Second key, Department has 48 possible values
  - Third key, Employee has 100,000 values
- Make your index unique if you can

Surrogate Keys – Beyond Indexes

- A Surrogate Key is an arbitrary, unique numeric key
- Unique Numeric keys are fastest for index access. If your key is too long or not unique, a surrogate key can improve your access performance, especially on updates

USE CAST ONLY IF THERE IS NO OTHER SOLUTION

- SQL allows joining data with different key types using CASTING
- Practical when no other solutions but precludes the use of indexes => SLOW PERFORMANCE

Select for Insert: Be Explicit

-Using SELECT * on an insert is an exposure if you make database changes

- Explicit column selects are safer

```
INSERT INTO
   EMPLOYEE_DATA
  (
EMPLOYEE_NBR,
EMPLOYEE_LAST_NAME,
SALARY_CATEGORY
)
SELECT
*
FROM EMPLOYEE_MASTER;
```

```
INSERT INTO
   EMPLOYEE_DATA
  (
EMPLOYEE_NBR,
EMPLOYEE_LAST_NAME,
SALARY_CATEGORY
)
SELECT
EM.EMPLOYEE_NBR,
EM.EMPLOYEE_LAST_NAME,
EM.EMPLOYEE_CATEGORY
FROM EMPLOYEE_MASTER EM;
```

SQL Testing Guidelines

- Test for Scale: What works on a small sample may be a dog with a large amount of data

- Test for number of rows: SQL processing is primarily about processing SETS of data. Make sure you create test cases where you can predict the resulting number of records, especially on JOIN statements

Get the Most out of your WHERE Clauses

- Order your WHERE Clauses by putting the comparisons in order of efficiency:
- =
- >, >=, <, <=
- LIKE
- <>

FETCH FIRST keyword

- Limit your results with FETCH FIRST

```
SELECT * FROM CUSTOMER AORDER BY
  A.SALES DESC FETCH FIRST 5 ROWS ONLY
```

BATCH vs Interactive

- USE BATCH when possible
- Batch mode processing is MUCH FASTER than interactive mode

Method to find the SQL Optimizer suggestions to improve performance (1 of 2)

1) Go in debug and change the job to record all activities and second level text

- STRDBG UPDPROD(*YES)
- CHGJOB LOG(4 4 *SECLVL)
  Note: with *SECLVL, both the message text and the message help (cause and recovery) of the error message are written to the job log

Method to find the SQL Optimizer suggestions to improve performance (2 of 2)

2) Call Stored Procedure from an SQL environment

3) Review the job log and look for the following messages:

"****** Starting optimizer debug message for query**"

Or

"**Access path suggestion for file**"

The system will typically make precise index suggestions, or not suggest at all

COMPILED vs INTERPRETED SQL

- Main advantage of interpreted code is simplicity
  - Simplicity in coding (no compiling)
- Main advantage is that compiled code allows
  - Variable manipulation
  - Do-loops
  - If-then-else constructs
  - Record-by-record processing
  - Retrieval of SQL Optimizer Messages

Promotion & Implementation Considerations

- Large scale use of SQL in production requires some promotion control planning
- SQL can be implemented without compilation – Ensure your security is setup so that you control what can enter your production SQL source files
- SQL is different from other conventional languages. Ensure your promotion control software can handle SQL code/objects

Using SQL to Retrieve Data from a REMOTE Database

- Type in "**CONNECT**" then press F4 in an interactive STRSQL session
- **CONNECT TO RMT_SYS USER USER_NAME USING 'PASSWORD'**
- Allows data retrieval with SQL from a remote iSeries
- NOTE: The password is visible on the screen when called interactively

SQL access on iSeries: ODBC Accessibility

- You can reach your data using SQL on Microsoft Excel and an ODBC connection
- This may be a security exposure
- Verify your ODBC security
- PowerLock and other vendors have tools to shut these down or authorize only certain users

SARBOX Considerations

- Auditors may ask:

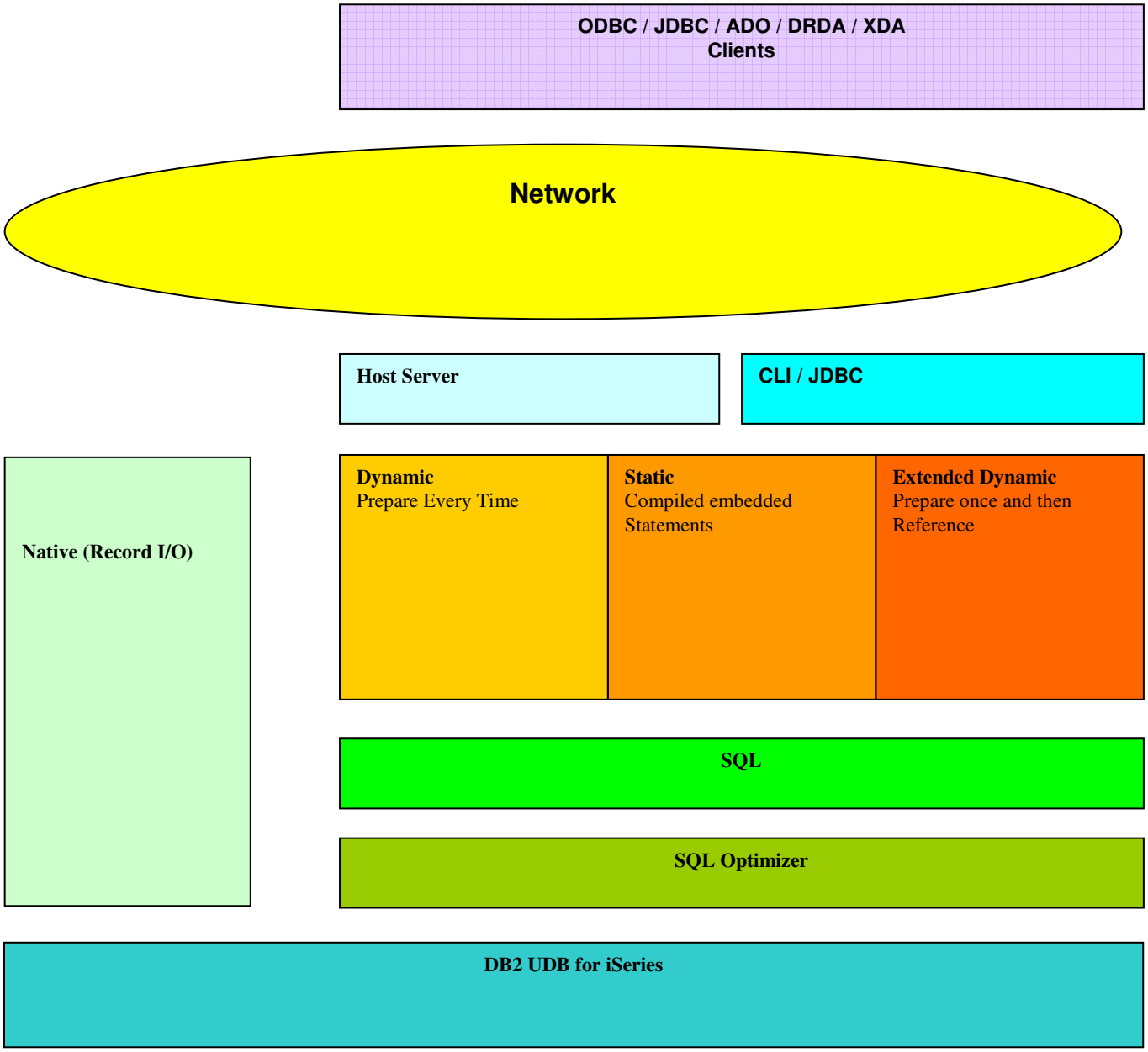
  Can SQL make "untraceable" changes in the database?

- AGAIN: Verify your ODBC security
- Journal critical tables if audit trails are absolutely necessary
- Create your own EXCSQL command and log the commands used
- Revoke STRSQL and allow SQL access only via EXCSQL

Performance & Security Recap

- Performance
  - Indexes
  - SQL Optimizer
- Data Retrieval Tips
  - Using the SQL Optimizer
  - ODBC Access, Keyword CONNECT
- Security
  - Audit Considerations
  - ODBC Access

What's Next?


ODBC / JDBC / ADO / DRDA / XDA
Clients
Network
Host Server
CLI / JDBC
Native (Record I/O)
Dynamic
Prepare Every Time
Static
Compiled embedded
Statements
Extended Dynamic
Prepare once and then
Reference
SQL
SQL Optimizer
DB2 UDB for iSeries

Questions?

Email: dambrine@tylogix.com
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Good Online SQL Tutorial Website:

http://www.w3schools.com/sql/default.asp

DB2 Personal Developer Website:

http://www-306.ibm.com/software/data/db2/udb/edition-pde.html