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Session: 401918
Agenda Key: 56CB

@server iSeries

Performance Tune iSeries Access ODBC

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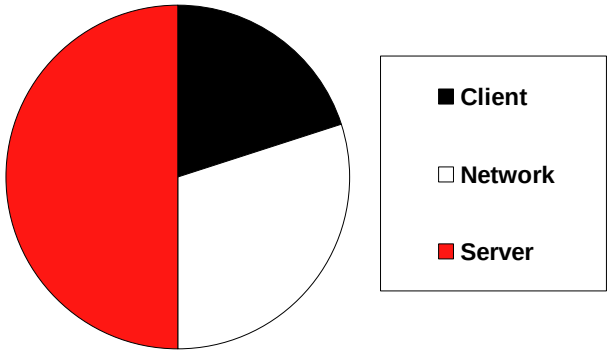
Typical Performance Problems

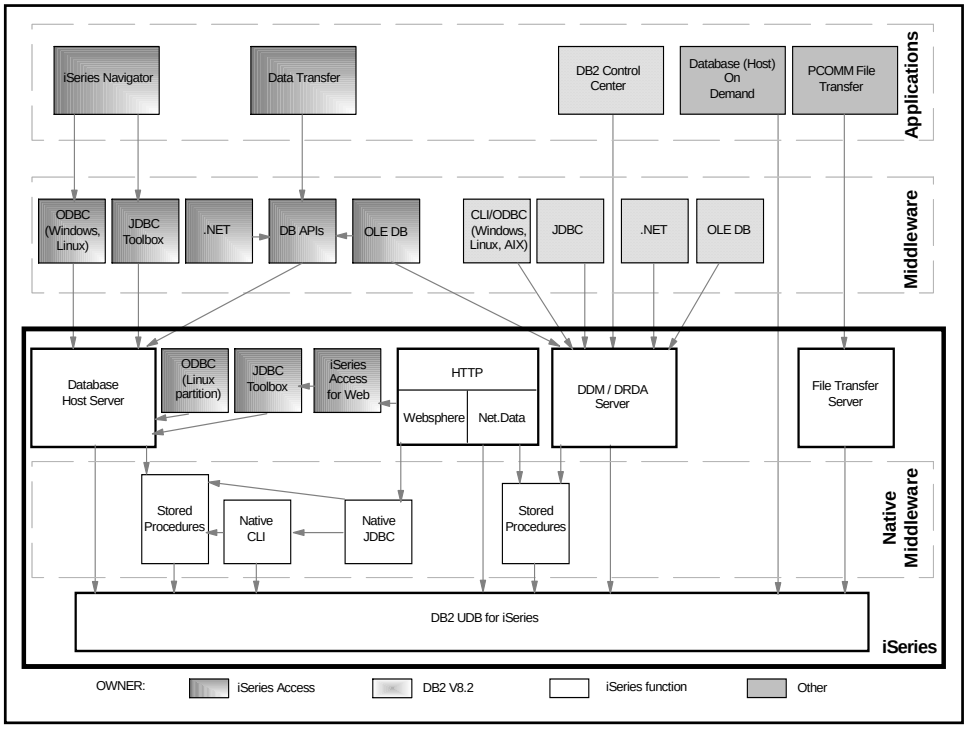
- Fetching data
- Long-running SQL queries
- Network issues
- Inserting data
- Lots of connections

Typical Performance Problems



Agenda

- Performance Considerations
  - Application Design
  - Network
  - Database Design
- Examples
  - 3-Tier Application
  - Off-the-shelf Applications
- Appendices



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Performance Considerations

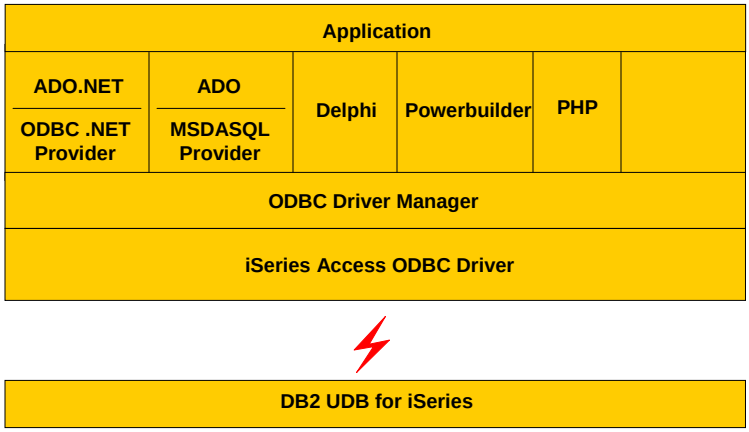
- **Application design**
  - Choice of programming interface
  - Tips on calling ODBC APIs
  - Block insert
  - Isolation level and concurrency
- Network
- Database design

Explanation of Scale

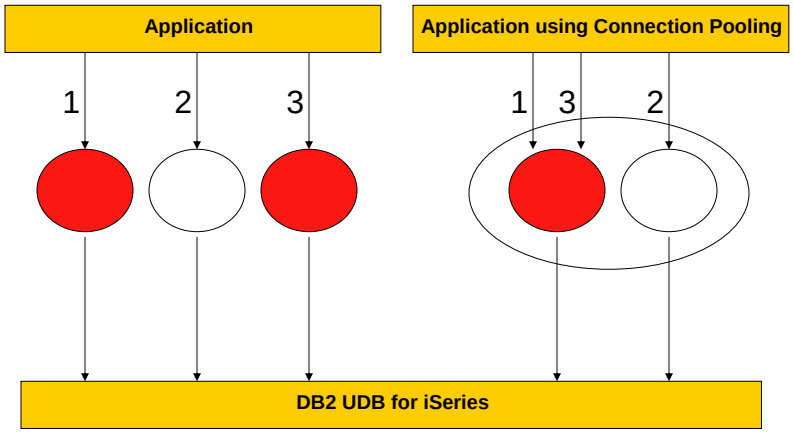
Programming Required?	Potential Benefit
Y	3
Y = Yes N = No	1 = Low 2 = Medium 3 = High

Y 2

Choosing a Programming Interface



Connection Pooling



Running SQL statements

- Statement pooling
- Use parameter markers (?'s)
- "Prepare once, Execute many" method

Insert Data - 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);
:
```


Insert Data - Prepare Once, Execute Many

```
strcpy(stmt,"insert into IBMLIB.TAB1 values (?,?,?)");
rc = SQLPrepare(hStmt,stmt,SQL_NTS);

/* Specify the bindings for each parameter */
rc = SQLBindParameter(hStmt, .... );

for (i=0;i<ROW_COUNT;i++) {
  /* Set variables for corresponding parameter markers */
  strcpy(col1,value);
  rc = SQLExecute(hStmt);
 }
```

Insert Data – Block Insert

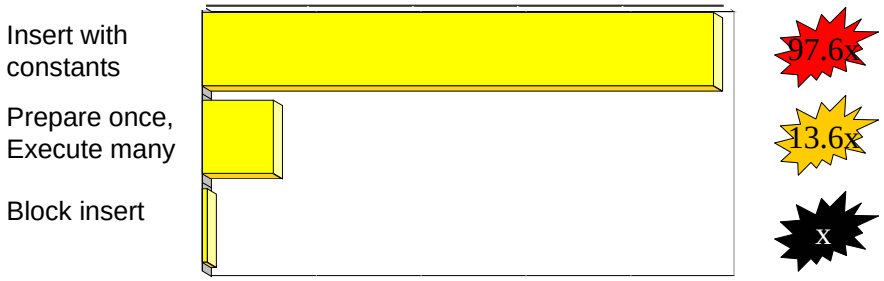
```
strcpy(stmt,"insert into IBMLIB.TAB1 values (?,?,?)");
rc = SQLPrepare(hStmt,stmt,SQL_NTS);

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

/* Specify the bindings for each parameter */
rc = SQLBindParameter(hStmt, .... );

for (i=0;i<ROW_COUNT;i++) {
  /* Set variables for corresponding parameter markers */
  strcpy(col1[i],value);
 }
rc = SQLExecute(hStmt);
```


Insert Data - Block Insert Notes

- 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



Deleting data

- Consider:

CALL QSYS.QCMDEXC('CLRPFM FILE(MYLIB/MYFILE)',0000000025.00000)

- Instead of:

DELETE FROM MYLIB.MYFILE

Fetching Data - Blocking

- Options that factor into blocking factor
  - Forward-only cursor
    - Block fetch of 1 row - (BLOCKFETCH keyword)
    - Block size – (BLOCKSIZE keyword)
    - Rowset size
  - Scrollable cursor
    - Rowset size

Fetching Data - Forward-only cursor examples

- Table retrieving from has a 32K row size
- **Example 1:**
  - Application is fetching one row at a time
  - Block fetch of 1 row is being used with a Block Size of 32K
  - Results: 1 Row at a time is fetched
- **Example 2:**
  - Application is fetching one row at a time
  - Block fetch of 1 row is being used with a Block Size of 512K
  - Results: ~16 Rows are fetched at a time
- **Example 3:**
  - Application is fetching with a rowset size of 50 rows
  - Results: 50 Rows are fetched at a time

Fetching Data - Scrollable cursor examples

- Table retrieving from has a 32K row size
- Example 1:
  - Application is fetching one row at a time
  - Results: 1 Row is fetched at a time
- Example 2:
  - Application is fetching with a rowset size of 50 rows
  - Results: 50 Rows are fetched at a time

Fetching Data – LOB threshold

- MAXFIELDLEN keyword
- Default is 32 (KB)
- Lower setting usually better

Fetching Data – Other Notes

- SQLBindCol vs. SQLGetData

Isolation Level

- By default, ODBC runs with autocommit ON
  - Equivalent to *NONE on pre-V5R3 iSeries
- 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

Application Design Summary

- Use parameter markers
- SQLPrepare once, SQLExecute many times
- Use blocking effectively

Performance Considerations

- Application design
- **Network**
  - Reduce Trips to Server
  - Reduce Data Between Server
- Database design

Network

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

Reduce Trips to Server

- Stored procedures
- Triggers
- Connection pooling
- IP Address lookup in iSeries Navigator connection properties
- Port lookup in iSeries Navigator connection properties
- Block inserts
- Block fetches
- Lazy close
- Pre-fetch

Reduce Data Between Server

- Data compression
- LOB threshold
- Avoid “select *” SQL statements

N 3

Data Compression

- “Enable Data Compression” DSN setting ON by default
- Highly recommended for variable length fields
  - e.g. VARCHAR, VARGRAPHIC
- Improved compression algorithm on V5R1+ servers

CWBCOPWR

- Options to concentrate on:
  - Communication buffer size (Option /SC)
  - TCP/IP buffer size (Options /WSS and /WSR)
  - TCP/IP nagling (Option /NGL)

- Found in \Program Files\IBM\Client Access directory
- See CWBCOPWR.HTM for help

Network Summary

- Reduce Trips to Server
- Reduce Data Between Server

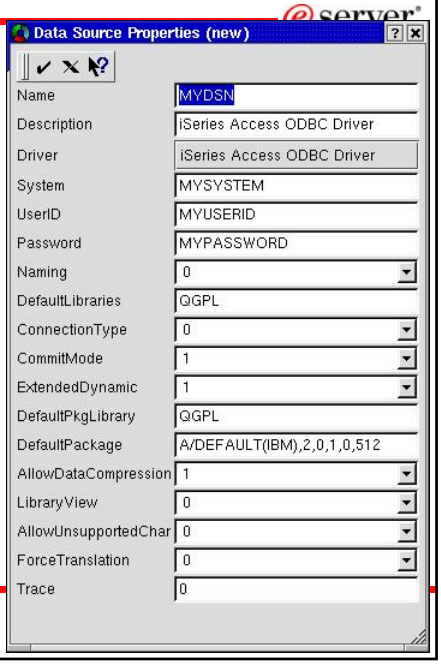
Windows ODBC DSN Setup GUI

- Performance tab
- Advanced performance options
- Package tab

- ODBC DSN keywords
  - http://publib.boulder.ibm.com/iseries/v5r2/ic2924/index.htm?info/rzaik/rzaik678.htm

Linux ODBC DSN GUI

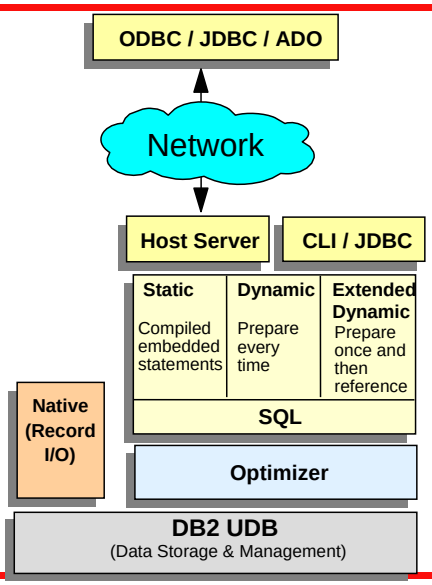
- Other options added to the .odbc.ini file or programmatically specified via SQLDriverConnect API



Performance Considerations

- Application design
- Network
- Database design
  - Indexes
  - Extended dynamic support
  - Stored procedures
  - Trigger programs

SQL Interfaces



SQL Statement Tuning

- Avoid SELECT *
- SQL clauses:
  - OPTIMIZE FOR N ROWS
  - 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

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

- White paper: "Indexing Strategies for DB2 UDB for iSeries"
  - http://www-919.ibm.com/servers/eserver/iseries/developer/bi/documents/strategy/strategy.pdf

Access Plans and ODPs

- Minimize access plan builds
  - Reduces CPU use on server
- Reuse (Open Data Path) ODPs
  - Prepare once/run many
  - Statement pooling
  - Connection pooling
  - Use parameter markers
  - Cache package locally

Extended Dynamic Access (Packages)

1. Application runs:

SELECT * FROM MYTABLE WHERE COL1=?

2. Application re-runs:

SELECT * FROM MYTABLE WHERE COL1=?

Package

Extended Dynamic Access (Packages)

- Caches SQL statements on server or local
- Allows reuse of statements (across sessions)
  - Prepare once, execute many
- Statements can be shared among many users
- Can reuse the ODP if local package caching used

SQL Statements in Packages

- 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

iSeries Navigator Tools

- SQL Performance Monitor
  - DSN setting for “Enable Database Monitor” located on Diagnostic tab
  - File stored in QUSRSYS/QODBxxx where xxx is the job number
- Visual Explain
  - Query Access Plan Diagram
  - Index Advisor

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) {
  :
```


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

Database Tools

- Graphical
  - Centerfield Technology DB Essentials
    - http://www.centerfieldtechnology.com
  - iSeries Navigator
    - http://www-1.ibm.com/servers/eserver/iseries/access/
  - Visual Explain
    - http://publib.boulder.ibm.com/infocenter/iseries/v5r3/ic2924/index.htm?info/rzajq/visexpl.htm
- Text-based
  - DBMON (Database monitor)
  - Debug joblogs
  - SST (iSeries Communication Trace)
  - ODBC trace (SQL.LOG)

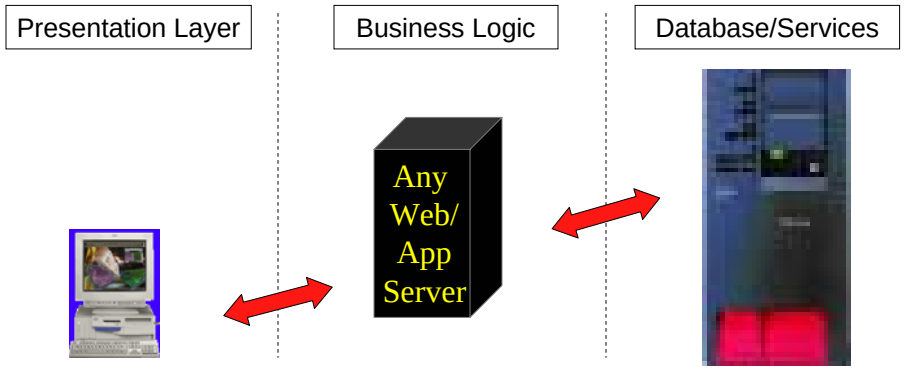
Database Design Summary

- Understand your application and the queries it runs
- Create indices where needed
- Use extended dynamic access
- Use stored procedures where possible

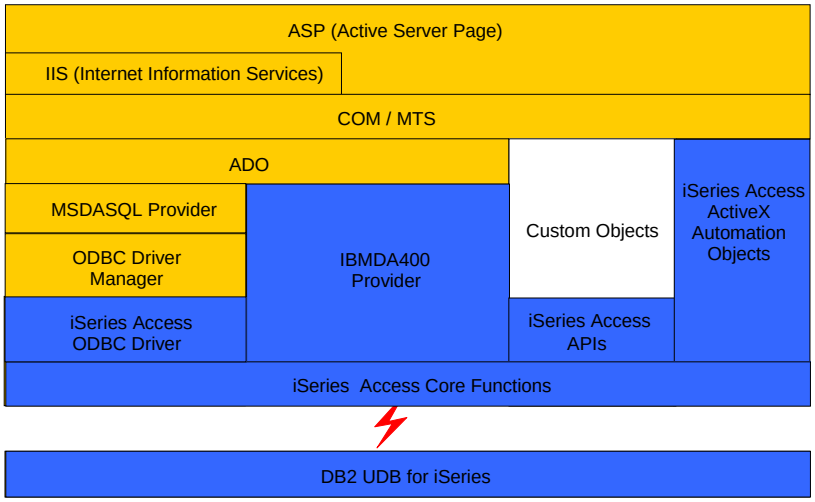
Examples

- 3-Tier application
- Stand-alone application
- Solutions for typical performance problems

Example scenarios (3-Tier application)



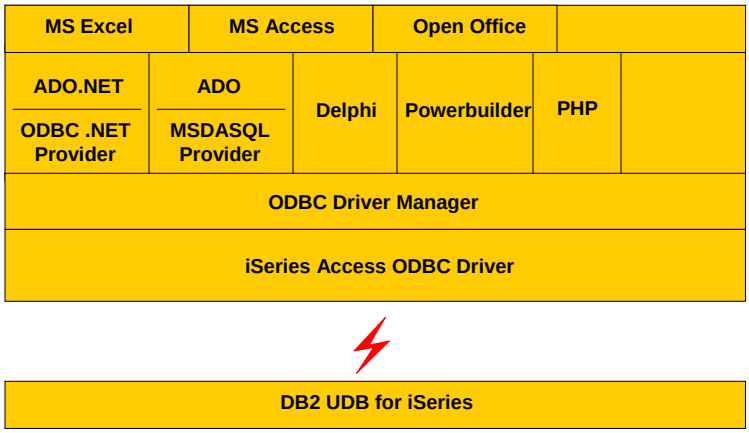
iSeries Access in Windows Environment



Helpful settings with 3-Tier applications

- Connection pooling
- Stored procedures
- Block fetches

Example scenarios (Stand-alone application)



Helpful settings with stand-alone applications

- Packages
- Block fetch of 1 row

Solutions for typical performance problems

- Fetching data
- Long-running SQL queries
- Network issues
- Inserting data
- Lots of connections

Summary

- Application Design:
  - Use parameter markers
  - Prepare once, execute many
- Network:
  - Use data compression
  - Use blocking
- Database Design:
  - Indexes
  - Use extended dynamic
  - Use stored procedures

iSeries Access for Windows – Sessions in Chicago

1. 26GH – MS Office with Client Access
2. 31GJ - Administration of iSeries Access for Windows: Advanced Tips
3. 31GH - MS Office and Client Access Integration Session 1: Setup and Overview
4. 32GH – MS Office and Client Access Integration Session 2: Word and Excel
5. 33GH – MS Office and Client Access Integration Session 3: Access-Web-Sending Data
6. 36CA - iSeries Access for Windows: What's New in V5R3
7. 41CB - iSeries Access Data Transfer: Tips and Techniques
8. 41LC - LAB: MS Office with CA/400
9. 42CB - iSeries Access for Windows: Security and Communications Tips
10. 44CA - iSeries Access for Windows in a .NET World
11. 45LA - OPEN LAB: iSeries Access for Windows with the Experts
12. 52CB - Everything you wanted to know about PC5250 emulation
13. 56CB - Performance Tune iSeries Access ODBC Driver

Session Title: Performance Tune iSeries Access ODBC

Session ID: 401918

Agenda Key: 56CB

Speaker: Brent Nelson

Appendices

- A – Reference Information
- B – Extended Dynamic Packages
- C – Compression
- D – Running CL Commands Through ODBC
- E – Exit Programs
- F – Identifying ODBC Job
- G – 3-Tier Application Picturesictures

A.1 - Additional Client-side Information

- ODBC
  - http://publib.boulder.ibm.com/infocenter/iseries/v5r3/ic2924/index.htm?info/rzaik/rzaikappodbc.htm
- OLE DB
  - See OLE DB Tech Ref installed with iSeries Access
- .NET
  - See .NET Tech Ref installed with V5R3 iSeries Access
- JDBC
  - http://publib.boulder.ibm.com/iseries/v5r3/ic2924/index.htm?info/rzahh/jdbc.htm

A.2 - 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/service/igs/db2performance.html
- 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)
- 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

A.3 - 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

A.4 - Tech Tip: Improve 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 builds are 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?coursecode=S6140
  - DB2 Symmetric Multiprocessing and DB2 OLAP Utilities:
    - http://isource.ibm.com/cgi-bin/goto?on=c4268db2/products

B.1 Package contents

- 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

B.2 - Package contents sample

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.
```


B.3 - Unusable packages

- 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

B.4 - Package names

- 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

C.1 - Compression

- 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)

D.1 - 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

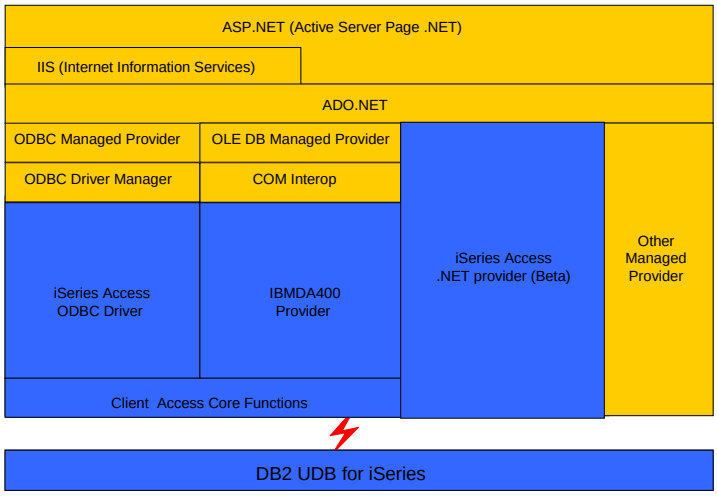
E.1 - Exit Programs For Job Initialization

- 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

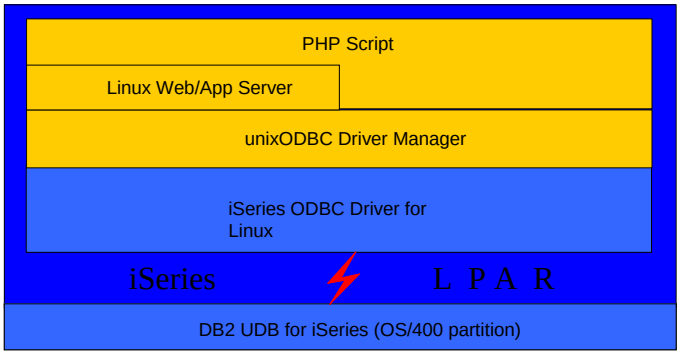
F.1 - Identifying your ODBC Server Job

- 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.

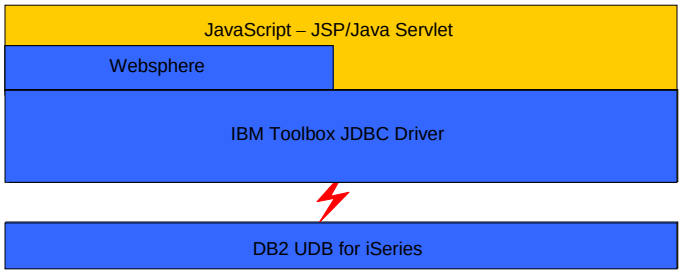
G.1 - iSeries Access in .NET Environment



G.2 - iSeries ODBC in Linux Environment



G.3 - Toolbox JDBC in Java Environment



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