IBM eServer J iSeries J

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# DB2 UDB: Making IBM's ODBC Fly!

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## Agenda

- Introduction
- Performance Considerations
  - Application Design
  - Network
  - Database Design
- Summary
- Appendices

## Introduction





## Performance Considerations

- **Application design**
- Network
- Database design

## Application Design Overview

- Choice of programming interface
- Tips on calling ODBC APIs
- Block insert
- Isolation level and concurrency





## Choosing a Programming Interface

- If you use a higher level language, e.g. ADO, you should understand how an ADO call gets converted to multiple ODBC calls.
- Write ODBC 3.x APIs: Don't use 2.x APIs for new applications
  - Coding directly to the ODBC APIs allows application to take advantage of server-specific features, e.g. block insert. Also you have better control of your application

## ODBC Tips

- Leave application connected
- Allocate statement once – statement pooling
- Prepare statement once/execute statement repeatedly
- Use bound variables on fetch APIs
  - Use the right one (SQLFetch, SQLFetchScroll, SQLExtendedFetch) with right block size
  - SQLBindCol vs. SQLGetData
  - Rebinding with new offset
- Do not call API to get the proper returned buffer length if length can be known in advance



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## ODBC Tips

- Use parameter markers
- Perform domain/validity checking at the client: avoid scalar functions, etc... but make sure rules match those at the server

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## Block Insert Example 1

Example1:  Insert with Constants

```
/*****************************************/
/* repeat for each row to be inserted */
/*****************************************/
strcpy(stmt,"insert into IBMLIB.TAB1 values('ax',123,'c')");

rc = SQLExecDirect(hStmt,stmt,SQL_NTS);
:
```



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## Block Insert Example 1

Example 1 comments:

- Gets the job done, but:
  - Requires full parse for each statement
  - Requires full open/close of target table on server
  - Requires send/receive for each row

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## Block Insert Example 2

Example 2: Insert with Parameter Markers

```
strcpy(stmt,"insert into IBMLIB.TAB1 values (?,?,?)");
rc = SQLPrepare(hStmt,stmt,SQL_NTS);
/* Set bind variables for each parameter marker */
rc = SQLBindParameter(hStmt, .... )
:
for (i=0;i<ROW_COUNT;i++) {
    /* Set variables for corresponding parameter */
    /* markers, and then execute the statement.  */
      strcpy(col1,value);
      rc = SQLExecute(hStmt);
 }
```



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## Block Insert Example 2

Example 2 comments:

- Better than constants because:
  - Doesn't require parsing
  - Doesn't require full open/close of target table
  - Still requires flows for each statement

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## Block Insert Example 3

```
Example 3:  Blocked Insert

/* Note, the "? rows" clause is needed when accessing pre-V5R1 systems */
strcpy(stmt,"insert into IBMLIB.TAB1 values (?,?,?)");

rc = SQLPrepare(hStmt,stmt,SQL_NTS);

rc = SQLSetStmtAttr(hStmt,SQL_ATTR_PARAMSET_SIZE,
       (PTR)ROW_COUNT,SQL_IS_INTEGER);

/* Set bind variables for each parameter marker */
rc = SQLBindParameter(hStmt, .... )
:
for (i=0;i<ROW_COUNT;i++) {
        /* Set variables in the array for corresponding parameter */
        /* markers, and then execute the statement.                */
        strcpy(col1[i],value);
        :
 }
rc = SQLExecute(hStmt);
```





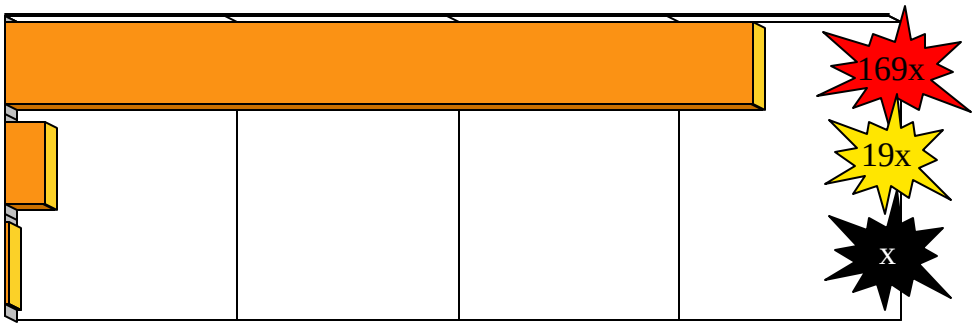
## Block Insert Example 3

Example 3 comments:

- Best alternative because:
  - Parsed only once
  - Avoids full open/close of target table
  - 1 send/receive for N rows
  - Path optimized from client->database
- Drawbacks
  - May not be practical for all applications
  - AS/400 only feature if "? rows" clause is used

## Block Insert Performance

For 500 36-byte rows with three columns



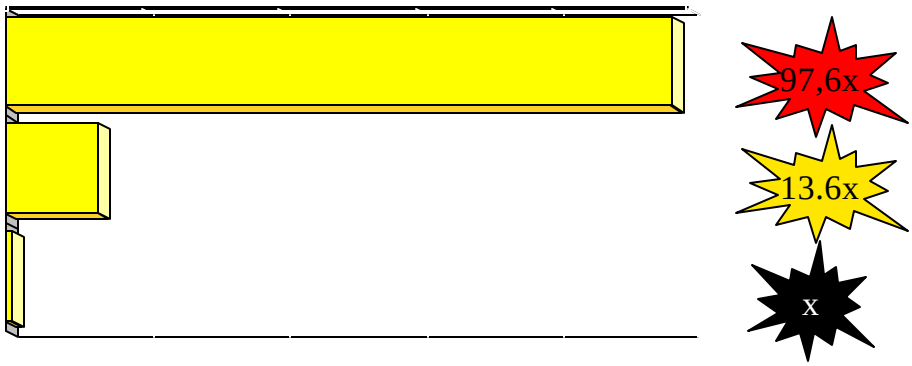

Server CPU time (169x, 19x, x)





## Block Insert Performance

For 500 36-byte rows with three columns

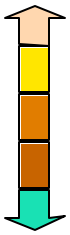



Response Time (97.6x, 13.6x, x)

## Isolation Level

- By default, ODBC runs with autocommit ON
  - Equivalent to *NONE on iSeries
- Must use SQLSetConnectAttr to turn autocommit OFF to use other isolation levels
- Use lowest level of transaction isolation for least overhead

| | Isolation Level | Overhead |
|---|---|---|
| (*NONE) | Commit immediate | less |
| (*CHG) | Read uncommitted | |
| (*CS) | Read committed | |
| (*ALL) | Repeatable read | |
| (*RR) | Serializable | more |







## Concurrency

- Concurrency is ability of two transactions to use the same data at the same time
- Increasing isolation level leads to reduction in concurrency
- Use appropriate ODBC cursor concurrency setting (SQL_ATTR_CONCURRENCY)
- Avoid “Open all cursors as updatable” DSN setting

## Application Design Summary

- Write directly to the APIs for greatest control
- Use parameter markers:
  - SQLPrepare once, SQLExecute many times
- Use blocking
- Set appropriate isolation level





## Application Design Summary

- General ODBC tips & techniques
  - http://www.ibm.com/as400/developer/client/index.html
- ODBC DSN keywords
  - http://publib.boulder.ibm.com/iseries/v5r2/ic2924/index.h

## Performance Considerations

- Application design
- **Network**
- Database design





## Network

- About 1/3 of ODBC performance problems are actually network performance problems
- ODBC sends much larger blocks of data then most applications

## CWBCOPWR

- Found in \Program Files\IBM\Client Access directory
- See CWBCOPWR.HTM for help
- Options to concentrate on:
  - Communication buffer size (Option /SC)
  - TCP/IP buffer size (Options /WSS and /WSR)
  - TCP/IP nagling (Option /NGL)





## Reduce Trips to Server

- Ways to reduce trips
  - Stored procedures
  - Triggers
  - Connection pooling
  - Block inserts
  - Block fetches
  - Block with fetch of 1 row
  - Lazy close
  - Pre-fetch

## Reduce Data Sent to Server

- Ways to reduce data
  - Data compression
  - LOB threshold
  - Catalog library list
  - Avoid “select *” SQL statements





## Data Compression

- “Enable Data Compression” DSN setting ON by default
- Can be activated at the connection level or statement level
- Highly recommended for variable length field with repetitive characters, e.g. VARCHAR, VARGRAPHIC
- New compression algorithm in V5R1
  - compression of data from and to server
  - also supports double byte characters

## Network Summary

- Reduce Trips to Server
- Reduce Data Sent to Server
- Use Data Compression



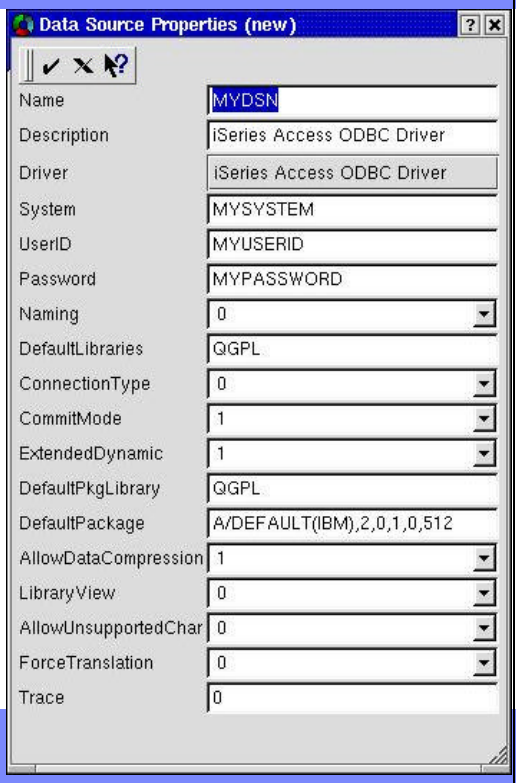


## Windows ODBC DSN GUI

- Performance tab
- Advanced performance options

## Linux ODBC DSN GUI

- ExtendedDynamic
- AllowDataCompression
- Other options are added to the .odbc.ini file or programmatically specified via SQLDriverConnect API








## Performance Considerations

- Application design
- Network
- **Database design**

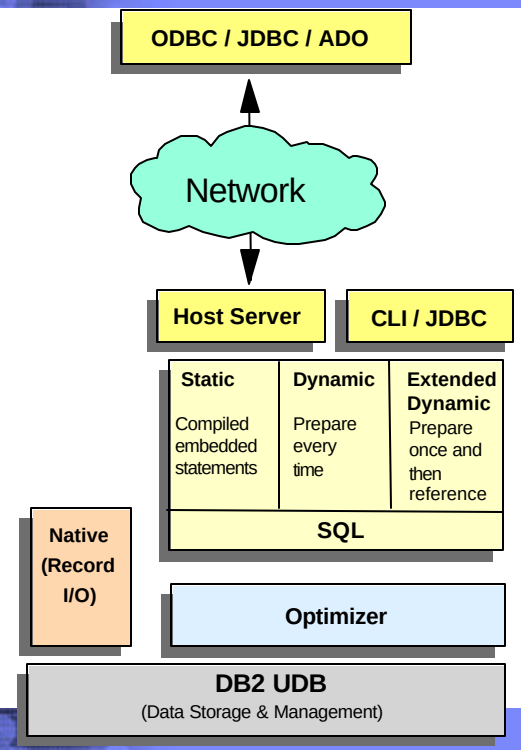
## Database Design Overview

- Indexes
- Extended dynamic support
- Stored procedures
- Trigger programs





## SQL Interfaces



## SQL Statement Tuning

- Avoid SELECT *
- SQL clauses:
  - FOR FETCH ONLY / FOR UPDATE
  - FETCH FIRST N ROWS ONLY





## Indexes

- Two methods for accessing data--keyed and sequential
  - Lack of understanding can seriously impact performance
- Aimed specifically at optimizing queries (SELECTs)
- Most important aspect--proper indices for queries

## Indexes

- Index is required for following cases:
  - ORDER BY
  - GROUP BY
  - JOIN of two tables
- Optimizer will create index if an appropriate one doesn't exist



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## Indexes

- Create index over tables when queries return less than 20% of table
  - Create index over columns used in WHERE clause
  - Create index over columns used to join tables
  - Create index on grouping columns

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## Access Plans and ODPs

- Minimize access plan builds
  - Access plans are the “way query is processed to retrieve result data”
  - Reduces CPU use on server
  -
- Reuse (Open Data Path) ODPs
  - An important performance tuning tip
  - Prepare once/run many, statement pooling, connection pooling, use parameter markers, etc
  - Cache package locally (statement names are reused, hence ODP is reused)





## Extended Dynamic Access

- Caches SQL statements on server or local
- Allows reuse of statements
  - Prepare once, execute multiple times (cross sessions)
- Statements can be shared among many users (cross sessions)

## Extended Dynamic Access

- Extended dynamic option can have the biggest impact IF parameter markers are used. Also can reuse the ODP by using the local cache.
- Package can become unusable if package attributes do not match application
  - Different CCSID, Date & time format attributes, decimal delimiter, default collection, etc
  - With ODBC packages, a default collection for unqualified names can be specified - if package already exists and the client application has a different default collection, then package cannot be used
  - If package unusable, new requests are executed as "pure" Dynamic SQL





## Stored Procedures

- Powerful tool--accepts input parameters, returns output parameters
- SQL procedure
- Stored procedure as external procedure
  - Does not need to contain SQL
  - Can be any C, RPG, CL, COBOL, Java program
- Can return multiple result sets
- Can hide details of application from user

## Stored Procedures

- Stored Procedures can be utilized to provide...
  - Static SQL performance behavior to dynamic ODBC & JDBC client requests
  - Access to tuning knobs/precompiler options such as ALWCPYDTA, etc





## Stored Procedures Example 1

Example:
Logic to execute 2 statements w/o stored procedure:

```
/* Application runs INSERT statement - if the     */
/* statement is successful, it runs an UPDATE   */
/* statement.                                                */
strcpy(stmt,"INSERT INTO IBMLIB.TAB1 VALUES(?,?,?)");
rc=SQLPrepare(hstmt1,stmt,SQL_NTS);
strcpy(stmt2,"UPDATE IBMLIB.TAB2 SET COL1 = ...");
rc=SQLPrepare(hstmt2,stmt2,SQL_NTS);
rc=SQLBindParameter(hstmt1,... );
:
rc = SQLExecute(hstmt1);
if (rc==SQL_SUCCESS)
 {
       rc=SQLExecute(hstmt2);
       if (rc==SQL_SUCCESS)
       :
```

## Stored Procedures Example 2

Example:
Logic to execute the same statements using stored procedure:

```
/* Application invokes stored procedure passing all      */
/* the parameters necessary for both the INSERT and */
/* UPDATE statement                                      */
strcpy(stmt,"CALL IBMLIB.PROC1 (?,?,?)");
rc = SQLPrepare(hstmt1,stmt,SQL_NTS);
rc = SQLBindParameter(hstmt1,... );
:
rc = SQLExecute(hstmt1);
if (rc==SQL_SUCCESS) {
   :
```





## Stored Procedures – Executing CL Commands

- Execute system CL commands via the QCMDEXC stored procedure
- CALL QSYS/QCMDEXC ('CHGQRYA QRYTIMLMT (0)', 0000000021.00000)
  - 21 is the character length of the CL command string
- Call a stored procedure that executes system commands or utilities like STRDBMON

## Trigger Programs

- Based on target file/table
- Invoked for each INSERT/UPDATE/DELETE against the table as defined by the triggers
- Advantage over stored procedures
  - Better performance (marginal)
- Caveat:  All operations, regardless of origin, fire the trigger program





## Exit Programs For Job Initialization

- When a JDBC or ODBC job (QZDASOINIT) is initiated in subsystem (QSERVER), the registered exit program is called automatically
- Add program to exit point for ODBCINIT via WRKREGINF CL command at QIBM_QZDA_INIT
- Example:  Create an exit program with CL that conditionally activates debug mode (STRDBG UPDPROD(*YES) ) so that you can see the optimizer debug messages for an ODBC or JDBC request

## Database Design Summary

- Understand your application and the queries it runs
- Identify most frequently used selection/join columns
- Create indices where needed
- Use extended dynamic access
- Use stored procedures where possible





## Additional Client-side Information

- ODBC
  - http://publib.boulder.ibm.com/iseries/v5r2/ic2924/index.htm?info/rz
  -
- OLE-DB
  - See OLE-DB Tech Ref installed with iSeries Access
  -
- JDBC
  - http://publib.boulder.ibm.com/iseries/v5r2/ic2924/index.htm?info/rz

## Additional Information

- DB2 UDB for iSeries home page
  - http://ibm.com/servers/eserver/iseries/db2/
- Newsgroups
  - comp.sys.ibm.as400.misc
  - comp.databases.ibm-db2
- Education Resources - Classroom & Online
  - http://ibm.com/servers/eserver/iseries/db2/db2educ_m.htm
- DB2 UDB for iSeries Publications
  - Online Manuals: http://ibm.com/servers/eserver/iseries/db2/books.htm
  - Indexing Strategies for DB2 UDB for iSeries: http://www.iseries.ibm.com/developer/bi/documents/strategy/strategy.pdf
  - DB2 UDB for AS/400 Redbooks (http://ibm.com/redbooks)
    - DB2 UDB for AS/400 Object Relational Support (SG24-5409)
    - DB2/400 Advanced Database Functions (SG24-4249-02)
- New book - SQL/400 Developer's Guide by Paul Conte & Mike Cravitz
  - 29th Street Press, ISBN 1-882419-70-7
  - http://as400network.com/str/books/Uniquebook2.cfm?NextBook=183





## Database Tools

- Graphical
  - Centerfield Technology DB Essentials
    - http://www.centerfieldtechnology.com
  - Client Access Operations Navigator
    - http://www-1.ibm.com/servers/eserver/iseries/access/
  - Visual Explain
    - http://publib.boulder.ibm.com/iseries/v5r2/ic2924/info/rzajq/rzajqmstvisexpl
- Text-based
  - DBMON (Database monitor)
  - Debug joblogs
  - SST (iSeries Communication Trace)
  - ODBC trace (SQL.LOG)

# DB2 UDB Tech Tip: Improving Query Performance

- DB2 UDB for iSeries has a phenomenal query optimizer built into it.
  - without the DB2 Symmetric Multiprocessing (SMP) feature your SQL database tasks and index bui running single-threaded?
  - the DEFAULT system tuning setup could be significantly hindering ODBC performance?
  - the database utility called DB2 OLAP can provide sub-second response times to complex queries?
- For more information about query optimization, check out these resources:
  - S6140 - DB2 UDB for iSeries SQL and Query Performance Tuning and Monitoring Workshop:
    - http://www-3.ibm.com/servlet/com.ibm.ls.lsow.servlets.CourseDescriptionServlet?coursecod
  - White paper: "Indexing Strategies for DB2 UDB for iSeries"
    - http://www-919.ibm.com/servers/eserver/iseries/developer/bi/documents/strategy/strategy.p
  - DB2 Symmetric Multiprocessing and DB2 OLAP Utilities:
    - http://isource.ibm.com/cgi-bin/goto?on=c4268db2/products





# Performance Service Tips

- Before calling SupportLine with a query performance problem...
  - Run query in DEBUG mode and check JOBLOG
    - Index recommendations
    - Understand query implementation
  - Check resources and Work Management
    - QQRYDEGREE or CHGQRYA
    - Memory and MAX ACTIVE settings
    - What else is running?
    - Does QQQOPTIONS data area exist?
  - Check file stats
    - Size of objects, number of rows
    - Number of indexes
  - Understand your data
  - Save JOBLOGs and system settings

## Summary

- Understand tradeoffs for performance
- Application Design:
  - Use parameter markers
  - Isolation level
- Network:
  - Use data compression
  - Use blocking
- Database Design:
  - Indexes
  - Use extended dynamic
  - Use stored procedures





## Appendices

## Appendix A1

- Extended dynamic access
- Use the extended dynamic feature of iSeries Access ODBC driver (also available to iSeries JDBC Toolbox driver)
  - Feature externalized as data source option
  - Used in conjunction with "Cache Package Locally" option, the majority of reuse processing will occur on client - especially with SQLExecDirect
  - Allows for private or shared packages





## Appendix A2

- Extended dynamic
  - Use PRTSQLINF command on the iSeries to dump the package containing your statements
  - PRTSQLINF produces spoolfile showing syntax and optimization information
  - Use PRTSQLINF to ensure all SELECT statements have parameter markers

# Appendix A3

Extended Dynamic
Sample PRTSQLINF output:

```
5722SS1 V5R2M0 030905     Print SQL information         SQL package QGPL/ODBCXXXFBA
Object name.............QGPL/ODBCXXXFBA
Object type.............*SQLPKG
  CRTSQL***
     PGM(QGPL/ODBCXXXFBA)
     SRCFILE(        /        )
     SRCMBR(         )
     COMMIT(*NONE)
     OPTION(*SQL *PERIOD)
     TGTRLS(*PRV)
     ALWCPYDTA(*OPTIMIZE)
     CLOSQLCSR(*ENDPGM)
     STATEMENT TEXT CCSID(37)
STATEMENT NAME:  QZ84DC1FE6AC488000
select * from qiws.qcustcdt where lstnam=?
  SQL4021  Access plan last saved on 09/16/02 at 12:47:36.
  SQL4020  Estimated query run time is 1 seconds.
  SQL4027  Access plan was saved with DB2 UDB Symmetric Multiprocessing installed on the system.
  SQL4010  Table scan access for table 1.
  :
```





# Appendix A4

- Extended dynamic access
- The following SQL statements are put into extended dynamic packages:
  - Statements that contain parameter markers
  - INSERT with subselect
  - Positioned UPDATE or DELETE
  - SELECT FOR UPDATE
  - DECLARE PROCEDURE
  - Can force all SELECT statements into package by adding Debug=4 to your SQLDriverConnect connection string (if Debug keyword already exists, add 4 to the value instead of overriding it with 4)

## Appendix A5

- Extended dynamic access
- First time an SQL statement is prepared, the package is created (if it doesn't exist yet)
- Can specify a name and location for package on the data source or let the system do that work
  - Default ODBC SQL package name is created by taken the first 7 characters of the application name and appending 3 letters that are encoding of the package configuration attributes
    - Default package name for Lotus Approach would be: APPROACFBA
    - New setup GUI allows setting of package name for a specific application
  - Default library determined by data source configuration





## Appendix B

- Data compression of ODBC data
  - Can be activated at the connection level or statement level
  - Connection level settings
    - COMPRESSION=1 in SQLDriverConnect connection string OR...
    - SQLSetConnectAttr(hdbc, 2106, 1) OR...
    - “Enable Data Compression” option on ODBC DSN setup GUI
  - Statement level settings
    - SQLSetStmtAttr(hstmt, 2106, 1)
  - Delivered via V4R2 PTF SF49349 and V4R3 PTF SF51501

## Appendix C

- How do you determine which ODBC server job (QZDASOINIT) is the one that you want to analyze?
  - WRKOBJLCK OBJ(userid) OBJTYPE(*usrprf)
  - Returns the QZDASOINIT job servicing your ODBC request
- In V5R1, job information can be obtained by calling SQLGetConnectAttr API with option 2110.





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