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Agenda Key:
Session Number:

V6R1 DB2 for i5/OS Overview

Presented by Jarek Miszczyk
DB2 for i5/OS Technology Team
IBM Rochester, MN



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DB2 for i5/OS V6R1 Enhancements

Application Flexibility & Portability

- **SQL & RPG Integration**
- **Enhanced JDBC & .NET support**
- **Skip Locked Data**
- **Extended Indicator Variables**
- **VALUES on FROM**
- **Hidden Timestamp Columns**
- **Improved DB2 Family Compatibility**
 - OLAP Support – Cube & Rollup
 - INSERT on FROM
 - Unsupported Syntax Tolerance
 - AES Encryption

OnDemand & Availability

- **Enhanced, online Reorg**
- **Library-level Journaling**

Performance

- **SQL Query Engine enhancements**
 - Sort sequence support
 - Self-Learning Optimizer
 - EVI-Only Processing
- **Derived SQL Indexes**
- **Faster Full Opens**
- **Client Special Registers**

Usability

- **System i Navigator Enhancements**
 - Customizable Performance Analysis
 - Spreadsheet integration
 - Plan Cache Enhancements
 - Index Advisor Improvements
- **DB2 Web Query for System i**
- **OmniFind Text Search Server**

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Application Development Enhancements

Enhancements for i5/OS Application Development

- Improved RPG & SQL Integration
 - IFS source file support
 - Improved Variable Scoping
 - Enhanced LIKE supports variables based on SQLCA variables (eg, SQLSTATE)
 - Improved WDSC integration for SQL source code error resolution
 - SQL support in IBM Application Development tools
 - SQL syntax highlighting
 - SQL statement(s) templates
 - Formatting
- ILE COBOL SQL Precompiler support for Unicode data
- Enhanced SQL Scripting
 - RUNSQLSTM support for IFS files
 - Larger & “Wider” SQL scripts
 - Improved db2 qshell utility

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RPG SQL Precompiler Variable Scoping

```

PSubProc1      B              EXPORT
D              PI
D OutArray      ds              qualified dim(1000)
D customer      25A
D region        25A
/free
    exec sql DECLARE c1 CURSOR FOR SELECT customer,region FROM cust_dim;
    exec sql OPEN c1;
    exec sql FETCH NEXT FROM c1 FOR 100 ROWS INTO :OutArray;
    exec sql CLOSE c1;
return;
/end-free

P              E
PSubProc2      B              EXPORT
D              PI
D OutArray      ds              qualified dim(1000)
D part          55A
D mfgr          25A
D brand         10A
/free
    exec sql DECLARE c2 CURSOR FOR SELECT part,mfgr,brand FROM part_dim;
    exec sql OPEN c2;
    exec sql FETCH NEXT FROM c2 FOR 200 ROWS INTO :OutArray;
    exec sql CLOSE c2;
return;
/end-free

```

V5R4 PTFs planned!

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Industry Standard Application Interface Improvements

- JDBC
 - JDBC 4.0
 - Alias support in Metadata APIs
 - Returning DEFAULT
 - Return update counts
- ADO.NET
 - Exploitation of ADO.NET 2.0
 - Visual Studio integration
 - Distributed transactions
 - Multi-row Insert
 - Enhanced data type support
- CLI
 - Wide API support for Unicode data
 - Alias support in Metadata APIs
 - Row-wise array INSERT
 - Complete ISO timestamp support

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Improved Scalability with Skip Locked Data

- By default, all DB2 requests wait for conflicting locks to be released
- SKIP LOCKED DATA clause can alter default behavior
 - Clause only honored with Cursor Stability(*CS) and Read Stability(*RS) levels
 - Clause can also be specified on Insert & Update statements

Executed at 11:30, not yet committed

```
UPDATE flights
SET departTime='05:25'
WHERE departTime = '04:30'
AND flightNum=331
AND destCity='HNL'
```

FLIGHTS

flightNum	destCity	departTime
...
4388	RST	08:23
331	HNL	05:25
3044	MSP	03:07
1025	SYD	02:45
389	HNL	06:10
...

Executed at 11:32

```
SELECT * FROM flights
WHERE
  departTime >= '05:15'
  AND destCity='HNL'
SKIP LOCKED DATA
```

Wait or Skip?

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INSERT on FROM (Select From Insert)

- Simplifies access to values generated by DB2 for identity columns
 - Prior support (IDENTITY_VAL_LOCAL function) required overhead of an extra SQL statement
 - Prior support had no solution for blocked Insert statements

Examples:

```
CREATE TABLE orders( order_id INTEGER AS IDENTITY,
                      order_date DATE,
                      order_qty INTEGER,
                      order_item CHAR(4));
```

```
SELECT order_id FROM FINAL TABLE (
  INSERT INTO orders VALUES(DEFAULT,'11/03/2007',50,'JM12'));
```

Result 1

```
SELECT order_id FROM FINAL TABLE (
  INSERT INTO orders VALUES(DEFAULT,'11/05/2007',12,'JM09'),
  (DEFAULT,'11/05/2007',1,'PC01'))
```

Result 2 3

```
ORDER BY INPUT SEQUENCE;
```

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VALUES on FROM

- Allows programmer to dynamically generate & populate temporary tables as part of the query definition
 - Enable SQL access of in-memory tables maintained by application
 - Supports table-less queries

Examples:

```
SELECT deptnum, deptname FROM org WHERE deptnum <20
UNION ALL
SELECT * FROM (VALUES(77,'New Department')) AS tmp(c1,c2)
```

```
WITH proposedRates(prType, prRate) AS ( VALUES(?,?),(?,?),(?,?),(?,?) )
SELECT rmttype, prRate, ((prRate - rmRate)/rmRate)*100 AS RateChgPercent
FROM rooms, proposedRates WHERE rmttype = prType
ORDER BY RateChgPercent DESC
```

SQL & DB2 Enhancements

Data Access Advancements

- SQL OLAP Extensions – Grouping Sets & Super Groups
- More “Flexible” FROM
 - VALUES on FROM
 - INSERT on FROM
 - FULL OUTER JOIN
- Expanded SQL Function Toolset
 - Data Encryption: ENCRYPT_AES
 - String Processing: ASCII & CHR
 - Date and Time Processing
 - TIMESTAMP_FORMAT & VARCHAR_FORMAT
 - MONTHS_BETWEEN
 - ROUND_TIMESTAMP & TRUNC_TIMESTAMP
- Limit Improvements
 - 120 columns on GROUP BY
 - 128-byte cursor and statement names
 - Partial support for 64K Result Set width (V5R4)

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Grouping Sets and Super Groups (ROLLUP & CUBE)

- Many BI applications and OLAP tools involve hierarchical, multi-dimensional aggregate views of transaction data
 - Users need to view results at multiple levels
 - Users need to view result data from different perspective
 - Current grouping support only allows aggregation data of along a SINGLE dimension

EXAMPLE: *SELECT country region, store, product, SUM(sales) FROM trans*
GROUP BY country region, store, product
 - Limitations result in extra coding for programmers
- V6R1 grouping and OLAP capabilities allow data to be grouped in multiple ways with a single SQL request
 - GROUPING SETS
 - ROLLUP
 - CUBE



**Less Coding
for Developers!**

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ROLLUP

- ROLLUP on GROUP BY clause results in DB2 returning aggregates for each level of the hierarchy implicitly represented in the grouping columns
 - ROLLUP(Country, Region) will result in the data being summarized at the following levels
 - (Country, Region)
 - (Country)
 - () << represents Grand Total

- **Example Query:**

```
SELECT country, region, SUM(sales)
FROM trans
GROUP BY ROLLUP (country, region)
```

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ROLLUP Output Example

```
SELECT country, region, SUM(sales) FROM trans
GROUP BY ROLLUP (country, region)
```

GROUP BY
country, NULL

GROUP BY
NULL, NULL

Country	Region	Sum(Sales)
Canada	-	100,000
Canada	NW	100,000
U.S.A.	-	3,250,000
U.S.A.	NE	450,000
U.S.A.	NW	940,000
U.S.A.	SE	550,000
U.S.A.	SW	1,310,000
-	-	3,350,000

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CUBE

- CUBE on GROUP BY clause results in DB2 returning aggregates for all possible distinct combinations represented by the grouping columns
 - CUBE(Country, Region) will result in the data being summarized at the following levels
 - (Country, Region)
 - (Country)
 - (Region)
 - () << represents Grand Total
 - Returns results at multiple intersection points
- **Example Query:**

```
SELECT country, region, SUM(sales)
FROM trans
GROUP BY CUBE(country, region)
```

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CUBE Output Example

```
SELECT country,region, SUM(sales) FROM trans
GROUP BY CUBE (country, region)
```

GROUP BY NULL, region →

GROUP BY NULL, NULL →

GROUP BY country, NULL →

Country	Region	Sum(Sales)
-	NE	450000
-	NW	1040000
-	SE	550000
-	SW	1310000
-	-	3350000
Canada	-	100000
U.S.A.	-	3250000
Canada	NW	100000
U.S.A.	NE	450000
U.S.A.	NW	940000
U.S.A.	SE	550000
U.S.A.	SW	1310000

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GROUPING SETS

- GROUPING SET on GROUP BY clause enables DB2 to return aggregates for multiple sets of grouping columns
 - GROUPING SETS((Country, Region), (Country, Store)) will result in the data being summarized at the following levels
 - (Country, Region)
 - (Country, Store)
 - CUBE and ROLLUP can be used in combination with Grouping Sets
 - **CAUTION:** These types of combinations can result in an exponential growth in the number of grouping sets returned by a query, combine carefully
- **Example Query:**

```
SELECT country, region, SUM(sales)
FROM trans
GROUP BY GROUPING SETS((country, region), (country, store))
```

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GROUPING SETS Output Example

```
SELECT country, region, store, SUM(sales) FROM trans
GROUP BY GROUPING SETS ((country, region), (country, store))
```

GROUP BY
COUNTRY, REGION

GROUP BY
COUNTRY, STORE

Country	Region	Store	Sum(Sales)
Canada	NW	-	100,000
U.S.A.	NE	-	450,000
U.S.A.	NW	-	940,000
U.S.A.	SE	-	550,000
U.S.A.	SW	-	1,310,000
Canada	-	Dougs	100,000
U.S.A.	-	Mariahs	350,000
U.S.A.	-	KMs	770,000
U.S.A.	-	Jennas	400,000
U.S.A.	-	Adrians	500,000
U.S.A.	-	Joshs	300,000
U.S.A.	-	TZs	200,000
U.S.A.	-	Maddies	210,000
U.S.A.	-	Dylans	520,000

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New Column Attributes – Hidden Timestamp

- Implicitly Hidden and Row Change Timestamp attributes enable DB2 to track row-level changes for you
 - Clauses can be used independently
 - Attributes frequently combined to create a Hidden Timestamp column
 - Hidden Timestamp Columns used to implement Optimistic Locking scheme
 - Read values in a row without an update lock
 - Perform calculations on fetched values
 - Update same row with new values, check timestamp column to see if row has changed

```
CREATE TABLE tickets(
  ticket_ord  INTEGER,
  ticket_qty  INTEGER,
  ticket_event VARCHAR(10),
  ticket_ts   TIMESTAMP NOT NULL
              IMPLICITLY HIDDEN
              FOR EACH ROW ON UPDATE AS ROW CHANGE TIMESTAMP);
INSERT INTO tickets VALUES(1,11,'mvGAME1'),
                          (2,8,'ihGAME4');
```

NOTE: Only 3 column values passed on INSERT

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New Column Attributes – Hidden Timestamp

Table contents after INSERT statement

SELECT * FROM tickets



TICKET_ORD	TICKET_QTY	TICKET_EVENT
1	11	mvGAME1
2	8	ihGAME4

Non-SQL interfaces
automatically
include any
hidden columns

Table contents after INSERT & UPDATE statements

UPDATE tickets SET ticket_qty = 6 WHERE ticket_ord = 2;

SELECT ticket_ord, ticket_qty, ticket_event, ticket_ts FROM tickets



TICKET_ORD	TICKET_QTY	TICKET_EVENT	TICKET_TS
1	11	mvGAME1	2007-11-26 16:19:08.516671
2	6	ihGAME4	2007-11-26 16:20:27.256864

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Unsupported Syntax Tolerance

- SQL parser enhanced to tolerate unsupported syntax that is not needed on DB2 for i5/OS
 - Unique architecture of i5/OS enables some SQL statements and clauses to be ignored
 - Speeds up porting process

Examples:

CREATE TABLESPACE TS1 MANAGED BY DATABASE USING (device '/dev/rcont \$N' 20000)

SQLSTATE: 01505 / SQLCODE: +143

Message: Statement CREATE TABLESPACE ignored.

CREATE TABLE newtab1 (c1 **INT**) **INDEX IN** ts1

SQLSTATE: 01680 / SQLCODE: +20367


Message: Clause INDEX IN ignored.

CREATE TABLE t1 (c1 **INT**) **IN** ts1

SQLSTATE: 42704 / SQLCODE: -204

Message: TS1 in L1 type *NODGRP not found.

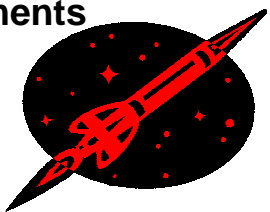
Performance Enhancements

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SQL Query Engine (SQE) Enhancements

- **Restriction Elimination**
 - National Language Sort Sequences
 - Translation support (UPPER, LOWER, etc)
 - User-Defined Table Functions
 - Remaining Restrictions
 - ICU 2.6.1 Sort Sequences
 - Non-SQL Interfaces (OPNQRYF, Query/400, QQQQRY api)
 - Logical File reference on FROM Clause
 - Select/Omit Logical Files defined on tables
- **Technological Advances**
 - Self-learning query optimization
 - Self-adjusting query execution
 - Faster optimization times
 - Smarter CASE processing

Default value for QAQQINI parameter:
IGNORE_DERIVED_INDEX
changed from *NO to *YES



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SQL Derived Indexes

- SQL key definitions support expressions, functions and operators enabling more usage of indexes by query optimizer on complex queries
 - Fully supported by SQE optimizer (limited support by CQE)
 - EXAMPLES:

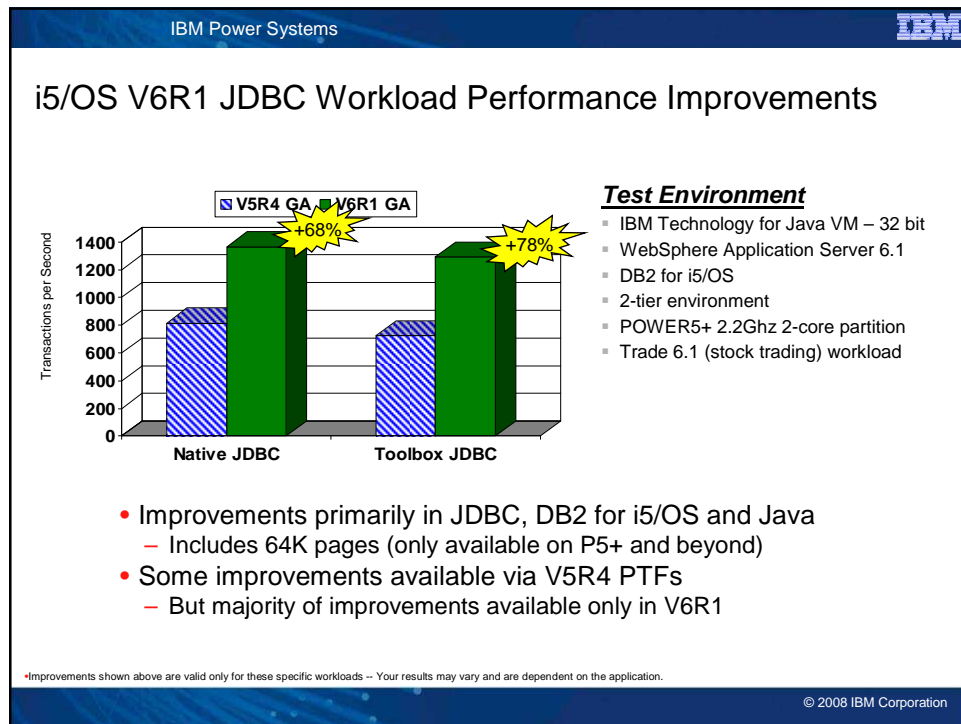
```
CREATE INDEX ix_TotalSalary ON employees (Sales + Bonus)
CREATE INDEX ix_FullName ON employees (CONCAT(CONCAT(FName, ' '), LName))
```
- Great for improving performance of case-insensitive searches


```
SELECT cust_id, cust_phone FROM customers
WHERE UPPER(company_name) = 'ACME'
```



```
CREATE INDEX ix_uCompName ON customers(UPPER(company_name))
```
- Create Index statement also supports the ability to create sparse indexes (ie, Select/Omit criteria) but there currently is no optimizer awareness
 - Short-term value: provide SQL replacement of DDS Select/Omit logicals
 - EXAMPLE: CREATE INDEX cust_ix1 ON customers(cust_id) WHERE activCust='Y'

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Ease of Use & Management Enhancements

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System i Navigator Enhancements

OnDemand Performance Center

- Spreadsheet Integration
- Column Customization
- Index Advice Condenser (PTF)
- Fast monitor summary compare
- Plan Cache Resize & Event Monitor
- Enhanced Plan Cache Analysis
- Visual Explain While Running
- Special Client Register

Run SQL Scripts

- Improved Font Size
- SQL Syntax Flagger
- Source Member Integration
- UTF-8 support

Database Management

- Show object locks (WRKOBJLCK)
- Schema-level Index Evaluator
- Enhanced SQL Details for Job

Health Center

- Environmental limits
- Journal and journal receivers
- Procedures and Packages
- Table activity

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System i Navigator – Index Advisor

- DB2 “Condenser” reviews and simplifies index advice for you
- Index Advisor now allows you to select and create multiple indexes with one click

Table for Which Index was Advised	Schema	Keys Advised	Index Type Advised	Last Advised for Query Use
QQUDFP004	HPT440	PHONEDP, KEYFLD	Binary Radix	11/12/07 10:32:11 AM
QQUDFP004	HPT440	MGRNUMS, KEYFLD	Binary Radix	11/12/07 10:36:42 AM
QQUDFP004	HPT440	PAGEPROTO	Binary Radix	11/12/07 10:32:09 AM
QQUDFP004	HPT440	EMPNUMC	Binary Radix	11/30/07 1:01:53 PM

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System i Navigator – Enhanced Index Evaluator

Environment: My Connections

Indexes for tables in QSYS2 - Y0551p2

Database: Y0551p2 Indexes for tables in QSYS2

SQL Name	Key Columns	Type	Last Query Use	Query Use Count
CHEMA...	Primary Key...	Primary Key...	12/21/07 10:46:55 AM	6488
SYSTEM...	Index	Index	12/21/07 1:01:51 PM	12587
ICPIC...	Index	Index	12/21/07 1:01:51 PM	182459

Context menu options: Definition, Generate SQL..., **Reset Usage Counts...**, Comments...

• Index usage stats can be reset to initiate “new” performance analysis

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System i Navigator – Enhanced Plan Cache Analysis

- Customized controls for systems pushing Plan Cache limits
 - Properties view allows you to change Cache size
 - Event Monitor can be started to “catch” statements removed from cache
 - Can manually delete or “pin” statements
- Additional data available when viewing Plan Cache contents
 - Average Processing Time
 - Plan Cache Score
 - Associated jobs

SQL Plan Cache Properties - Z2332p1(Z2332p1)

Description	Value
Time Of Summary	2007-08-13-20.15.02.83718
Active Query Summary	
Number of Currently Active Queries	21
Number of Queries Run Since Start	17322051
Number of Query Full Opens Since Start	3322485
Plan Usage Summary	
Current Number of Plans in Cache	425
Current Plan Cache Size	488 MB
Plan Cache Size Threshold	512 MB

SQL Plan Cache Event Monitor Wizard - Z2332p1(Z2332p1)

To limit the amount of data collected, specify which filters to use. When filters are provided, only statements that match the specified filter values will be captured.

☐ Minimum runtime for the longest execution of the statement: [] Seconds

☐ Statements that ran on or after this date and time: 2013/07/21 11:52 PM

☐ Statements the following user has ever run:

☐ Statements that are currently active

☐ Statements for which an index has been advised

☐ Statements for which statistics have been advised

☐ Include statements initiated by the operating system

☐ Statements that reference the following objects:

Schema	Name

☐ Statements that contain the following text:

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Additional Information

- DB2 for i5/OS Websites
 - Home Page: ibm.com/systemi/db2
 - DeveloperWorks Zone: ibm.com/developerworks/db2/products/db2i5OS
 - Porting Zone: ibm.com/servers/enable/site/db2/porting.html
- Newsgroups
 - USENET: comp.sys.ibm.as400.misc, comp.databases.ibm-db2
 - System i Network DB2 Forum - <http://systeminetwork.com/isnetforums/forumdisplay.php>
- Education Resources - Classroom & Online
 - ibm.com/systemi/db2/gettingstarted.html
 - ibm.com/partnerworld/wps/training/i5OS/courses
- DB2 for i5/OS Publications
 - White Papers: ibm.com/partnerworld/wps/whitepaper/i5OS
 - Online Manuals: ibm.com/systemi/db2/books.html
 - DB2 for i5/OS Redbooks (<http://ibm.com/redbooks>)
 - [Getting Started with DB2 Web Query for System i \(SG24-7214\)](#)
 - [OnDemand SQL Performance Analysis ... in V5R4 \(SG24-7326\)](#)
 - [Preparing for and Tuning the SQL Query Engine on DB2 for i5/OS \(SG24-6598\)](#)
 - [Modernizing iSeries Application Data Access \(SG24-6393\)](#)

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