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# Application Modernization DB2 UDB Style

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IBM eServer iSeries  
ITSO Technical Forum  
2004



**Redbooks**  
International Technical Support Organization

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## Agenda

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- Why modernize with SQL & DB2 UDB?
- Approaches & Options
- Modernizing Database Definitions
- Modernizing Data Access
- Next Steps

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## Why Structured Query Language (SQL)?

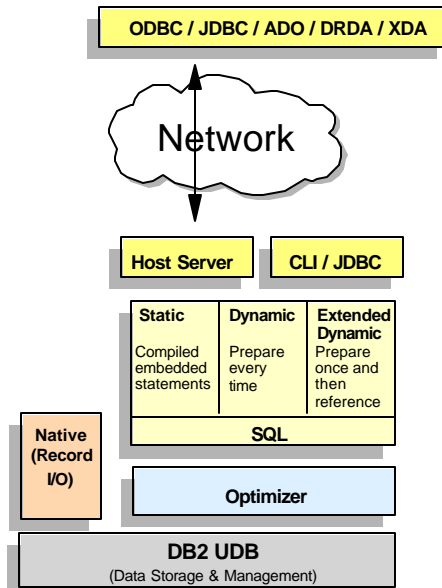
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- **Portability of code & skills**
- **Strategic database interface for industry & OS/400**
  - ▶ **Faster performance delivered by SQE only available to SQL-based interfaces**
  - ▶ **SQL required for certain functions & middleware**
    - J2EE architecture based on SQL interfaces
    - Data types: BLOB, CLOB, Datalink, ...
    - Auto-Incrementing Constructs: Sequence & Identity column attribute
    - Column-level Triggers
    - Encryption & Decryption functions
    - Encoded Vector Indices
    - ...
- **Enables better positioning of iSeries as a Database Server**
- **SQL as a programming language can reduce Total LOC**
- **DB2 SMP - parallel database processing**

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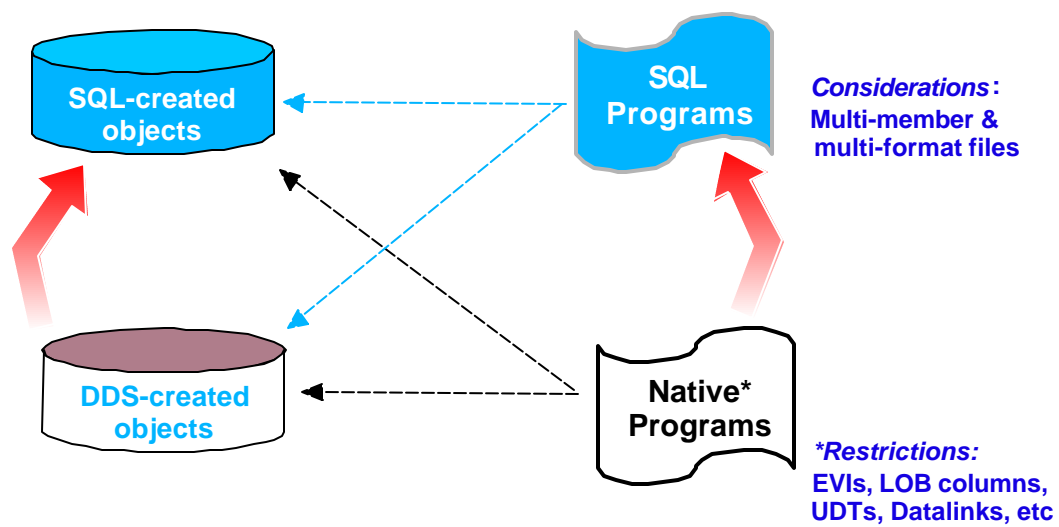
## Approaches & Options



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- High level picture of DB architecture and where the optimization occurs
- ADO = Active data objects (i.e. OLE DB)
  - Implemented via ODBC or directly to Host Server (project Lightning)
- ODBC/JDBC/ADO = client query program interfaces
- CLI/JDBC = server query program interfaces
- All the components will be covered throughout the course
- Components will be covered from the bottom up

## Approaches & Options



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## Modernizing Definitions & Objects

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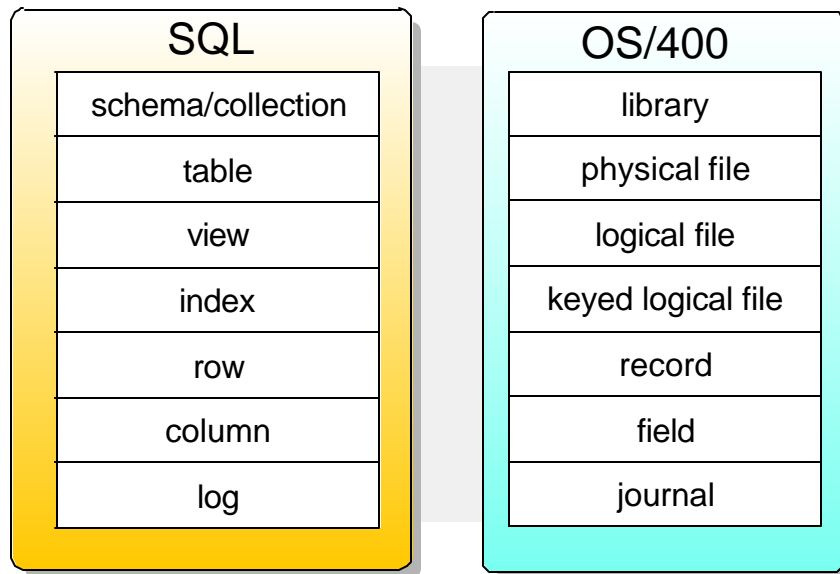
- Terminology
- Moving from DDS to SQL DDL
- SQL object management
- Embedding business logic into database definitions

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## Modernizing Database Objects - Terminology

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- The terms on the left side of the table equate to the terms on the right side. Traditional OS/400 users are accustomed to using the terms on the right. While the terms used may be different, the function provided is the same.
- You'll notice that member is not anywhere on the chart, no SQL equivalent

## Modernizing Database Definitions & Objects

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### *Tables vs PFs*

- SQL Tables compared with Physical Files
  - ▶ Advantages
    - More data types
    - Constraint definitions can be included in object source
    - Faster reads
    - Longer, more descriptive column names
    - Data Modeling Tool support
    - DB2 attempts to automatically journal tables
  - ▶ Disadvantages
    - Slower writes
    - No DDM, BUT SQL can utilize DRDA connections
    - Multi-member files
      - SQL ALIAS provides solution:  
CREATE ALIAS JanSales FOR SALES (JANUARY )

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- ▶ One disadvantage used to be that SQL tables did not support field reference files - fixed with V5R2 CREATE TABLE LIKE enhancement



## Modernizing Database Definitions & Objects

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### *Indexes vs LFs*

#### ■ SQL Indexes compared with Keyed Logical Files

##### ► Advantages

- Encoded Vector Index Structure
- 64K Logical Page Size (since V4R2)
  - Change was made to improve the performance of queries that scan lots of key values in an index (64K I/O operation brings more keys into memory)
  - Single key lookups in index may or may not be as efficient
  - Larger logical page size can lend itself to more efficient index maintenance
  - Considerations:
    - ◆ Larger index pages may strain memory-starved environments
    - ◆ SQL Indexes that are journaled explicitly or implicitly (SMAPP) will increase size of journal receivers
      - > Use RCVSIZOPT(\*RMVINTENT \*MAXOPT2)
      - > Journal Receiver Threshold should be at least 6.5 GB

##### ► Disadvantages

- 8K Logical Page Size
  - No support for Select/Omit filtering or join logical files
- 

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- SQL Indexes can be opened as keyed logical files - SQL Index "DDS" includes all of the fields into the logical file

# Modernizing Database Definitions & Objects

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## Views vs LFs

### ■ SQL Views compared with Logical Files

#### ▶ Advantages

- More flexibility in terms of selecting & processing data
  - CASE expressions & Date/Time functions
  - Grouping & more advanced Join processing
- Can be used as logical files to enhance native functionality

#### ▶ Disadvantages

- Views cannot be keyed/ordered
  - Does that mean Views have slower performance?
    - NO - assuming you have the right set of indexes/statistics in place for the query optimizer to use
    - View is used by SQL just to transform data, query optimizer's job to find the best method to speed up selection or sorting
    - Fastest method may not be a keyed access method

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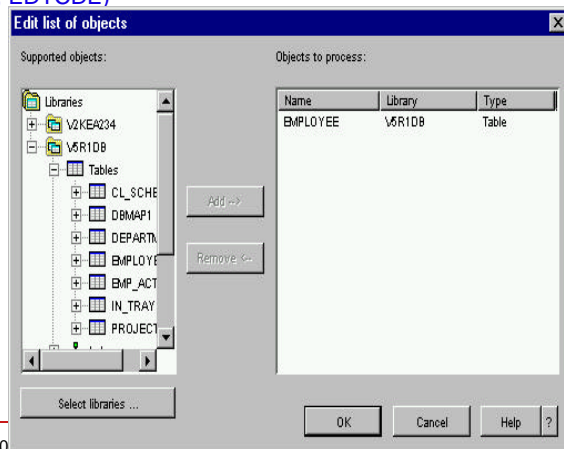
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# Modernizing Database Definitions & Objects

## DDS to SQL Conversion Tool

### ■ iSeries Navigator Generate SQL Task (QSQGNDDL API)

- ▶ Useful in converting object definitions from DDS to SQL
- ▶ Supports physical & logical files
  - Not all DDS features can be converted, tool will convert as much as possible and generate warnings for unconvertable options (eg, EDTCDE)
  - Logical files converted to SQL Views
  - SQL Field Reference File support not used
- ▶ Can convert a single object or a group of objects
- ▶ Output can be edited & saved directly into source file members



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# Modernizing Database Definitions & Objects

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## SQL Object management

### ■ SQL Source Management best practices:

- ▶ Just like DDS SQL source can be stored in source physical file members just and referenced with the RUNSQLSTM CL command instead of CRTPF/CRTLFL
  - If change management tools are not iSeries specific, store SQL scripts in PC or IFS files
  - If SQL source misplaced, Generate SQL can be used to retrieve the SQL source from System Catalogs (SYSIBM & QSYS2)
- ▶ SQL Table definitions can use Field Reference File

```
CREATE TABLE customer AS  
(SELECT id cust_id, lname cust_lastname, fname cust_firstname,  
city cust_city FROM RefFile)  
WITH NO DATA
```

### ■ May need to adjust process for moving from development to production

- ▶ Best practice is to re-execute SQL creation script
- ▶ Save/Restore process for SQL databases documented at:  
[ibm.com/developerworks/db2/library/techarticle/0305milligan/0305milligan.html](http://ibm.com/developerworks/db2/library/techarticle/0305milligan/0305milligan.html)

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- ▶ One disadvantage used to be that SQL tables did not support field reference files - fixed with V5R2 CREATE TABLE LIKE enhancement
  - ▶ SQL Field Reference support forces you to use all data types from field reference file

## Modernizing Database Definitions & Objects

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### *SQL Object Management*

- **SQL Column & Object names have maximum lengths of 30 & 128, but many OS/400 utilities, commands and interfaces only support a 10-character length. How does that work?!?!?**
  - ▶ System automatically generates a short 10 character name
    - First 5 chars with unique 5 digit number  
CUSTOMER\_MASTER >> CUSTO00001
- **Might be different each time a specific table is created, depending on creation order and what other objects share the same 5 character prefix**
- **Use iSeries SQL syntax to specify your own short name**
  - ▶ RENAME TABLE (tables & views) & RENAME INDEX
  - ▶ FOR COLUMN clause for columns
  - ▶ SPECIFIC clause for procedures, functions

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- ▶ One disadvantage used to be that SQL tables did not support field reference files - fixed with V5R2 CREATE TABLE LIKE enhancement

# Modernizing Database Definitions & Objects

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## SQL Object Management

### ■ Short & Long Name Co-existence Example

- ▶ Specify the short name at creation:

```
CREATE TABLE dbtest/cusmst  
(customer_name FOR COLUMN cusnam CHAR(20),  
customer_city FOR COLUMN cuscty CHAR(40))
```

- ▶ Specify a long name for existing short-name:

```
RENAME TABLE dbtest/cusmst TO customer_master  
FOR SYSTEM NAME cusmst
```

### ■ If long name specified on SQL Table definition, can also add/control the short name after table created:

```
RENAME TABLE dbtest/customer_master TO SYSTEM NAME cusmst
```

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- ▶ One disadvantage used to be that SQL tables did not support field reference files - fixed with V5R2 CREATE TABLE LIKE enhancement

# Modernizing Definitions & Objects

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## *SQL & Non-relational data*

### ■ User-Defined Table Functions

- ▶ Allows non-relational & legacy data to be virtualized as an SQL table

```
SELECT * FROM TABLE(myudtf('Part XYZ'))
```

- ▶ Both SQL & External Table Functions supported

- External UDTFs can be easily written to access multi-format files, S/36 files, and stream files
- Table functions can only be invoked from SQL-based interfaces

### ■ Datalinks

- ▶ URL-based data type to provide linkage to related objects in IFS
- ▶ Can establish RI relationship between table row & IFS object

### ■ LOBs

- ▶ Allows you to keep non-relational data along with all the other business data

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## Modernizing Definitions & Objects

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### *Moving Business Logic into DB2 - Automatic Key Generation*

#### ■ Identity Column Attribute

- ▶ Attribute that can be added to any numeric columns to have DB2 generate next value
- ▶ Not guaranteed to be unique, primary key or unique index must be defined
- ▶ Only available for SQL tables, BUT identity column value generated for both SQL and non-SQL interfaces (RPG, etc) that are adding new rows

```
CREATE TABLE emp( empno INTEGER GENERATED ALWAYS AS IDENTITY
                  (START WITH 10 , INCREMENT BY 10),
                  name CHAR(30), dept# CHAR(4))
```

```
INSERT INTO employee(name,dept) VALUES('MIKE','503A') or
INSERT INTO employee VALUES(DEFAULT,'MIKE', '503A')
```

#### ■ Sequence Object

- ▶ Separate object that can be shared across multiple tables
- ▶ Generated value to be part of non-numeric keys

```
CREATE SEQUENCE order_seq START WITH 10 INCREMENT BY 10
```

```
INSERT INTO orders(ordnum,custnum) VALUES( NEXT VALUE FOR order_seq, 123 )
```

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# Modernizing Definitions & Objects

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## *Moving Business Logic into DB2 - Constraints*

### ■ Database Constraints Benefits

- ▶ Easier code reuse & better modularity
- ▶ Improved data integrity
- ▶ Improved query performance - SQE query optimizer is constraint aware

### ■ Constraint Types

- ▶ Primary & Unique Key
- ▶ Referential Integrity Constraints
  - Enforce Parent/Child & Master/Detail relationships
- ▶ Check Constraints
  - Ensure that a column is only assigned legal values

```
CREATE TABLE orders(  
  ordnum INTEGER PRIMARY KEY,  
  ordqty INTEGER CHECK(ordqty>0 AND ordqty<999),  
  ordamt DECIMAL(7,2),  
  part_id CHAR(4),  
  CONSTRAINT ordpart FOREIGN KEY(part_id) REFERENCES parts(PartID)  
  ON DELETE RESTRICT ON UPDATE RESTRICT )
```

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# Modernizing Definitions & Objects

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## *Moving Business Logic into DB2 - Triggers*

- **Triggers allow you initiate business policies & processes whenever new data comes in or existing data is changed**
  - ▶ DB2 responsible for always invoking the trigger program
  - ▶ Execution is independent of the user interface
  - ▶ Can be used to transform data before it gets into DB2
- **DB2 UDB for iSeries Trigger Support**
  - ▶ Before & After Insert, Update, & Delete events - up to 300 triggers
  - ▶ SQL & External(ADDPFTRG) Triggers
    - Column-level & Statement-level triggers only available with SQL Triggers

```
CREATE TRIGGER audit_salary
AFTER UPDATE ON employee(salary)
REFERENCING NEW AS n
REFERENCING OLD AS o
FOR EACH ROW
WHEN (n.salary - o.salary >= 5000)
  INSERT INTO audit
    VALUES(n.empno, n.deptno, n.salary,current timestamp)
```

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## Modernizing Data Access

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- Programming Interfaces
- Native I/O to SQL Comparison
- Using SQL to Reuse & Repurpose Existing Code
- DB2 & New Application Models
- Tools

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# Modernizing Data Access

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## Programming Interfaces

Static SQL	Dynamic SQL	Extended Dynamic SQL
Embedded Static	Embedded Dynamic	QSQPRCED
	JDBC, SQLJ	Toolbox JDBC & iSeries Access ODBC
	OLE DB, .NET	XDA API set
	CLI, ODBC	
	Net.Data	
	RUNSQLSTM	

***\*\*DB2 UDB SQL Development Kit only required if embedded SQL into HLL programs***

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# Modernizing Data Access

## Native I/O to SQL Example

```

...
C/EXEC SQL
C+ DECLARE sql_jn CURSOR FOR SELECT
C+  t.year,t.month,i.orderdt,c.country,c.cust
C+  p.part,s.supplier,i.quantity,i.revenue
C+ FROM item_fact i
C+ INNER JOIN part_dim p ON (i.partid=p.partid)
C+ INNER JOIN time_dim t ON (i.orderdt=t.datekey)
C+ INNER JOIN cust_dim c ON (i.custid=c.custid)
C+ INNER JOIN supp_dim s ON (i.suppdt=s.suppdt)
C+ WHERE year=1998 AND month=6
C/END-EXEC

C/EXEC SQL
C+ OPEN sql_jn
C/END-EXEC

C/EXEC SQL
C+ FETCH NEXT FROM sql_jn FOR :RowsReq ROWS
C+ INTO :result_set
C/END-EXEC

C          If          SQLCOD = 0 and
C          SQLER5 = 100 and
C          SQLER3 > 0
C          Eval      RowsRd = SQLER3
...

```

```

C  SearchKey  KList
C          Kfld
C          SearchYear
C          SearchMonth
...
C  Times      Occur
C  SearchKey  Setll
C          If
C          DOU
C          READ
C          If
C          Leave
C          Endif
C  DATEKEY    Setll
C          If
C          DOU
C          READ
C  DATEKEY    READ
C          If
C          Leave
C          Endif
C  PARTKEY    CHAIN
C          If
C          Iter
C          Endif
C  CUSTKEY    CHAIN
C          If
C          Iter
C          Endif
C  SUPPKEY    CHAIN
C          If
C          Iter
C          Endif ...

```

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- SQL only getting a subset of the columns, RPG/Native gets all of the fields back - if you want to change "projection", then need to create a new logical

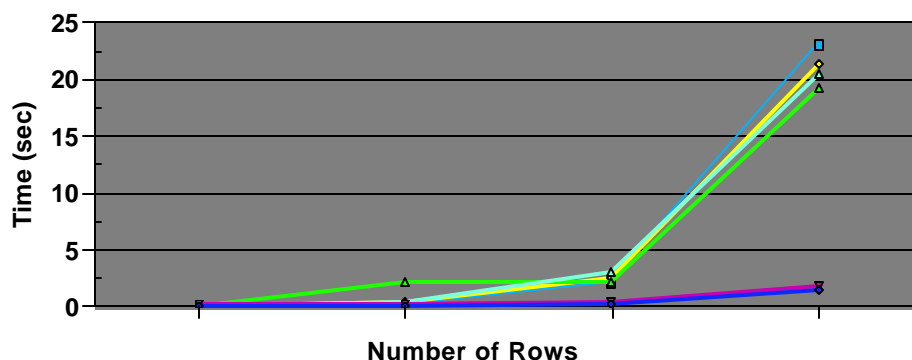
# Modernizing Data Access

## Native I/O to SQL Example - Joined LFs & Views

...	..		
C/EXEC SQL	C	SearchKey	KList
C+ DECLARE sql_jn CURSOR FOR	C		Kfld SearchYear
C+ SELECT * FROM JoinView	C		Kfld SearchMonth
C+ WHERE year=1998 AND month=6	...		
C/END-EXEC			
C/EXEC SQL	C	SearchKey	Setl
C+ OPEN sql_jn	C	If	NTVJOIN002
C/END-EXEC	C	DO	%FOUND
	C	Times	RowsReq Times
	C	Occur	Result_Set
	C	READ	NTVJOIN002
	C	If	%EOF
	C	Leave	
	C	Endif	
C/EXEC SQL			
C+ FETCH NEXT FROM sql_jn FOR	C	Eval	RowsRd = RowsRd + 1
C+ :RowsReq ROWS INTO :result_set	C	ENDDO	
C/END-EXEC			
C			
C If SQLCOD = 0 and	C	Endif	
C SQLER5 = 100 and			
C SQLER3 > 0			
C Eval RowsRd = SQLER3			

## Modernizing Data Access

### Native I/O to SQL Example - Performance Comparison



Note: Tests run on Model 720 w/1600 CPW & 2 GB Memory - your performance results may vary

	1	100	1000	10000
Native File Join	0.002512	0.260248	2.219504	23.228176
Native JoinLF	0.002304	0.362128	2.544608	21.366480
Native JoinLF w/blk	0.002400	2.144288	2.125032	19.311464
SQL - No IOA	0.145160	0.489136	3.166704	20.452984
SQL IOA	0.251168	0.267208	0.417800	1.898800
SQL SQE IOA	0.013536	0.019320	0.250160	1.576536

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- All SQL runs did blocked fetches
- Findings
  - RLA slightly better than SQL when retrieving small number of rows
    - 1 to 100 rows
  - SQL outperforms RLA when retrieving large result sets
    - ~10000 rows or more
  - Blocking DDS adds more up front overhead
    - more efficient for larger volumes
    - similar to SQL support which implicitly blocks
  - Index only access provides dramatic performance efficiency at approximately 100 rows
    - available to SQL only
  - SQE optimization costs are getting closer to RLA costs
- Conclusions
  - In general, when processing sets of data, SQL performance is equivalent to or better than RLA access
  - RLA outperforms SQL for single or small numbers of row access. However, tuning SQL via Index only access may achieve run time or response time objectives for small result sets.
  - For mission critical applications RLA may be the best choice
  - Continue to revisit SQL with each release

## Modernizing Data Access

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### Comparing SQL & Native Performance

	RPG	SQL	
<i>Arrival Sequence</i>	202,000	173,000	rows per minute
<i>Keyed Access</i>	131,000	117,000	
<i>Keyed Access (memory-constrained)</i>	8000	12,000	
<i>Pesudo-Random Keyed Access</i>	3950	3440	
<i>Direct Key Access</i>	5100	4100	

Published by *NEWS/400* in March 2000 - Measured on V4R4  
V5R2 and V5R3 DB Engine is faster

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- Highly optimized RPG code with specialized override
- Southern Wine:
  - 24 hrs vs minutes



# Modernizing Data Access

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## *Native to SQL Considerations*

- **ORDER BY clause is only way to guarantee the sequencing of results when using SQL - no clause, means ordering by chance**
- **SQL Precompilers do not support all the latest features - still missing from RPG Precompiler in latest release:**
  - ▶ Support for free format embedded SQL
  - ▶ Support for properly scoping a local variable in a subprocedure as a host variable in an SQL statement (ie, multi-pass)
  - ▶ Support for qualified names with more than one level of qualification
- **Consider impact of SQL isolation level & journaling on native applications**
- **Critical Performance Success Factors**
  - ▶ Sound Indexing & Statistics Strategy  
([ibm.com/servers/enable/site/education/ibo/record.html?indxng](http://ibm.com/servers/enable/site/education/ibo/record.html?indxng))
  - ▶ Reusable ODPs (Open Data Paths)
    - Prepare Once, Execute Many
    - Connection Pooling
    - Keep Connections & Jobs active as long as possible
  - ▶ Blocked Fetches & Inserts

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- ▶ Websphere EJBs require an isolation level other than \*NONE

# Modernizing Data Access

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## *Using SQL to Reuse & Repurpose Existing Code*

- **Stored Procedures, Functions, & Triggers provide vehicle for improving and changing the architecture of your solution**
  - ▶ Improved modularity by allowing same code to be used by multiple interfaces & applications
  - ▶ Better partitioning of logic (eg, separation of presentation & database logic)
  - ▶ Easy transision to multi-tier architectures since many interfaces exist for remote invocations
- **DB2 UDB for iSeries support provides maximum flexibility by supporting both SQL & External types**
  - ▶ External support allows reuse of existing iSeries code & skills
  - ▶ SQL Procedural Language (PSM) enables better portability of logic (& programming skills) to/from other platforms
  - ▶ Data security can be enhanced/maintained with OS/400 Adopted Authority

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# Modernizing Data Access

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*Using SQL to Reuse & Repurpose Existing Code: User-Defined Functions*

- **UDFs allow the database to invoke user-written functions during the processing of an SQL statement**
  - ▶ Allows you to customize SQL to meet your business requirements
  - ▶ Example:

```
CREATE FUNCTION Euro(EuroAmt DECIMAL(11,2))
RETURNS DECIMAL(11,2)
LANGUAGE SQL
BEGIN
    DECLARE rate DECIMAL(9,5);

    SELECT conversion_rate INTO rate FROM ratetable WHERE ...;
    RETURN rate*EuroAmt;
END
```

```
SELECT item_name, Euro(item_name) FROM parts...
```

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# Modernizing Data Access

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## *Using SQL to Reuse & Repurpose Existing Code: Procedures*

- **Stored Procedures are similar to UDFs, but invoked with an SQL Call statement**
  - ▶ **More than just a remote program call**
    - Supported by majority of the application development tools & languages
    - Result sets can improve performance by minimizing network trips
  - ▶ **Procedures most effective when multiple operations performed on a single procedure call**
  - ▶ **External Procedure considerations**
    - May have to make slight modifications to existing code to match stored procedure parameter conventions or develop "wrapper" procedures
    - Need to design process for installing & upgrading stored procedures
  - ▶ **SQL Procedure considerations**
    - Generated C code with embedded SQL not as fast as user-written code
    - Minimize the number of nested calls to other SQL procedures
    - No support for blocked fetches & inserts

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# Modernizing Data Access

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## *DB2 & New Application Models - Distributed Transactions*

### ■ **DB2 UDB for iSeries supports XA Transactions**

- ▶ **OS/400 Transaction manager was substantially enhanced in V5R2 for distributed transaction modes - including support for JTA**
- ▶ **OS/400 XA support designed for SQL Interfaces**
- ▶ **Native code can participate in XA Transactions if they are "wrapped" as external stored procedures or user-defined functions**

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# Modernizing Data Access

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## *DB2 & New Application Models - Web Services*

### ■ **DB2 Web Services - WORF (Web Services Object Runtime Framework)**

- ▶ Easily create simple XML based Web services that access DB2 - part of Websphere Express
- ▶ Create DADX documents by using a simple text editor, and deploy them in Websphere with minimal knowledge of XML or SQL
- ▶ Used through Websphere and SOAP
  - SQL Select, Update, Insert, Delete, Procedures, etc.
  - XML Extender can also be used
- ▶ Read more at:

[www.iseriesnetwork.com/artarchive/index.cfm?fuseaction=viewarticle&CO\\_ContentID=17566&channel=art&subart=auth&authid=329](http://www.iseriesnetwork.com/artarchive/index.cfm?fuseaction=viewarticle&CO_ContentID=17566&channel=art&subart=auth&authid=329)

```
<?xml version="1.0"?>
<DADX xmlns="http://schemas.ibm.com/db2/dxx/dadx"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <documentation xmlns="http://schemas.xmlsoap.org/wsdl/">Accesses the city versus zip code database.
  </documentation>
  <operation name="findCityByZipCode">
    <documentation xmlns="http://schemas.xmlsoap.org/wsdl/">Finds the city for a zip code.
    </documentation>
    <query>
      <SQL_query>SELECT CITY FROM DEMO.CITY_TAB WHERE ZIPCODE = :zipcode</SQL_query>
      <parameter name="zipcode" type="xsd:string"/>
    </query>
  </operation>
</DADX>
```

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## Modernizing Data Access

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### *DB2 & New Application Models - XML & Text Mining*

- **DB2 Extenders provide low-level plumbing to allow you to concentrate on the business logic**
- **DB2 & XML Integration with DB2 XML Extender**
  - ▶ Allows an XML document to be stored & retrieved from a column
  - ▶ Enables XML document to be generated dynamically from existing DB2 data
  - ▶ Provides ability to decompose an XML document & generate new rows in your database
- **Text Mining with DB2 Text Extender**
  - ▶ High-speed, sophisticated searches for any character columns
    - Fuzzy searches
    - Search on tenses of word
    - Customize search to words in same sentence or paragraph
  - ▶ Can also search text documents stored in IFS
- **More Extender details at:**  
[ibm.com/servers/enable/site/education/ibo/record.html?db2udbext](http://ibm.com/servers/enable/site/education/ibo/record.html?db2udbext)

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# Modernizing Data Access

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## *Development Tools*

- **WebSphere Development Studio Client for iSeries**
  - ▶ DB2 Web Service Support
  - ▶ XML Extender Aids
  - ▶ SQL statement wizard
- **RSE & Code/400 co-exist with SQL**
- **PDM has basic SQL prompting support**
- **Visual Studio .NET Plugins** (Beta - <https://www6.software.ibm.com/reg/dm/dm-adtpapp-i>)
- **DB2 Information Integrator for non-DB2 data access**  
[ibm.com/servers/enable/site/education/ibo/record.html?hetdata](http://ibm.com/servers/enable/site/education/ibo/record.html?hetdata)
- **DB2 Development Center**
  - ▶ Stored Procedures
  - ▶ User-Defined Functions

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# Modernizing Data Access

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## *Development Tools*

- **Toolbox Graphical Debugger for ILE & SQL-source level debug**  
([ibm.com/servers/enable/site/education/abstracts/sqldebug\\_abs.html](http://ibm.com/servers/enable/site/education/abstracts/sqldebug_abs.html))
- **iSeries Navigator**
  - ▶ Editors for procedure, functions, triggers
  - ▶ SQL statement wizard for INSERT, SELECT, UPDATE
  - ▶ Downloadable Tutorials at:  
([ibm.com/servers/enable/education/i/ad/db2/recentindex1.html](http://ibm.com/servers/enable/education/i/ad/db2/recentindex1.html))
- **Visual Explain**
- **Database Monitor (STRDBMON CL command)**
- **PRTSQLINF**
- **DB2 SMP - licensed feature (OS/400 Option 26)**

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## Next Steps

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### ■ EDUCATION

- ▶ iSeries SQL Performance Workshop
  - [ibm.com/servers/eserver/iseries/service/igs/db2performance.html](http://ibm.com/servers/eserver/iseries/service/igs/db2performance.html)
  - [ibm.com/servers/enable/education/i/ad/db2/recentindex1.htm](http://ibm.com/servers/enable/education/i/ad/db2/recentindex1.htm)
- ▶ Indexing & Stats Strategy White Paper  
[ibm.com/servers/enable/site/education/ibo/record.html?indxng](http://ibm.com/servers/enable/site/education/ibo/record.html?indxng)
- Identify First Project
  - ▶ Write a new function/program component using SQL
  - ▶ Rewrite an existing component using SQL (ie, reporting function)
  - ▶ Port SQL-based program to DB2 UDB for iSeries
    - Porting guides & conversion tools at: [ibm.com/servers/enable/site/db2/porting.html](http://ibm.com/servers/enable/site/db2/porting.html)
- Get Help
  - ▶ Solutions Enablement DB2 Technology Team
  - ▶ eServer Custom Technology Center - [www.ibm.com/ctc](http://www.ibm.com/ctc)
  - ▶ iSeries IBM Global Services Team - [heithoff@us.ibm.com](mailto:heithoff@us.ibm.com)

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## DB2 UDB Family Certifications



### **Certified Database Associate - DB2 UDB Family (Test 700)**

- **Website:** [ibm.com/certify/certs/dbdaudv81.shtml](http://ibm.com/certify/certs/dbdaudv81.shtml)
- **Education Resources:** [ibm.com/certify/tests/edu700.shtml](http://ibm.com/certify/tests/edu700.shtml)
- **Online Tutorial:**  
[www7b.boulder.ibm.com/dmdd/library/tutorials/db2cert/db2cert\\_V8\\_tut.html](http://www7b.boulder.ibm.com/dmdd/library/tutorials/db2cert/db2cert_V8_tut.html)

### **Certified Application Developer - DB2 UDB Family (Test 703)**

- **Website:** [ibm.com/certify/certs/dbapudv81.shtml](http://ibm.com/certify/certs/dbapudv81.shtml)
  - **Education Resources:** [ibm.com/certify/tests/edu703.shtml](http://ibm.com/certify/tests/edu703.shtml)
- **Sample Tests:** [certify.torolab.ibm.com/ice](http://certify.torolab.ibm.com/ice)
- Exams were refreshed & updated for DB2 UDB for iSeries

## Additional Information

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- **DB2 UDB for iSeries home page** - <http://www.iseries.ibm.com/db2>
- **Newsgroups**
  - ▶ USENET: comp.sys.ibm.as400.misc, comp.databases.ibm-db2
  - ▶ iSeries Network (NEWS/400 Magazine) SQL & DB2 Forum - <http://www.iseriesnetwork.com/Forums/main.cfm?CFApp=59>
- **Education Resources - Classroom & Online**
  - ▶ [http://www.iseries.ibm.com/db2/db2educ\\_m.htm](http://www.iseries.ibm.com/db2/db2educ_m.htm)
  - ▶ <http://ibm.com/servers/enab/education/i/ad/db2/recentindex1.html>
- **DB2 UDB for iSeries Publications**
  - ▶ Online Manuals: <http://www.iseries.ibm.com/db2/books.htm>
  - ▶ Porting Help: <http://ibm.com/servers/enab/site/db2/porting.html>
  - ▶ DB2 UDB for iSeries Redbooks (<http://ibm.com/redbooks>)
    - [Stored Procedures & Triggers on DB2 UDB for iSeries \(SG24-6503\)](#)
    - [DB2 UDB for AS/400 Object Relational Support\\_ \(SG24-5409\)](#)
    - [Advanced Functions & Administration on DB2 UDB for iSeries \(SG24-4249\)](#)
  - ▶ ***SQL/400 Developer's Guide*** by Paul Conte & Mike Cravitz
    - <http://as400network.com/str/books/Uniquebook2.cfm?NextBook=183>

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