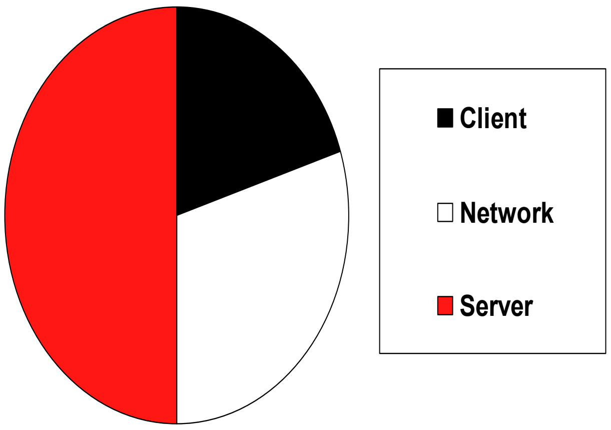
Session: 401918
Agenda Key: 42MK

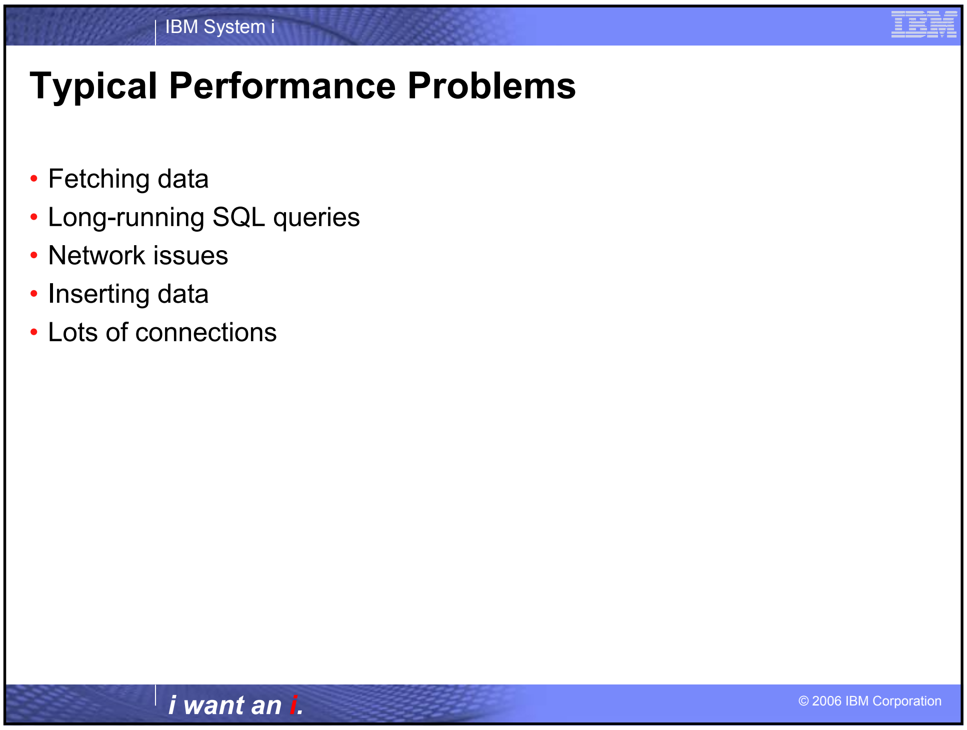
Performance Tune iSeries Access ODBC

Brent Nelson - bmnelson@us.ibm.com
iSeries Access Development

i want stress-free IT.
i want control.
i want an i.

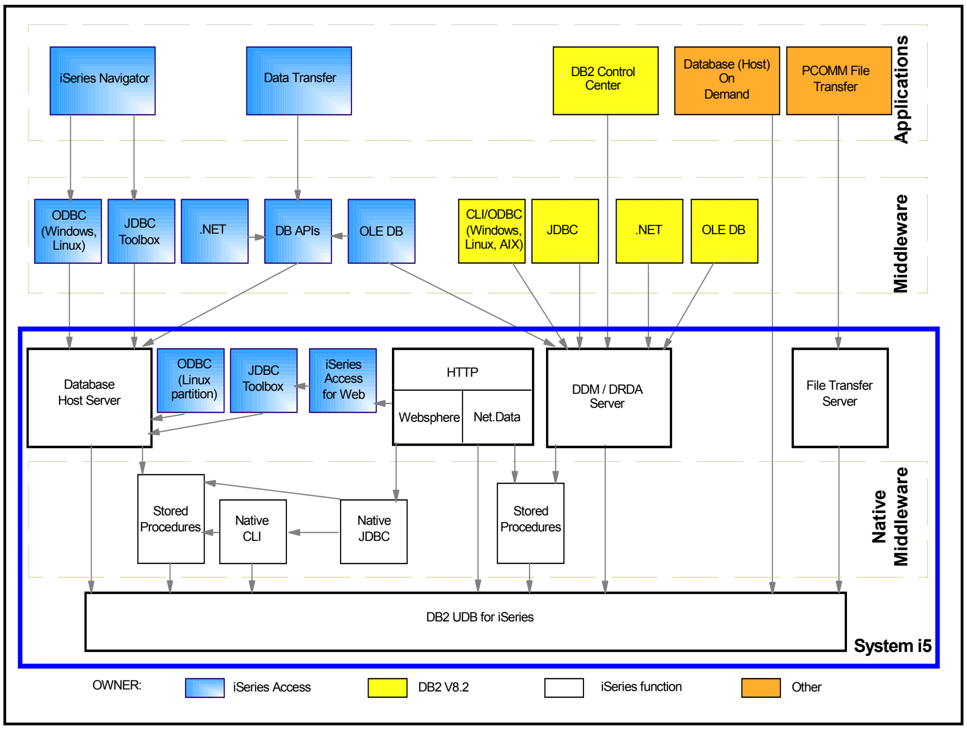
Typical Performance Problems





Typical Performance Problems

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



Explanation of Scale

Programming Required?	Potential Benefit
Y	🟢 3

Y = Yes
N = No
	1 = Low
	2 = Medium
	3 = High

Agenda

- Process for Analyzing Performance Problems
- Performance Considerations
  - Application Design
  - Network
  - Database Design
- Examples
  - 3-Tier Application
  - Off-the-shelf Applications
- Appendices

Process for Analyzing Performance Problems

1. Understand what the application is doing
2. Narrow down the problem
3. Understand options to fix the problem
4. Fix the problem

Understand What the Application is Doing

- Lots of data retrieved?
- Lots of data inserted?
- Lots of connections?
- Complex queries?
- LOB fields?
- Problem related to scaling application?
- Did something change recently?
- …

Narrow Down the Problem

- Review database design
- Time parts of code

Understand Options to Fix Problem

- Research options
- Understand the benefits to different alternatives

Fix the Problem

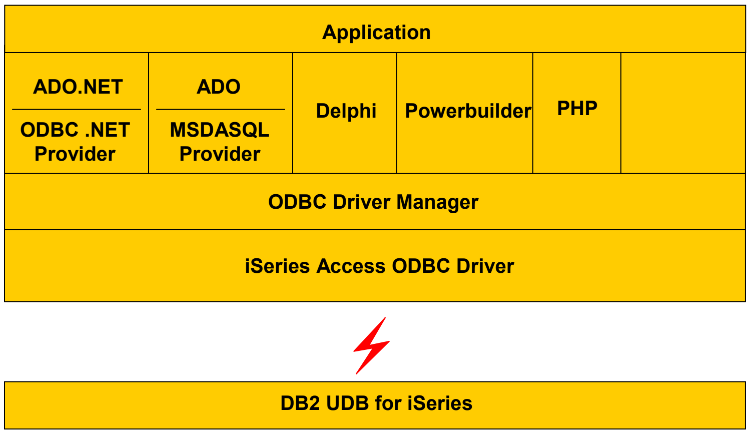
- Make changes
- Compare performance before / after

Performance Considerations

- Application design
  - Choice of programming interface
  - Connection pooling
  - Inserting data
  - Fetching data
  - Isolation level and concurrency
- Network
- Database design

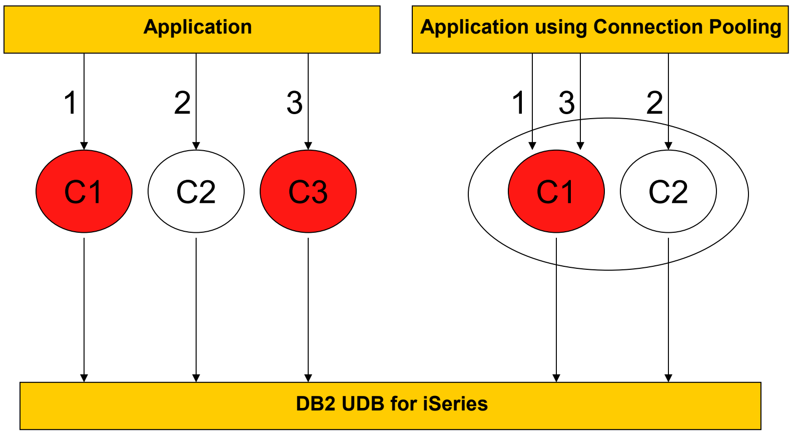
Choosing a Programming Interface

Y 2



Connection Pooling

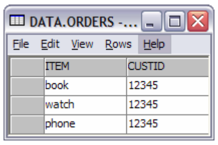
Y 3



Insert Data (Example Scenario)

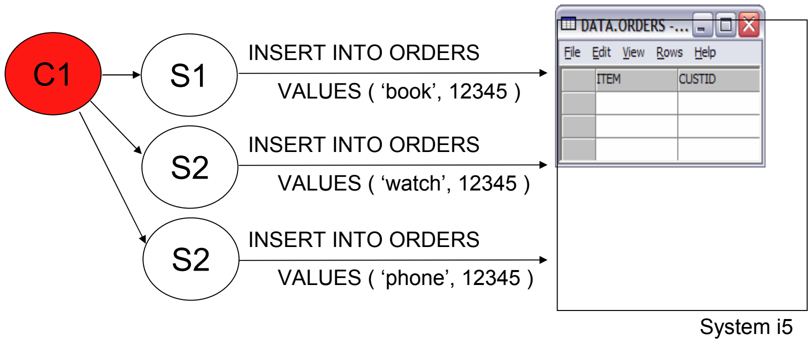
Customer has submitted an order for 3 items on our website

We need to record this in the ORDERS table on the System i5



ITEM	CUSTID
book	12345
watch	12345
phone	12345

Insert Data - Insert with Constants

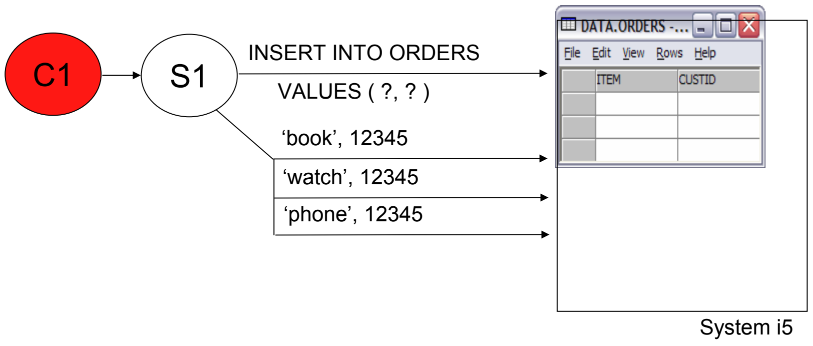


INSERT INTO ORDERS
VALUES ('book', 12345)

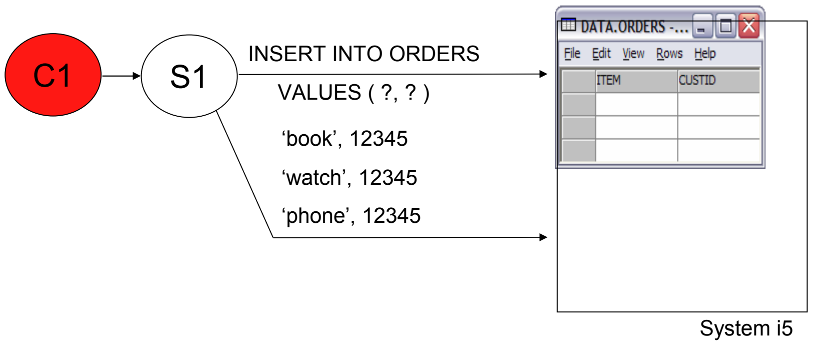
INSERT INTO ORDERS
VALUES ('watch', 12345)

INSERT INTO ORDERS
VALUES ('phone', 12345)

Insert Data - Prepare Once, Execute Many



Insert Data - Block Insert

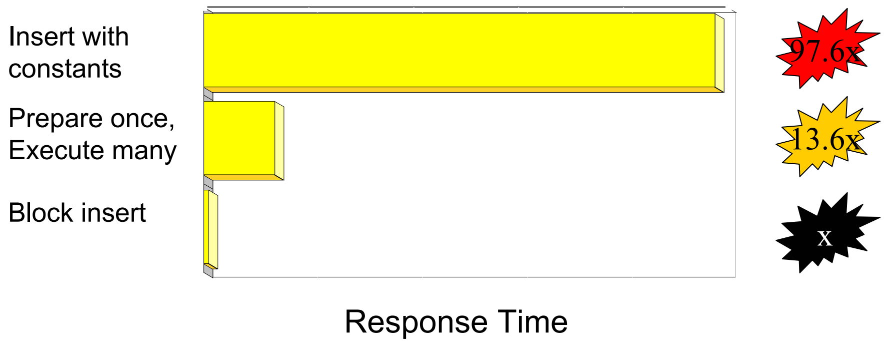


Insert Data - Block Insert Notes

- 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 use "? rows" SQL clause

Block Insert Performance

For 500 36-byte rows with three columns



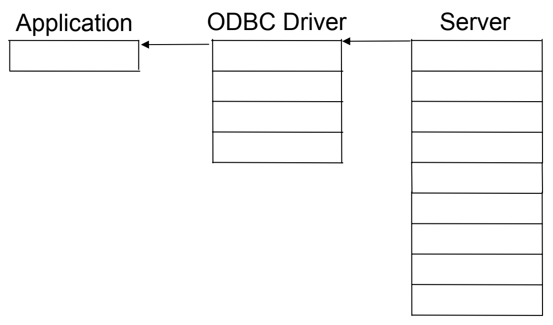
Deleting Data

Y 1

- Consider:
  CALL QSYS.QCMDEXC(‘CLRPFM FILE(MYLIB/MYFILE)’,0000000025.00000)
- Instead of:
  DELETE FROM MYLIB.MYFILE
- NOTE: This is not necessary on V5R3 (and later) systems.

Fetching Data - Blocking

N 3



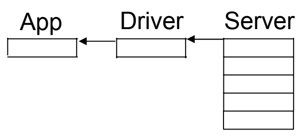
Fetching Data – Settings that Affect Blocking

N 3

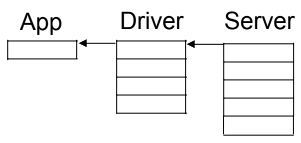
- Cursor Type
  - SQLSetStmtAttr API with SQL_ATTR_CURSOR_TYPE option
  - Forward-only versus Scrollable
- Rowset size
  - SQLSetStmtAttr API with SQL_ATTR_ROW_ARRAY_SIZE option
- Block fetch of 1 row option (BLOCKFETCH keyword)
  - Block size option – (BLOCKSIZE keyword)
- Cursor Concurrency
  - SQLSetStmtAttr API with SQL_ATTR_CONCURRENCY option

Fetching Data - Forward-only Cursor Examples

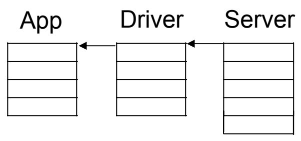
- Table retrieving from has a 32K row size
- Example 1:
  - Application is fetching one row at a time
  - Block fetch of 1 row option with a Block Size of 32K
  - Results: 1 row at a time is fetched



- Example 2:
  - Application is fetching one row at a time
  - Block fetch of 1 row option with a Block Size of 128K
  - Results: ~4 rows are fetched at a time

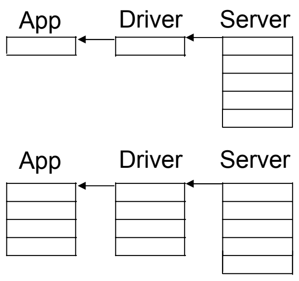


- Example 3:
  - Application is fetching with rowset size of 4 rows
  - Results: 4 rows are fetched at a time



Fetching Data - Scrollable Cursor Examples

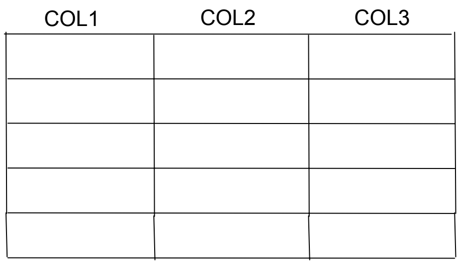
- Table retrieving from has a 32K row size
- Example 1:
  - Application is fetching one row at a time
  - Results: 1 Row is fetched at a time
- Example 2:
  - Application is fetching with rowset size of 4 rows
  - Results: 4 Rows are fetched at a time

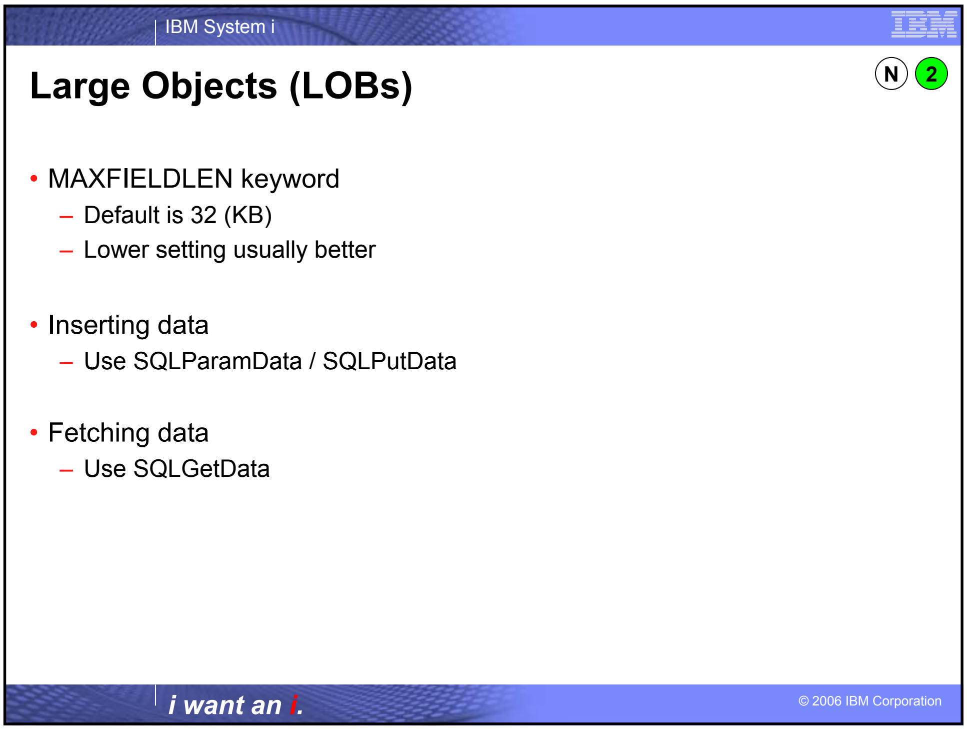


Fetching Data – SQLBindCol vs SQLGetData

Y 2

- Example:
  - SQLBindCol usage:
    - 3 SQLBindCol calls
    - up to 5 SQLFetch calls
  - SQLGetData usage:
    - 5 SQLFetch calls
    - 15 SQLGetData calls

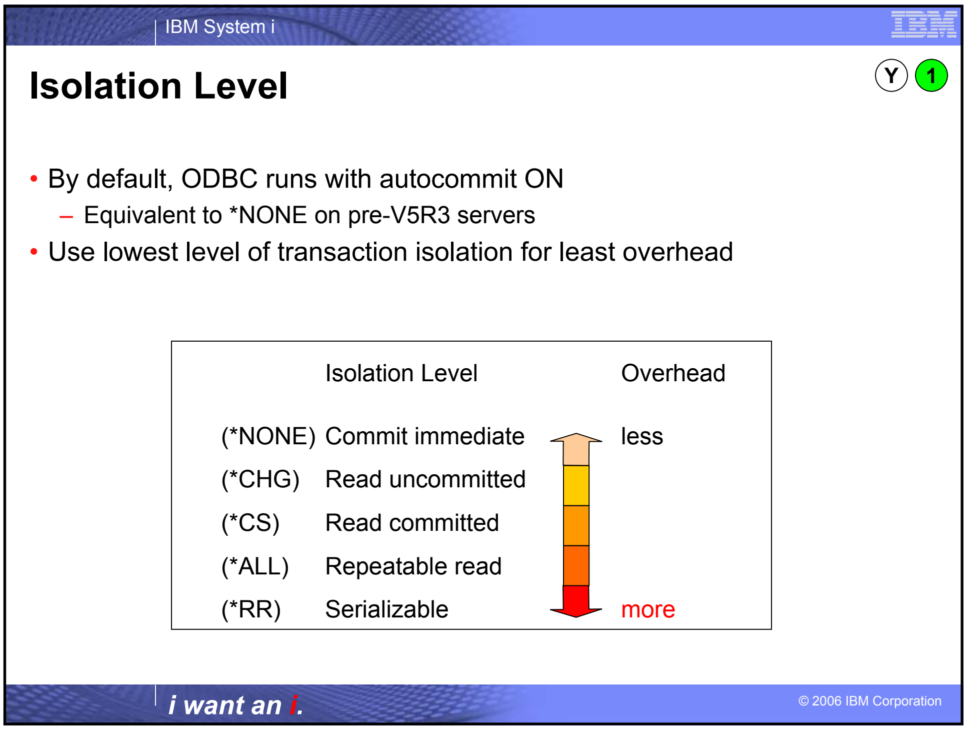




Large Objects (LOBs)

N 2

- MAXFIELDLEN keyword
  - Default is 32 (KB)
  - Lower setting usually better
- Inserting data
  - Use SQLParamData / SQLPutData
- Fetching data
  - Use SQLGetData



Isolation Level

Y 1

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

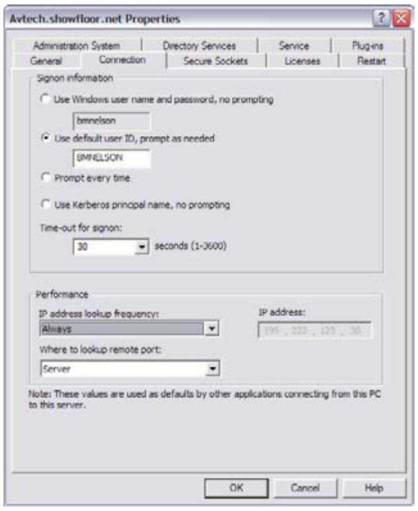
Reduce Trips to Server

N 2

- Stored procedures
- Triggers
- Connection pooling
- Block inserts
- Block fetches
- Lazy close
- Pre-fetch

Reduce Trips to Server

- iSeries Navigator connection properties
  - IP Address lookup
  - Port lookup



Avtech.showfloor.net Properties

Signon information

- ( ) Use Windows user name and password, no prompting: bmnelson
- (●) Use default user ID, prompt as needed: BMNELSON
- ( ) Prompt every time
- ( ) Use Kerberos principal name, no prompting

Time-out for signon: 30 seconds (1-3600)

Performance

IP address lookup frequency: Always

IP address: 199 . 222 . 123 . 30

Where to lookup remote port: Server

Note: These values are used as defaults by other applications connecting from this PC to this server.

Reduce Data Between Server

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

N 3

Data Compression

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

N 2

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

N 3

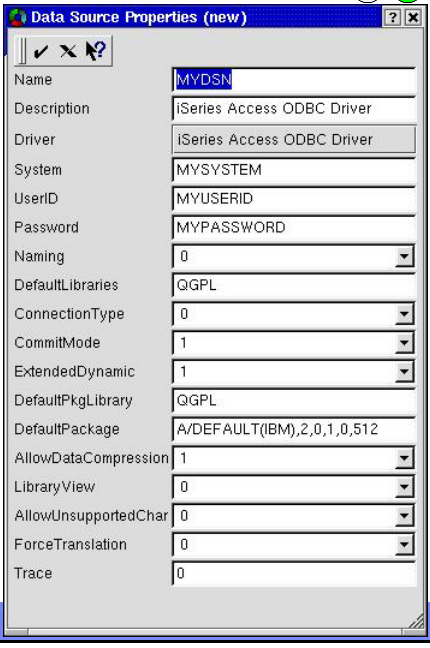
- Performance tab
- Advanced performance options
- Package tab

ODBC DSN keywords:
http://publib.boulder.ibm.com/infocenter/iseries/v5r4/index.jsp?topic=/rzaik/connectkeywords.htm

N 3

Linux ODBC DSN GUI

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

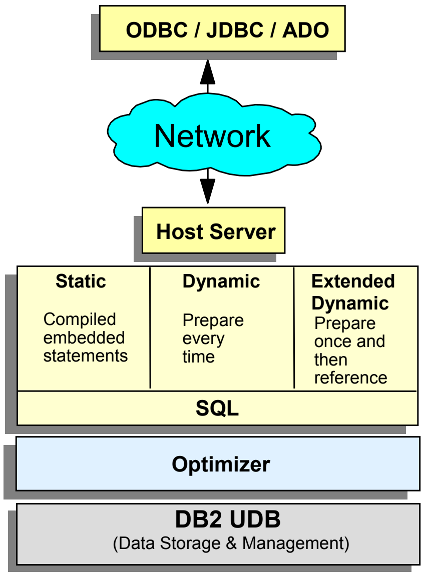


Name	MYDSN
Description	iSeries Access ODBC Driver
Driver	iSeries Access ODBC Driver
System	MYSYSTEM
UserID	MYUSERID
Password	MYPASSWORD
Naming	0
DefaultLibraries	QGPL
ConnectionType	0
CommitMode	1
ExtendedDynamic	1
DefaultPkgLibrary	QGPL
DefaultPackage	A/DEFAULT(IBM),2,0,1,0,512
AllowDataCompression	1
LibraryView	0
AllowUnsupportedChar	0
ForceTranslation	0
Trace	0

Performance Considerations

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

SQL Interfaces



SQL Statement Tuning

Y 2

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

Indexes

N 3

- 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-03.ibm.com/servers/enable/site/education/abstracts/indxng_abs.html

Access Plans and ODPs

Y 3

- 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)

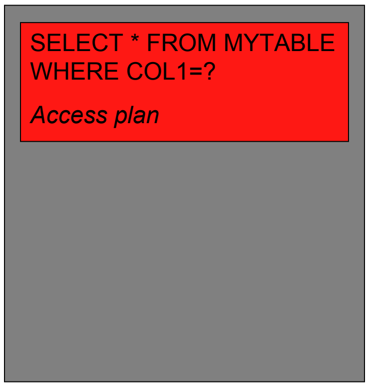
Y 3

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)
- Can be shared among many users

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

QAQQINI file

N 2

- OPTIMIZATION_GOAL
  - *DEFAULT
    - Packages: *ALLIO
    - No Packages: *FIRSTIO
  - *FIRSTIO
  - *ALLIO

- QAQQINI query options:
  http://publib.boulder.ibm.com/infocenter/iseries/v5r4/index.jsp?topic=/rzajq/qryopt.htm

Stored Procedures

Y 3

- 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

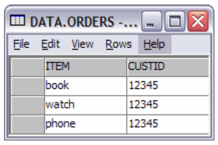
Stored Procedures

- 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

Insert Data (Example Scenario)

Customer has submitted an order for 3 items on our website

We need to record this in the ORDERS table on the System i5



ITEM	CUSTID
book	12345
watch	12345
phone	12345

Insert Data - Stored Procedure Example

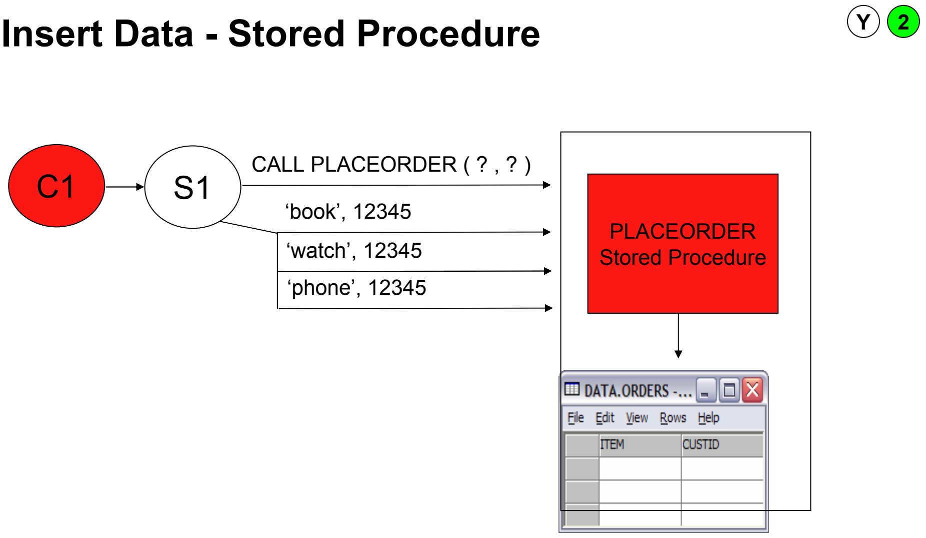
```
create procedure PLACEORDER( ITEM in varchar(20), CUSTID in int)
language sql
begin

declare sqlstmt char(2048);

set sqlstmt = 'insert into ORDERS values ( ''' || ITEM || ''', ' || CUSTID || ')';
execute immediate sqlstmt;

end
```

Insert Data - Stored Procedure



Insert Data - Stored Procedure Example

```
create procedure PLACEORDER( ITEM in varchar(20), CUSTID in int)
language sql
begin

declare sqlstmt char(2048);

set sqlstmt = 'insert into ORDERS values ( ''' || ITEM || ''', ' || CUSTID || ')';
execute immediate sqlstmt;

set sqlstmt =
  'update ORDERLOG set TIME=CURRENT_TIMESTAMP
                                  where CUSTID = ' || CUSTID;
execute immediate sqlstmt;

end
```

Trigger Programs

Y 2

- Based on target file/table
- Can be invoked for each INSERT/UPDATE/DELETE against the table
- Slight performance advantage over stored procedures
- Be careful: All operations, regardless of origin, fire the trigger program

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
- Links:
  - http://www-1.ibm.com/servers/eserver/iseries/access/
  - http://publib.boulder.ibm.com/infocenter/iseries/v5r4/index.jsp?topic=/rzajq/visexpl.htm

Other Database Tools

- Graphical
  - Centerfield Technology DB Essentials
    - http://www.centerfieldtechnology.com
- Text-based
  - Debug joblogs
  - SST (iSeries Communication Trace)
  - ODBC trace (SQL.LOG)

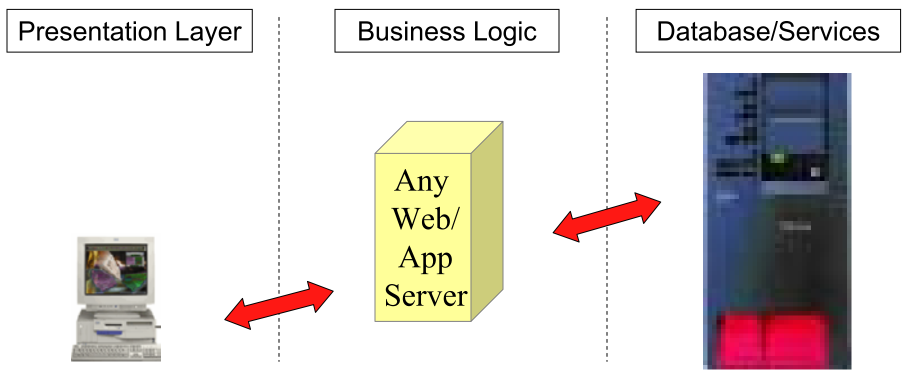
Database Design Summary

- Create indices where needed
- Use stored procedures where possible

Examples

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

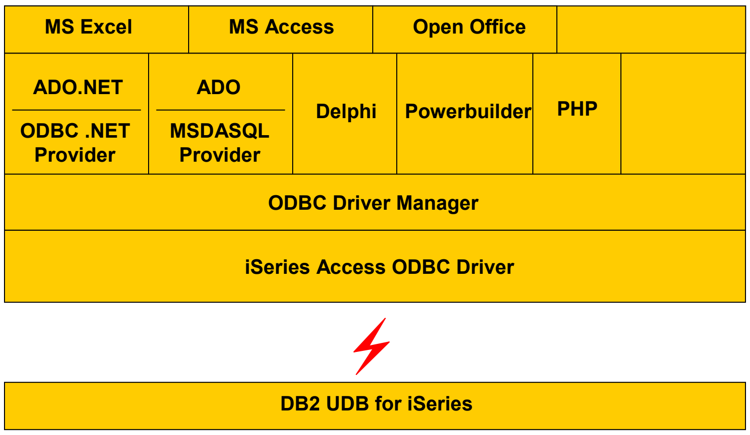
Example Scenarios (3-Tier Application)



Helpful Settings with 3-Tier Applications

- Goals
- Settings
  - Connection pooling
  - Stored procedures
  - Block fetches

Example scenarios (Stand-alone application)



Helpful settings with stand-alone applications

- Goals
- Settings
  - Block fetch of 1 row
  - Compression
  - LOB threshold
  - Packages

Summary

- Process
  - Understand application
  - Narrow problem
  - Understand options
  - Fix problem
- Application Design:
  - Use parameter markers
  - Prepare once, execute many
- Network:
  - Adjust data compression as needed
  - Use blocking
- Database Design:
  - Indexes
  - Use stored procedures

iSeries Access for Windows sessions:

32MC - iSeries Access for Windows: What's New in V5R4
33MI - iSeries Access Data Transfer: Tips & Techniques
42MK - Performance Tune iSeries Access ODBC
43MC - PC5250 Emulation: Everything You Need To Know
46ME - iSeries Access in the .NET World

iSeries Access for Linux session:

53ML – Creating the iSeries Linux Desktop

Stop in EXPO for a demo…

Functional enhancements can be submitted via the FITS system. The url is:
http://www.ibm.com/eserver/iseries/access/
And click on link "Request for Design Change"

Session Title:	Performance Tune iSeries Access ODBC
Session ID:	401918
Agenda Key:	42MK
Speaker:	Brent Nelson

Appendices

- A – Reference Information
- B – Insert data example code
- C – Compression
- D – Extended Dynamic Packages

A.1 - Additional Client-side Information

- ODBC
  – http://publib.boulder.ibm.com/infocenter/iseries/v5r4/index.jsp?topic=/rzaik/rzaikappodbc.htm
- OLE DB
  – See OLE DB Tech Ref installed with iSeries Access
- .NET
  – See .NET Tech Ref installed with V5R4 iSeries Access
- JDBC
  – http://publib.boulder.ibm.com/infocenter/iseries/v5r4/index.jsp?topic=/rzahh/page1.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://www-03.ibm.com/servers/eserver/iseries/db2/books.html
  - Indexing Strategies for DB2 UDB for iSeries: http://www-03.ibm.com/servers/enable/site/education/abstracts/indxng_abs.html
  - 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 – iSeries/i5 Performance Analysis Workshop:
    - http://www-304.ibm.com/jct03001c/services/learning/ites.wss/us/en?pageType=course_description&courseCode=AS024
  - DB2 Symmetric Multiprocessing and DB2 OLAP Utilities:
    - http://www-128.ibm.com/developerworks/db2/library/techarticle/0301milligan/0301milligan.html

B.1 - Insert Data - Insert with Constants

```
strcpy(stmt, "insert into ORDERS values(‘book‘, 12345)");
rc = SQLExecDirect(hStmt, stmt, SQL_NTS);

strcpy(stmt, "insert into ORDERS values(‘watch‘, 12345)");
rc = SQLExecDirect(hStmt, stmt, SQL_NTS);

strcpy(stmt, "insert into ORDERS values(‘phone‘, 12345)");
rc = SQLExecDirect(hStmt, stmt, SQL_NTS);
```

B.2 - Insert Data - Prepare Once, Execute Many

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

rc = SQLBindParameter(hStmt, 1, .... , szItem, … );
rc = SQLBindParameter(hStmt, 2, .... , &custID, … );

strcpy(szItem, ”book”);
custID = 123
rc = SQLExecute(hStmt);

strcpy(szItem, ”watch”);
rc = SQLExecute(hStmt);

strcpy(szItem, ”phone”);
rc = SQLExecute(hStmt);
```

B.3 - Insert Data – Block Insert

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

rc = SQLSetStmtAttr(hStmt, SQL_ATTR_PARAMSET_SIZE, (PTR)3, … );

rc = SQLBindParameter(hStmt, 1, .... , szItemArray[0], … );
rc = SQLBindParameter(hStmt, 2, .... , &custID, … );

strcpy(szItemArray[0], ”book”);
strcpy(szItemArray[1], ”watch”);
strcpy(szItemArray[2], ”phone”);
custID = 12345;

rc = SQLExecute(hStmt);
```

B.4 - Insert Data - Stored Procedure

```
strcpy(stmt, "CALL PLACEORDER (?,?)");
rc = SQLPrepare(hstmt1, stmt, SQL_NTS);

rc = SQLBindParameter(hStmt, 1, .... , szItem, … );
rc = SQLBindParameter(hStmt, 2, .... , &custID, … );

strcpy(szItem, ”book”);
custID = 123
rc = SQLExecute(hStmt);

strcpy(szItem, ”watch”);
rc = SQLExecute(hStmt);

strcpy(szItem, ”phone”);
rc = SQLExecute(hStmt);
```

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 Package contents

- Extended dynamic
  - Use iSeries Navigator to view the contents of the package
  - Alternatively, you can use the PRTSQLINF command on the System i5 to dump the package containing your statements
  - PRTSQLINF produces spoolfile showing syntax and optimization information

D.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.
```

D.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

D.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

Sample Code Disclaimer

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