Minimize your trips to DB2

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Questions?

- You can submit questions by typing into the questions area of your webinar control panel.
- Questions will be answered as time permits.
- Any questions not answered due to time constraints can be answered afterward via an email.

DB3052 DB2 for z/OS Database Performance Tuning
Public course offering: 10/11/2016

Agenda

- ✓ Identify Threads with high DB2 Entry/Exit Events
- ✓ Coding Techniques to minimize trips to DB2
- ✓ Optimized Coding techniques unique to DBAT threads
- ✓ SQL and Bind options to optimize multi-row processing

Application Elapsed Time

Application

- Thread Allocation
- Program A
  - Statement 1
  - Statement 2
  - Statement 3
- Program B
  - Statement 1
  - Statement 2
- Thread Deallocation, goes Inactive, Authid Changes or ROLLUP

DB2

- Plan
- Package A
  - Statement 1
  - Statement 2
  - Statement 3
- Package B
  - Statement 1
  - Statement 2
- Trace Record Written

Identify Threads with high DB2 Entry/Exit Events

- Long Running Threads
  - DSNB2601I long-running reader
  - DSNJ031I long running updates
- Code Review
- DB2 Accounting Trace
  - High APPL(Class 1) time
  - High number of DB2 (Class 2) ENT/EXIT
  - High number of DB2 (Class 7) ENT/EXIT

Accounting Trace Report

DB2 ENT/EXIT

TIMES/EVENTS	APPL(CL.1)	DB2 (CL.2)
ELAPSED TIME	~	
CP CPU TIME	~	
SE CPU TIME	~	
SUSPEND TIME	~	
NOT ACCOUNT.	~	
DB2 ENT/EXIT	N/A	#####
EN/EX-STPROC	N/A	0
EN/EX-UDF	N/A	0
DCAPT.DESCR.	N/A	N/A
LOG EXTRACT.	N/A	N/A

SQL DML

SQL DML	TOTAL
SELECT	?
INSERT	?
ROWS	0
UPDATE	0
ROWS	0
MERGE	?
DELETE	0
ROWS	0
DESCRIBE	0
DESC.TBL	0
PREPARE	0
OPEN	?
FETCH	?
ROWS	?
CLOSE	?
DML-ALL	#####

Code Review:
Minimizing Trips to DB2

- Avoid unnecessary SQL Statements
- Perform loops
- Application join vs. SQL Join
- Use output only Updates/Deletes where possible
- Use ROWSET processing

Extended Indicator Variables

What do you do when the input columns received for an update or insert change from execution to execution?

- Dynamic SQL?
- Static code for all possibilities?
- Have 1 update or insert that includes all columns each time?

New for Inserts	New for Updates / Merge Updates
-5 = Use default value	-5 = Use default value
-7 = Use default value	-7 = No Update

Bind / Rebind EXTENDEDINDICATOR (YES)

Prepare WITH EXTENDED INDICATORS

Examples

MOVE -5 (or -7) TO V-ADDRESS2-NI *(no address2, use default)*

```
INSERT INTO EMP (EMPNO, ADDRESS, SALARY)
 VALUE (:V-EMPNO,
            :V-ADDRESS2 :V-ADDRESS2-NI,
            :V-SALARY     :V-SALARY-IND)
```

MOVE 0 TO V-ADDRESS2-NI (*address2 changed*)
MOVE -7 TO V-SALARY-NI *(salary not changed, skip column)*

```
UPDATE EMP
SET ADDRESS2  = :V-ADDRESS2 :V-ADDRESS2-NI,
      SALARY      = :V-SALARY      :V-SALARY-NI
WHERE EMPNO = :EMPNO
```

ROWSET POSITIONING

- Reduce DB2 Entry/Exit using ROWSET POSITIONING
  - Use of Arrays
  - Multi-Row Fetch
  - Multi-Row Insert
- Reduce database calls using the MERGE (upsert) and Multi-Row Fetch
- SELECT from INSERT, UPDATE, DELETE or MERGE
- Use of GET DIAGNOSTICS

Multi-row Fetch

- **1 Trip returns 100 rows**

```
EXEC SQL
  DECLARE CURSOR1  CURSOR WITH ROWSET POSITIONING FOR
              SELECT   COL1,  COL2,  COL3
                 FROM  TABLE1
END-EXEC
MOVE   +100   TO   N
EXEC SQL
    FETCH  NEXT ROWSET FROM CURSOR1 FOR :N ROWS  INTO
      :COL1-ARRAY
   ,  :COL2-ARRAY
   ,  :COL3-ARRAY   :COL3-IND-ARRAY
END-EXEC
```

Multi-Row Fetch

```
    EXEC SQL
      DECLARE TABLE1 TABLE
       ( COL1   CHAR(100)
        ,COL2   DECIMAL(9,2)
        ,COL3   DATE)
    END-EXEC .
01   WORK-AREAS.
    03   COL1-ARRAY        OCCURS 100 TIMES  PIC X(100).
    03   COL2-ARRAY        OCCURS 100 TIMES  PIC S9(07)V9(02)  COMP-3.
    03   COL3-ARRAY        OCCURS 100 TIMES  PIC X(10).
    03   COL3-IND-ARRAY    OCCURS 100 TIMES  PIC S9(04) COMP.
    03   N                                    PIC S9(09) COMP.
```

```
EXEC SQL
DECLARE CURSOR1  CURSOR WITH ROWSET POSITIONING FOR
            SELECT     COL1,  COL2,  COL3
            FROM       TABLE1
END-EXEC
MOVE   +100   TO   N
EXEC SQL
   FETCH  NEXT ROWSET FROM CURSOR1 FOR :N ROWS  INTO
    :COL1-ARRAY ,  :COL2-ARRAY ,  :COL3-ARRAY   :COL3-IND-ARRAY
END-EXEC.
```

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Looping with Multi-Row Fetch

```
 PERFORM UNTIL EOF-FLG = 'Y'
    EXEC SQL FETCH NEXT ROWSET FROM MRFCUR FOR 10 ROWS
      INTO :hv1, :hv2, :hv3
    END-EXEC
    MOVE SQLERRD(3) TO WS-RETURNED
    MOVE SQLCODE TO WS-SQLCODE
    IF WS-SQLCODE = 100
       MOVE 'Y' TO EOF-FLG
    ELSE
       IF WS-SQLCODE NOT = 0
          PERFORM Z100-DB2-ERROR
       END-IF
    END-IF

******* LOOP WITHIN THE LOOP
    PERFORM VARYING SUB1 FROM 1 BY 1 UNTIL SUB1 >
                WS-RETURNED
          DISPLAY hv1(SUB1) hv2(SUB1) hv3(SUB1)
    END-PERFORM

END-PERFORM.
```

Multi-Row Insert

```
WORKING-STORAGE SECTION.
01  NUMBER-TO-INSERT                PIC S9(04) COMP.
01  COL1-ROWSET-ARRAY               OCCURS 10   PIC .....
01  COL2-ROWSET-ARRAY               OCCURS 10   PIC .....
01  COL3-ROWSET-ARRAY               OCCURS 10   PIC .....
01  INSERT-ROWSET-INDICATORS OCCURS 10   PIC .....

PROCEDURE DIVISION.
Populate arrays with values to insert
Set indicator variable elements as required
MOVE +10  TO  NUMBER-TO-INSERT
EXEC SQL
INSERT INTO TABLEA
  (COL1, COL2, COL3)
    VALUES   ( :COL1-ROWSET-ARRAY
               ,:COL2-ROWSET-ARRAY
               ,:COL3-ROWSET-ARRAY   :INSERT-ROWSET-INDICATORS
               )
FOR :NUMBER-TO-INSERT ROWS
NOT ATOMIC CONTINUE ON SQLEXCEPTION
END-EXEC
```

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Insert Processing comparison

100 Trips to DB2

```
01 TABLE_DCLGEN
~
PERFORM ~INS-LOOP 100 TIMES
~
INS-LOOP.
Read  1 input record &
  move data to columns
INSERT INTO TABLEA
 (COL1, COL2, COL3)
VALUES
 ( :COL1-ROWSET-ARRAY   ~   )
```

1 Trip to DB2

```
01  NUM-TO-INSERT          PIC S9(04) COMP.
01  COL1-ROWSET-ARRAY   OCCURS 100   PIC ~
~
Read 100  input records & move data to arrays
MOVE +100  TO  NUM-TO-INSERT
~
INSERT INTO TABLEA
 (COL1, COL2, COL3)
VALUES
 ( :COL1-ROWSET-ARRAY   ~   )
FOR :NUM-TO-INSERT ROWS
NOT ATOMIC CONTINUE ON SQLEXCEPTION
~
```

LOAD…… RESUME YES

Merge Processing

2 TRIPS TO DB2

```
SELECT ….
   FROM  T1 ….
IF SQLCODE = 0
  UPDATE  T1 …..
ELSE
IF SQLCODE = +100
  INSERT INTO T1 …
```

1 TRIP TO DB2

```
MERGE INTO T1
  USING (VALUES…)
        AS NEW (…)
 ON I.~ = NEW.~
WHEN MATCHED THEN
  UPDATE …
WHEN NOT MATCHED
THEN
  INSERT …
```

MERGE Statement, 1 trip to DB2


```
EXEC SQL
  MERGE INTO ITEM I
   USING (VALUES(:ITEMNO, :ITEMNAME) FOR 5 ROWS)
      AS NEWITEM ( ITEMNO, ITEMNAME)
   ON  I.ITEMNO = NEWITEM.ITEMNO
  WHEN MATCHED THEN
     UPDATE SET ITEMNAME = NEWITEM.ITEMNAME
  WHEN NOT MATCHED THEN
     INSERT (ITEMNO,ITEMNAME)
      VALUES (NEWITEM.ITEMNO,NEWITEM.ITEMNAME)
  NOT ATOMIC CONTINUE ON SQLEXCEPTION
END-EXEC.
```

GET DIAGNOSTICS Example

Example 1.

```
EXEC SQL
  GET DIAGNOSTICS
        :WS-ROW-COUNT = ROW_COUNT
      , :WS-COND-NUM   = NUMBER
END-EXEC
```

Example 2.

```
EXEC SQL
  GET DIAGNOSTICS      CONDITION 1
        :WS-SQLCODE    =
DB2_RETURNED_SQLCODE
      , :WS-SQLSTATE  = RETURNED_SQLSTATE
END-EXEC
```

Example 3.

```
   EXEC SQL
     GET DIAGNOSTICS
           :WS-TOT-COND = NUMBER
   END-EXEC
PERFORM  VARYING WS-COND-NUM FROM 1 BY 1
              UNTIL WS-COND-NUM IS GREATER THAN WS-TOT-COND
    EXEC SQL
       GET DIAGNOSTICS
         CONDITION :WS-COND-NUM
            :WS-SQLCODE    = DB2_RETURNED_SQLCODE
          , :WS-SQLSTATE  = RETURNED_SQLSTATE
          , :WS-ROW-NUM  = DB2_ROW_NUMBER
    END-EXEC
END-PERFORM
```

Delete Processing

- DELETE … WHERE key=unique_value
- DELETE … WHERE CURRENT OF
- DELETE … WHERE search-condition
- DELETE FROM tbname
- TRUNCATE TABLE tbname
  - IMMEDIATE
  - IGNORE DELETE TRIGGERS
- LOAD …. REPLACE
  //SYSREC DD DUMMY
- REORG …. DISCARD --*will be deprecated in future releases*

Returning Modified Data

- SELECT ….. FROM FINAL TABLE
  - (INSERT INTO tbname ……)
  - (UPDATE tbname ……)
  - (MERGE INTO tbname ……)
- SELECT ….. FROM OLD TABLE
  - (DELETE FROM tbname ……)
  - (UPDATE tbname ……)

Minimizing Trips to DB2, DBAT Threads

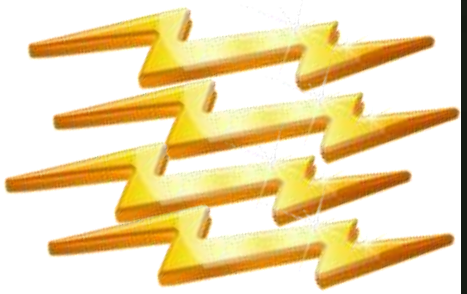
- SQL enabled block fetching for Distributed apps
  FOR FETCH ONLY
  OPTIMIZE FOR n ROWS
  EXTRASRV -- subsystem parameter
- Enable package-based continuous block fetch
  Bind: DBPROTOCOL(DRDACBF).for z/OS client
- FETCH FIRST n ROWS ONLY clause in a distributed query for fast implicit close **Caution!**
- Use V11 Array datatypes
- Move SQL from client to DB2 (Stored Procedures)

Network Traffic

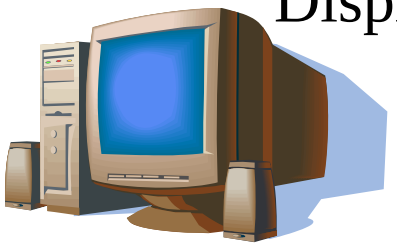
Receive Request

Validation

Get Data
Process Data



Display Result



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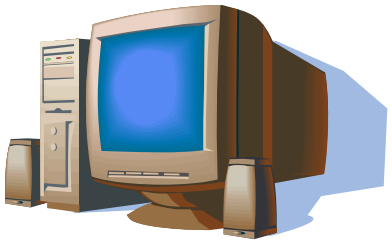
Solution

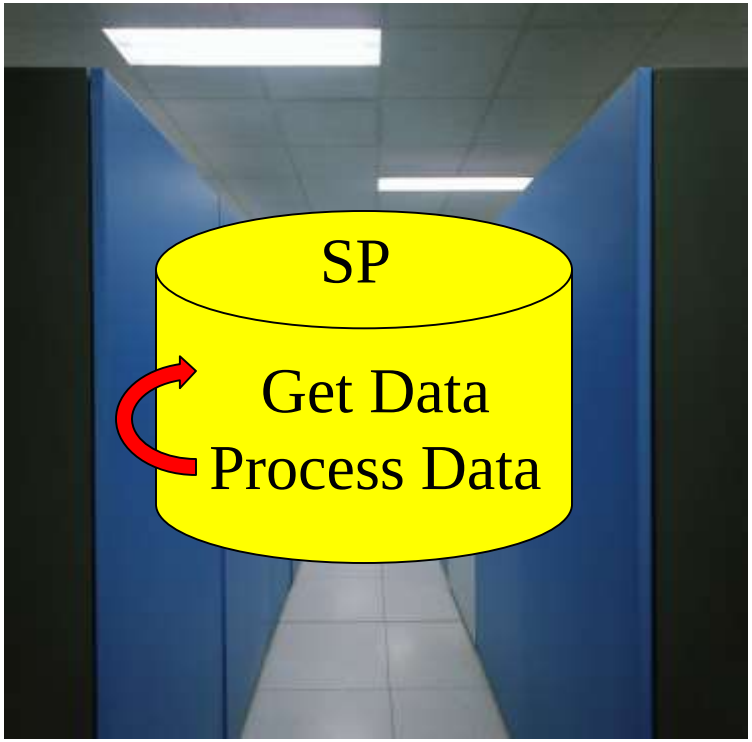
Receive Request

Validation

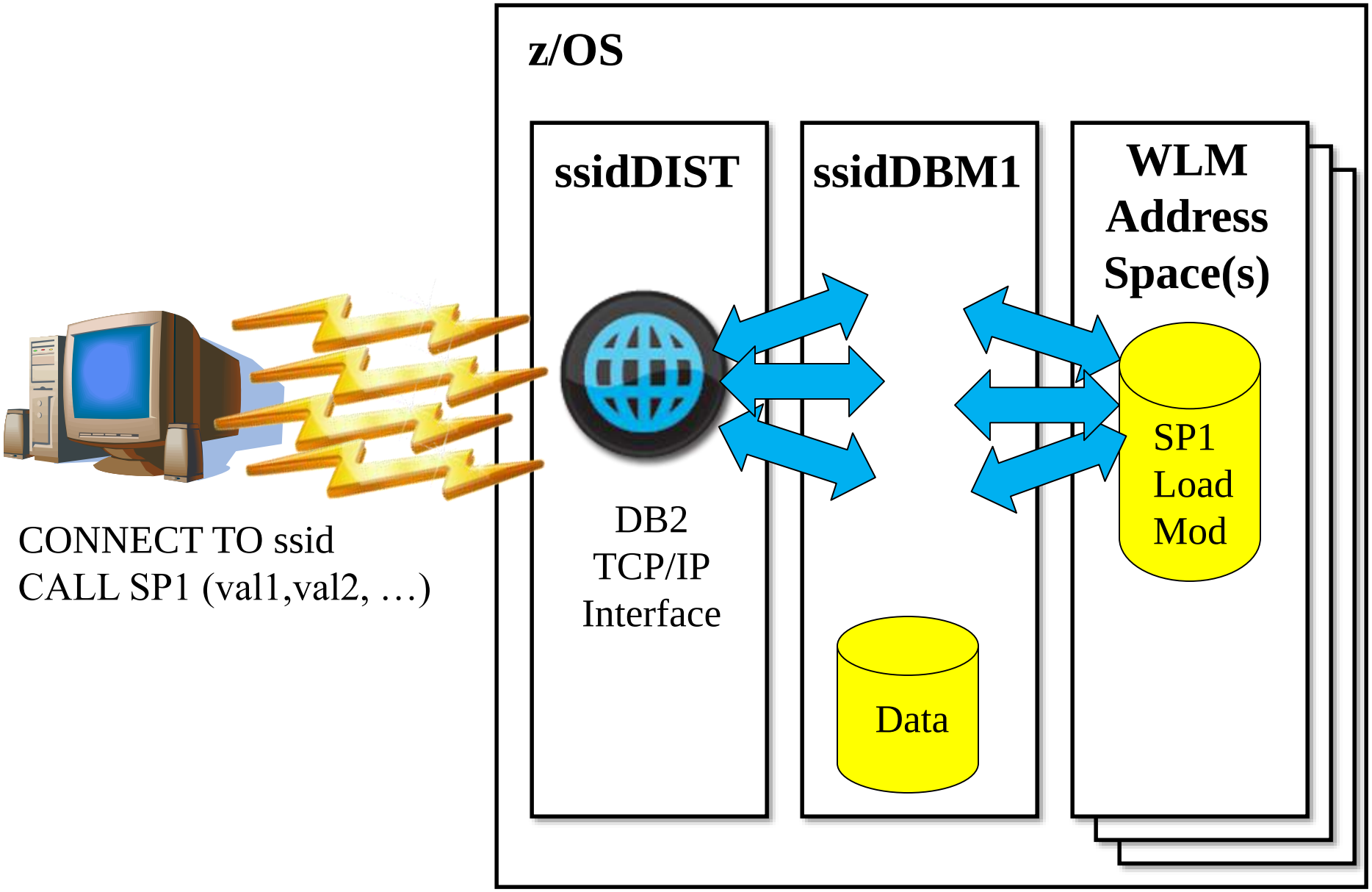
Call Procedure

Display Result

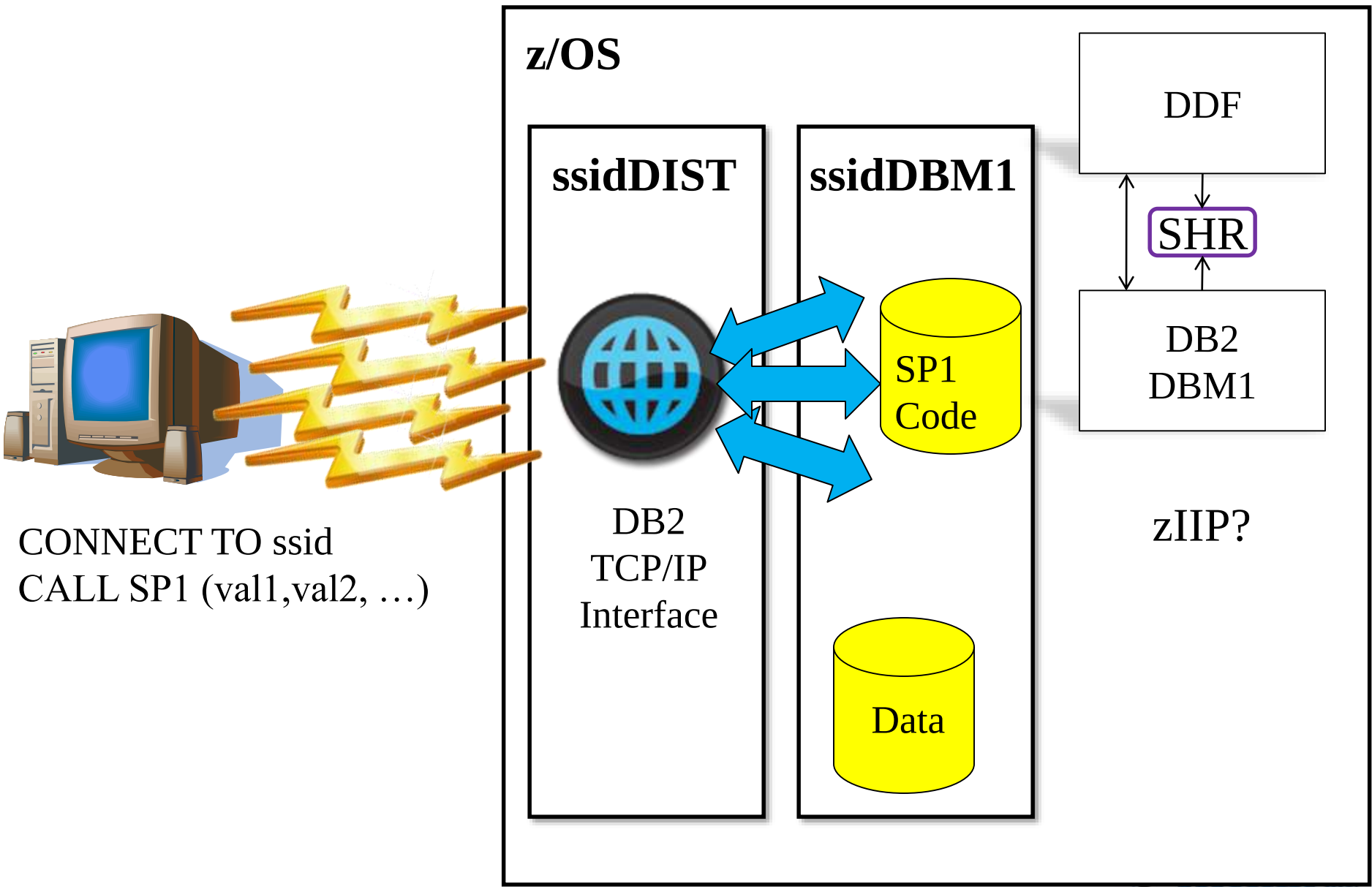




External Stored Procedures



Native Stored Procedures



Bind Options

- BIND/REBIND ……..
- ISOLATION (CS | RR | RS | UR | NC)
- CURRENTDATA (**NO** | YES)
- DBPROTOCOL (DRDA | **DRDACBF**)
- RELEASE (COMMIT | **DEALLOCATE**)
- CONCURRENTACCESSRESOLUTION (USECURRENTLYCOMMITTED | WAITFOROUTCOME)

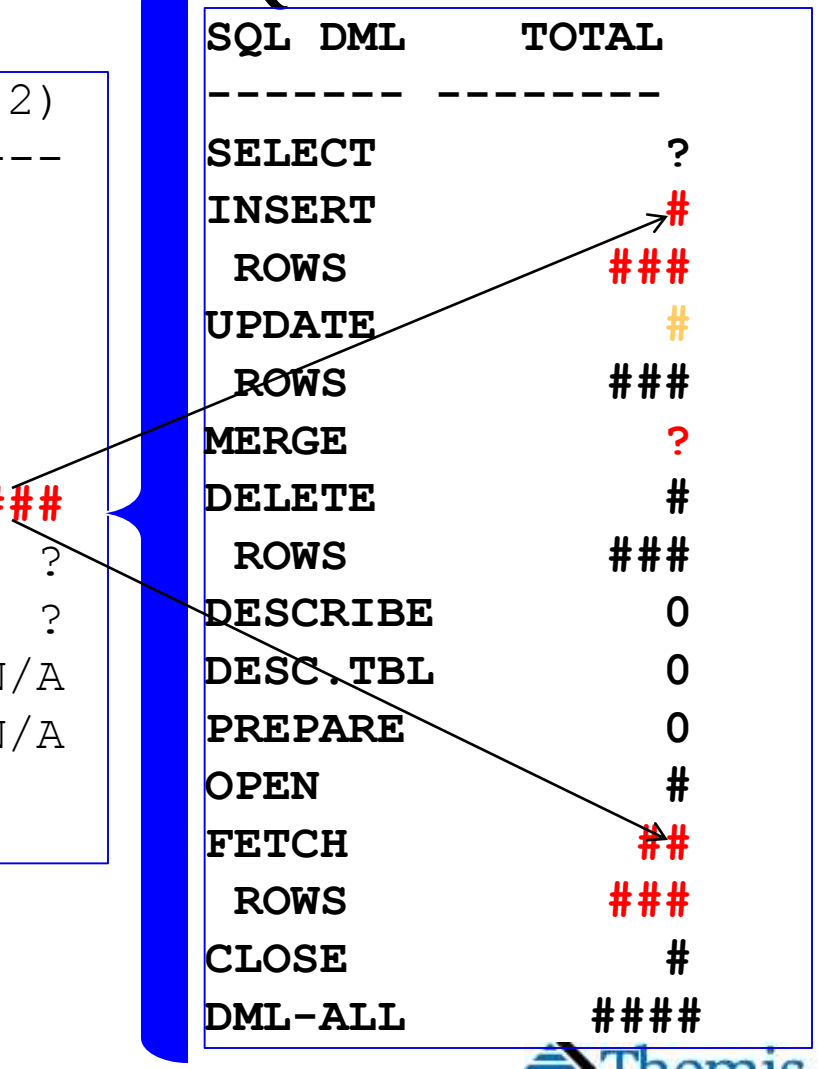
Review Accounting Trace

DB2 ENT/EXIT

TIMES/EVENTS	APPL(CL.1)	DB2 (CL.2)
ELAPSED TIME	~	
CP CPU TIME	~	
SE CPU TIME	~	
SUSPEND TIME	~	
NOT ACCOUNT.	~	
DB2 ENT/EXIT	N/A	###
EN/EX-STPROC	N/A	?
EN/EX-UDF	N/A	?
DCAPT.DESCR.	N/A	N/A
LOG EXTRACT.	N/A	N/A

SQL DML

SQL DML	TOTAL
SELECT	?
INSERT	#
ROWS	###
UPDATE	#
ROWS	###
MERGE	?
DELETE	#
ROWS	###
DESCRIBE	0
DESC.TBL	0
PREPARE	0
OPEN	#
FETCH	##
ROWS	###
CLOSE	#
DML-ALL	####



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Sample Run Time Results Comparisons

- Run: ODYLC.SP5N00:V1(CHAR(3), INTEGER)
  - Base table cursor
  - Fetch/Insert into DGTT
  - Open Cursor on DGTT
  - Query execution time => 820 ms
- Run: ODYLC.SP5N00:V2(CHAR(3), INTEGER)
  - Mass insert into DGTT from Base Table
  - Open Cursor on DGTT
  - Query execution time => 570 ms
- Run: ODYLC.SP5N00:V3(CHAR(3), INTEGER)
  - Cursor with Return on Base Table
  - Query execution time => 290 ms

Minimizing Trips to DB2 Recap

- Review Long running units of work (DSN messages)
- CODE Reviews
  - Avoid unnecessary SQL Statements
  - Perform loops
  - Application join vs. SQL Join
  - Use output only Updates/Deletes where possible
  - Use ROWSET processing
- Accounting Trace
  - ENT/EXIT Events
  - Compare to SQL DML
  - Plus overall performance
- OPEN Discussion/Questions

Recommendations

1. Identify Threads with high DB2 ENT/EXIT Events
2. Identify Long Running Threads
3. Implement standardized Code Reviews
4. Ban the words ***NEVER & ALWAYS***
5. Choose more than 1 solution
6. Test each solution
7. Implement

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