



# DB2 for i → 7.2 Overview

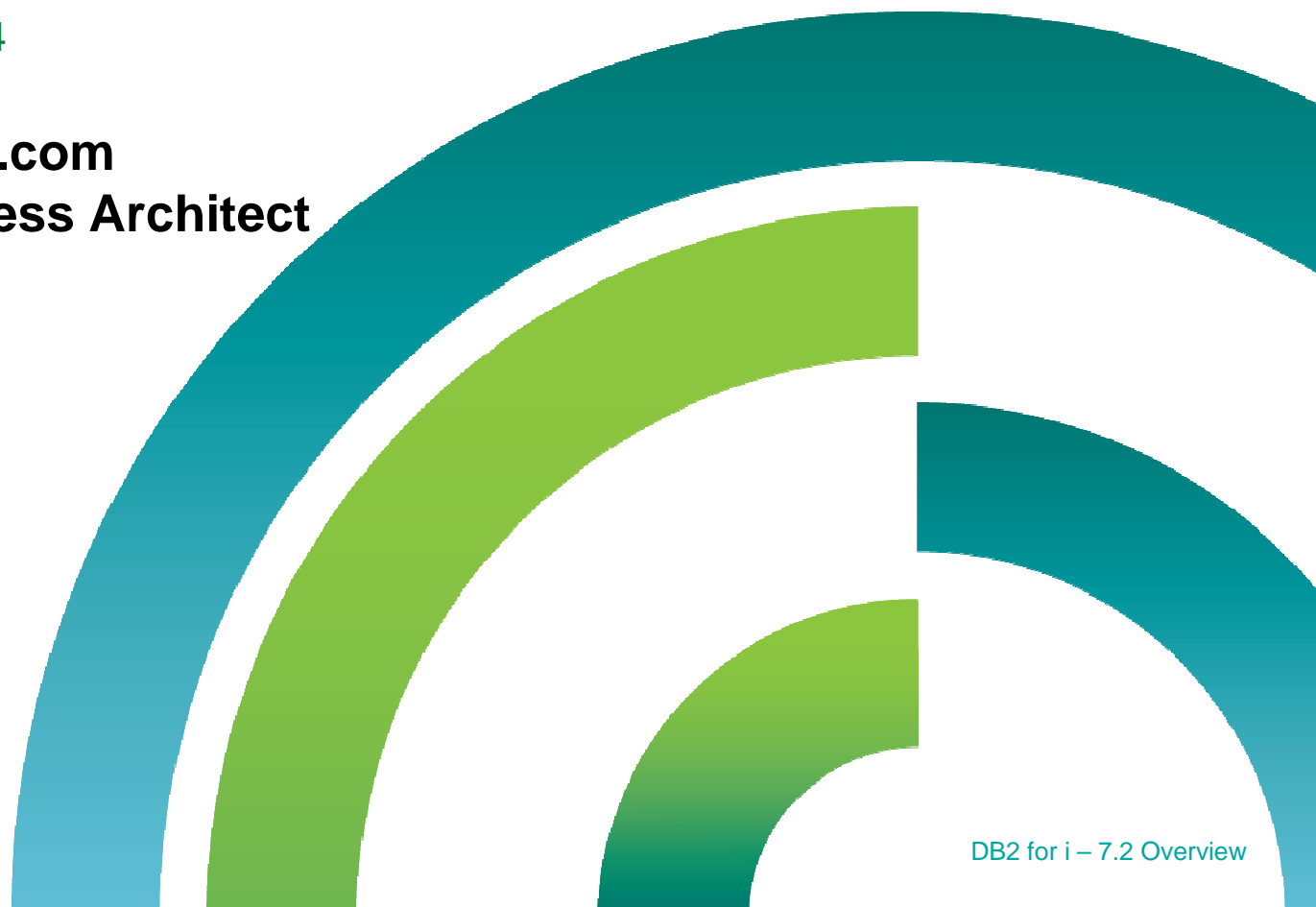
*for SEMIUG and WMSUG*

Power Systems 2014

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**DB2 for i Business Architect**



- DB2 for i**
- Standard compliant
  - Secure
  - Scalable
  - Functionally Advanced
  - Excellent Performance
  - Easier to use
  - Easier to maintain

**Value Proposition**

**Continual Investment and Innovation**

**V5R1**

- SQL triggers
- Java Functions
- DRDA DUW TCP/IP
- 2 GB LOBs
- 1 Terabyte Table
- Journal Minimal Data
- Two-phase over TCP/IP
- DDL Journaling
- Database Navigator
- Generate SQL

**V5R2**

- SQE Stage 1
- IASPs
- Identity columns
- Savepoints
- UNION in views
- Scalar subselect
- UDTFs
- DECLARE GLOBAL TEMPORARY TABLE
- Catalog views
- JDBC V3.0
- DRDA Kerberos
- Journal Standby

**V5R3**

- Partitioned tables
- UFT-8 and UTF-16
- ICU sort sequence
- MQTs
- Sequences
- Implicit char/numeric
- BINARY/VARBINARY
- GET DIAGNOSTICS
- DRDA Alias
- DECIMAL(63)
- SQE Stage 3
- Ragged SWA
- QDBRPLAY
- Online Reorganize

**V5R4**

- WebQuery
- SSD Memory Preference
- On Demand Performance Center
- Health Center
- Completion of SQL Core
- Scalar fullselect
- Recursive CTE
- INSTEAD OF triggers
- Descriptor area
- XA over DRDA
- DDM 2-phase
- Scrollable cursor
- 2M SQL statement
- 1000 tables in a query
- SQE Stage 5
- Implicit journaling enhancements

**6.1**

- Omnifind
- MySQL storage engine
- DECFLOAT
- Grouping sets /super groups
- INSERT in FROM
- VALUES in FROM
- Extended Indicator Variables
- Expression in Indexes
- ROW CHANGE TIMESTAMP
- Statistics catalog views
- CLIENT special registers
- SQE Stage 6
- DDM and DRDA IPv6
- Deferred Restore of MQT and Logicals
- Environmental limits

**7.1**

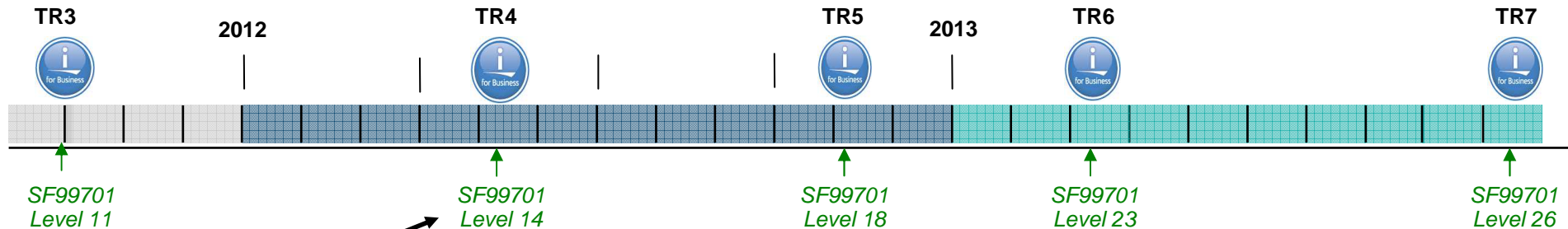
- XML Support
- Encryption enhancements (FIELDPROCS)
- Result set support in embedded SQL
- CURRENTLY COMMITTED
- MERGE
- MQ Functions
- Global variables
- Array support in procedures
- Partition table enhancements
- Three-part names and aliases
- SQE Logical file support
- SQE Adaptive Query Processing
- EVI enhancements
- Inline functions
- CREATE OR REPLACE

**7.2**

- Row and Column Access Control
- XMLTABLE
- CONNECT BY
- TRANSFER OWNERSHIP
- Named arguments and defaults for parameters
- Obfuscation of SQL routines & triggers
- Array support in UDFs
- Timestamp precision
- Multiple-action Triggers
- Built-in Global Variables
- Record movement between partitions on UPDATE
- 1.7 Terabyte Indexes
- Health Center – Non-database limits
- Navigator Graphing and Charting
- SQE I/O Costing model improvement
- TRUNCATE

# DB2 for i – Enhancements delivered via DB2 PTF Groups

## IBM i 7.1



**TR4 timed Enhancements:**

- Performance enhancements for large numbers of row locks
- Automatic management of SQL Plan Cache size
- Field Procedure Masking
- CPYTOIMPF order by
- Many Others...

**TR5 timed Enhancements:**

- InfoSphere Guardium V9.0 – DB2 for i
- SQE enhancement for Encoded Vector Indexes defined with INCLUDE
- SQL metrics in Collection Services
- Many Others...

**TR6 timed Enhancements:**

- Database Reorganization (User specified starting point)
- Tracking System Limits (Phase 1)
- Index Advice for ORs
- Many Others...

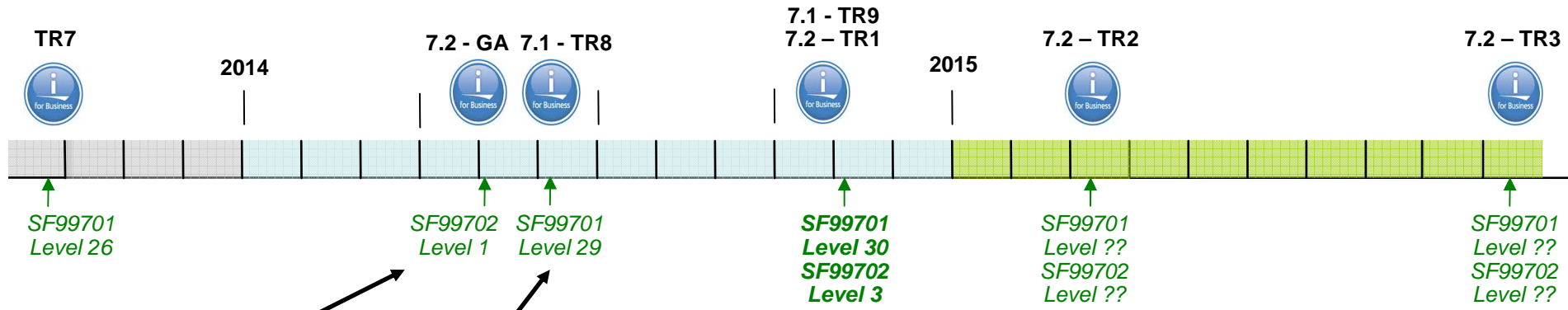
**TR7 timed Enhancements:**

- 1.7 TB Indexes
- Tracking System Limits (Phase 2)
- RDB Alias support for 3 part names
- Deferred restore for journals
- Plan Cache properties and controls
- Many Others...

**Enhancements delivered by PTF are documented here:**  
[www.ibm.com/developerworks/ibmi/techupdates/db2](http://www.ibm.com/developerworks/ibmi/techupdates/db2)  
**& in this article “A Hit Parade of DB2 for i Enhancements”**  
<http://iprodeveloper.com/database/hit-parade-db2-i-enhancements>

# DB2 for i – Enhancements delivered via DB2 PTF Groups

## IBM i 7.1 & 7.2



### 7.2 - GA

- First DB2 PTF Group for 7.2
- All IBM i 7.1 Enhancements thru TR8

### 7.1 - TR8 timed Enhancements:

- Faster JDBC Toolbox
- Use SQL to programmatically analyze performance
- Generate SQL procedure
- Program & Package statement level statistical catalogs
- Procedural alternative for Analyze Plan Cache Snapshot
- And more...

**IBM i 7.1 TR8 – Landing page for all 7.1 TR8 enhancements:**  
<http://www.ibm.com/developerworks/ibmi/techupdates/i71-TR8>

**IBM i 7.2 – Landing page for all 7.2 enhancements:**  
[www.ibm.com/developerworks/ibmi/techupdates/i72](http://www.ibm.com/developerworks/ibmi/techupdates/i72)

Enhancements delivered by PTF are documented here:  
[www.ibm.com/developerworks/ibmi/techupdates/db2](http://www.ibm.com/developerworks/ibmi/techupdates/db2)

# DB2 for i - 7.2 Enhancements by role - Security

## Security & DB2 for i

- Column Masks  
→ **Deploy “need to know” logic**
- Row Permissions  
→ **Simpler & safer security**
- Violation clause for CHECK constraints  
→ **Protect data integrity**
- Secure remote journal using SSL  
→ **Achieve HA & DR objectives without exposure**
- SQL alternative to CHGOBJOWN  
→ **Embrace separation of duty, using SQL**
- Use adopted authority identity within business logic  
→ **“Who am I?” conditional code using SQL**

## Data-Centric Security

- Comprehensive
- Auditable
- Sustainable
- Scalable
- Manageable



Data is an asset... what's your data worth?

## DB2 for i - 7.2 Enhancements by role - Performance

### Database Performance

- **SQE** enhancements:
  - Support for Native Queries
  - Improved I/O Costing Model
  - Enhanced implementation for IN list processing
- **Navigator** enhancements:
  - New PDI perspectives
  - Native Queries in the SQL Plan Cache
  - Enhanced SQL Plan Cache detail and tuning
- New system level resource...  
**Temporary Storage** consumption
- And other enhancements that were brought back to IBM i 7.1 alongside Technology Refreshes

### Out of the Box... what's **\*\*faster\*\***?

- ✓ **OPNQRYF & Query/400 complex queries**
- ✓ **I/O intensive queries**
- ✓ **Queries with long IN lists**

\*\* Disclaimer: Realized performance gains depends upon many factors



### New Services

- QSYS2/SYSTMPSTG catalog
- QSYS2/DUMP\_SNAP\_SHOT\_PROPERTIES() procedure

## DB2 for i - 7.2 Enhancements by role – App Dev

### Database Application Development

- Increased timestamp precision
- Named and Default parameter support on UDF/UDTFs
- Use of ARRAYS within UDF/UDTFs
- Obfuscation of SQL triggers
- Built-in Global Variables
- Expressions on PREPARE & EXECUTE IMMEDIATE
- Autonomous procedures
- CURRENT USER special register
- Constants in LANGUAGE SQL routines
- Unified debugger support for SQL functions
- Datetime scalar function improvements
- And other enhancements that were brought back to IBM i 7.1 alongside Technology Refreshes

### New SQL Statement

- TRUNCATE

### New Built-in Functions

- LPAD()
- RPAD()

New capabilities for solving business problems with **SQL** and **DB2 for i**



# SQL Query Engine (SQE) – Progression

## SQE Characteristics

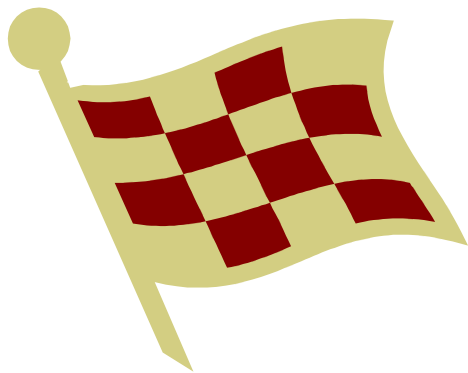
- Object Oriented Design
- Enhanced Performance for complex queries
- Enhanced Optimization Engine
- Separate Statistics Management
- Maintained Temporary Indexes
- Encoded Vector Indexes Enhancements
- Single, System-wide Plan Cache
- and much more...

## 6.1 → SQE

- **Translation support**
- **Lateral Correlation**
- **UDTF support**
- **Optimization time improvements**
- Other miscellaneous performance
- Simple Logical File support

## 7.1 → SQE

- **Logical File support**
- **Adaptive Query Processing (AQP)**
- **EVI Aggregate capability**
- **Global Statistics Cache**
- Other miscellaneous performance



## 7.2 → SQE

- **Native Opens including:**
  - **Open Query File (OPNQRYF)**
  - **Query/400 commands**
- **Improved I/O costing**
- Other miscellaneous performance



## DB2 for i & IBM i 7.2 – Other enhancements

### DBA/DBE

- Queued exclusive locks control
- SQL Server Mode detail in collection services
- SQL Details for Jobs enhancement
- Improved VARCHAR & LOB space management
- Automatic record movement between partitions

### Navigator for DBA/DBE

- **Performance Data Investigator (PDI)**
  - Investigate Data – DB2 category
  - SQL Plan Cache perspectives
  - Physical vs Logical I/O breakdowns
  - And more...
- **On Demand Performance Center**
  - Observance of Native Queries
  - Advanced Monitor Compare



### Navigator for DB App Dev

- **Support of all new SQL features**
  - Permissions
  - Masks
  - Named and default parameters
  - Obfuscation of Triggers
  - Arrays in UDFs/UDTFs
  - Create based ON

# DB2 for i & IBM i 7.2 – Reasons to Upgrade

## Why move to 7.2?

### 1. Major improvements for SQL & Native DB users

- Improved database performance, out of the box
- New capabilities to protect business critical data
- Improved insight into database workloads

*“faster”  
“safer”  
“easier to maintain”*



### 2. Major improvements for SQL application development

- User defined function advancements
- New DB2 built-in global variables, special register and more
- Enhanced SQL behavior
- Extended capabilities in Navigator & PDI

*“sustainable  
solutions for  
business  
computing”*

### 3. Position your company to receive future DB2 for i enhancements

- DB2 for i enhancements on the Technology Refresh (TR) cadence  
*Note: While 7.2 will include all enhancements, some will also be PTF'd to previous releases*

*“stay current,  
value extended”*

# DB Security – 7.2 Enhancements

## DB2 for i - 7.2 Enhancements by role - Security

### New SQL Statements for security

- CREATE PERMISSION
- ALTER PERMISSION
- CREATE MASK
- ALTER MASK
- ALTER TRIGGER
- TRANSFER OWNERSHIP

### New Boss Option

IBM Advanced Data Security for i  
**(Boss option 47)**  
 No Charge



*New tools in the toolbox...*

### New Built-in Function

- VERIFY\_GROUP\_FOR\_USER()

### New Function Usage ID

- QIBM\_DB\_SECADM

### New Catalogs

- QSYS2/SYSCONTROLS
- QSYS2/SYSCONTROLSDEP

### New Journal Entry Types

For journal code D - Database file:

- M1, M2, M3 for create/drop/alter mask
- P1, P2, P3 for create/drop/alter permission

For journal code T – Audit trail:

- AX for Row and Column Access Control
- X2 for Query manager profile changes

## Before 7.2

In order to grant or revoke privileges, a user must have one of the following:

1. Object ownership
2. Object management (\*OBJMGT) authority for the specified object.  
Note: A user with object management authority can grant to other users any authority that the user has, except object management authority
3. All object (\*ALLOBJ) user special authority

**Problem: If you are allowed to grant the SELECT privilege, you are also allowed to query the data.**

Does the Security administrator need to have access to data to do their job?

## IBM i 7.2

**A user with security administration function usage (QIBM\_DB\_SECADM) will be able to grant or revoke privileges on any object to anyone, even if they do not have the SELECT privilege.**

This enables the management of security, **without exposing the data** to be read or modified.

### Note that:

- Audit the SECADM users for \*SECURITY to ensure they are not granting themselves privileges to access the data
- Only QSECOFR or someone with \*SECADM authority can grant the security administrator function usage.

## Separation of Duty & DB2 for i - Use case exploration

### Meet the users:

- **MARYSEC** – A Security Officer responsible for granting and revoking security, including data security

```
CRTUSRPRF USRPRF(MARYSEC) PASSWORD(xxxxxxxx)
USRCLS(*SECADM) TEXT('Security Officer')
```

```
GRTOBJAUT OBJ(<data-libraries>) OBJTYPE(*LIB)
USER(MARYSEC) AUT(*USE)
```

```
CHGFCNUSG FCNID(QIBM_DB_SECADM)
USER(MARYSEC) USAGE(*ALLOWED)
```



- **FRANKDBA** – A Database Administrator with authority to do everything but change security settings

```
CRTUSRPRF USRPRF(FRANKDBA) PASSWORD(xxxxxxxx) USRCLS(*USER)
TEXT('Database Administrator')
SPCAUT(*ALLOBJ *JOBCTL *SAVSYS *SPLCTL)
```



- **JOEUSER** – An end user with no special authority (manager)

```
CRTUSRPRF USRPRF(JOEUSER) PASSWORD(xxxxxxxx)
USRCLS(*USER) TEXT('User with no special authorities')
```



## Separation of Duty & DB2 for i - Use case exploration

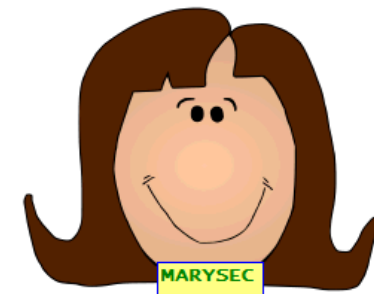
- **Database security can be managed on 7.2 without having \*ALLOBJ**

**Commands:**

CHGOBJOWN  
CHGOBJPGP  
GRTOBJAUT  
RVKOBJAUT  
EDTOBJAUT  
DSPOBJAUT  
WRKOBJ  
WRKLIB  
  
ADDAUTLE  
CHGAUTLE  
RMVAUTLE  
RTVAUTLE  
DSPAUTL  
DSPAUTLOBJ  
EDTAUTL  
WRKAUTL

**APIs: (also used by Navigator)**

qsyrtvua - retrieve users authorized to an object  
qsylusra - list users authorized to an object  
qsylatlo - list objects secured by an autl  
qsyrautu - retrieve users authorized to an object  
qsylautu - list authorized users  
qsyrusri - retrieve user information  
quslobj - list objects  
qgyolobj - open list of objects



**MARYSEC can manage database security  
(and more) without \*ALLOBJ or specific authorization**

- **Other aspects of managing security don't have this alternative authorization method for security officers**

## RCAC terminology

<b>Base Table</b>	The table (physical file) containing business critical data.
<b>Dependent Object</b>	Any object (file, schema, function, or other object) the permission or mask references.
<b>Permission</b>	<p>A row permission defines a row access control rule for rows of a table by setting an SQL search condition that describes the set of rows a user can access.</p> <p><b>0 to many → permissions allowed per table</b></p>
<b>Mask</b>	<p>A column mask defines a column access control rule for a specific column in a table by using an SQL CASE expression that describes what column values a user is permitted to see and under what conditions.</p> <p><b>0 or 1 → masks allowed per column</b></p>
<b>RULETEXT</b>	The expression to be used by the permission (WHERE clause predicates) or mask (selection CASE expression)



## IBM Advanced Data Security for i (Boss Option 47)

- **Option 47 must be installed** to:
  - CREATE PERMISSION and CREATE MASK (RCAC)
  - Open a file that has RCAC activated

```
5770SS1 47 IBM Advanced Data Security for i
```

- RCAC is **applied after checking object authorization** requirements
  - If you pass the object authorization check:
    - Row permissions reduce the set of rows returned
    - Column Masks limit full or partial access to sensitive column data
- **RCAC constructs exist within the table** (\*FILE)
- When ENABLED & ACTIVATED, **RCAC is automatically applied by SQE**
- **RCAC is comprehensive** and applies to every database interface (Native DB, SQL, RPG, APIs, Commands, etc)
- Only users with **QIBM\_DB\_SECADM** authority can manage RCAC

## Row and Column Access Control (RCAC)

```
CREATE MASK SSN_MASK ON EMPLOYEE
FOR COLUMN SSN RETURN
CASE
    WHEN (VERIFY_GROUP_FOR_USER(SESSION_USER, 'PAYROLL') = 1)
        THEN SSN
    WHEN (VERIFY_GROUP_FOR_USER(SESSION_USER, 'MGR') = 1)
        THEN 'XXX-XX-' CONCAT SUBSTR(SSN, 8, 4)
    ELSE NULL
END
ENABLE;
ALTER TABLE EMPLOYEE ACTIVATE COLUMN ACCESS CONTROL;
```

```
CREATE PERMISSION PATIENT_TABLE_HMO_PERMISSION
ON HOSPITAL.PATIENT_TABLE
FOR ROWS
WHERE((VERIFY_GROUP_FOR_USER(SESSION_USER, 'PCP') = 1 AND
        HOSPITAL.PATIENT_TABLE.PCP_ID = SESSION_USER) OR
        VERIFY_GROUP_FOR_USER(SESSION_USER, 'ACCTGROUP') = 1 OR
        VERIFY_GROUP_FOR_USER(SESSION_USER, 'RESGROUP') = 1)
ENFORCED FOR ALL ACCESS
ENABLE;
ALTER TABLE HOSPITAL.PATIENT_TABLE ACTIVATE ROW ACCESS CONTROL;
```

IBM Advanced Data Security for i  
(Boss option 47)  
No Charge

## Row Permission – Employee table example

- Many users have access to the employee table
- A row permission can be used to reduce access to data

```
CREATE OR REPLACE PERMISSION toystore7.permission_on_employee ON  
toystore7.employee FOR ROWS WHERE
```

```
(TOYSTORE7.manager_of_department = WORKDEPT)  
/* Managers see their department members */
```

```
OR (USER_PROFILE_NAME = USER)  
/* Random users can see their own row */
```

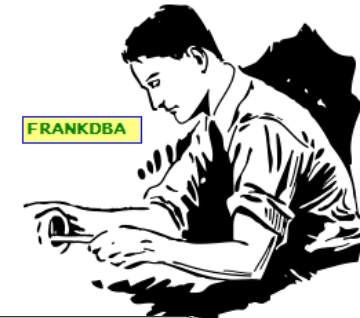
```
OR (VERIFY_GROUP_FOR_USER(SESSION_USER, 'DBATEAM') = 1)  
/* DBA's see every row */
```

```
ENFORCED FOR ALL ACCESS ENABLE;
```

An enabled and activated RCAC rule is automatically applied by SQE

## Row Permission – Employee table example

- FRANKDBA – what data does he see?



**SELECT SESSION\_USER, A.\* FROM toystore7.employee A**

SESSION_USER	EMPNO	FIRSTNME	M...	LASTNAME	WO...	P...	HIRE...	JOB	E...	..	BIRT...	SALARY
FRANKDBA	000010	CHRISTINE	I	HAAS	A00	3978	1965-...	PRE...	18	F	1933-...	52750.00
FRANKDBA	000020	MICHAEL	L	THOMPSON	B01	3476	1973-...	MAN...	18	M	1948-...	41250.00
FRANKDBA	000030	SALLY	A	KWAN	C01	4738	1975-...	MAN...	20	F	1941-...	38250.00
FRANKDBA	000050	JOHN	B	GEYER	E01	6789	1949-...	MAN...	16	M	1925-...	40175.00
FRANKDBA	000060	IRVING	F	STERN	D11	6423	1973-...	MAN...	16	M	1945-...	32250.00
FRANKDBA	000070	Joe	D	Smith	D21	7831	1980-...	MAN...	16	F	1953-...	36170.00
FRANKDBA	000090	EILEEN	W	HENDERSON	E11	5498	1970-...	MAN...	16	F	1941-...	29750.00
FRANKDBA	000100	THEODORE	Q	SPENSER	E21	0972	1980-...	MAN...	14	M	1956-...	26150.00
FRANKDBA	000110	VINCENZO	G	LUCCHESSI	A00	3490	1958-...	SAL...	19	M	1929-...	46500.00
FRANKDBA	000120	SEAN		O'CONNELL	A00	2167	1963-...	CLE...	14	M	1942-...	29250.00
FRANKDBA	000130	DELORES	M	QUINTANA	C01	4578	1971-...	ANA...	16	F	1925-...	23800.00
FRANKDBA	000140	HEATHER	A	NICHOLLS	C01	1793	1976-...	ANA...	18	F	1946-...	28420.00
FRANKDBA	000150	BRUCE		ADAMSON	D11	4510	1972-...	DES...	16	M	1947-...	25280.00
FRANKDBA	000160	ELIZABETH	R	PIANKA	D11	3782	1977-...	DES...	17	F	1955-...	22250.00
FRANKDBA	000170	MASATOSHI	J	YOSHIMURA	D11	2890	1978-...	DES...	16	M	1951-...	24680.00
FRANKDBA	000180	MARILYN	S	SCOUTTEN	D11	1682	1973-...	DES...	17	F	1949-...	21340.00
FRANKDBA	000190	JAMES	H	WALKER	D11	2986	1974-...	DES...	16	M	1952-...	20450.00
FRANKDBA	000200	DAVID		BROWN	D11	4501	1966-...	DES...	16	M	1941-...	27740.00
FRANKDBA	000210	WILLIAM	T	JONES	D11	0942	1979-...	DES...	17	M	1953-...	18270.00
FRANKDBA	000220	JENNIFER	K	LUTZ	D11	0672	1968-...	DES...	18	F	1948-...	29840.00
FRANKDBA	000230	JAMES	J	JEFFERSON	D21	2094	1966-...	CLE...	14	M	1935-...	22180.00
FRANKDBA	000240	SALVATORE										
FRANKDBA	000250	DANIEL										
FRANKDBA	000260	SYBIL										
FRANKDBA	000270	MARIA										
FRANKDBA	000280	ETHEL										
FRANKDBA	000290	JOHN	R	PARKER	E11	4502	1980-...	OPE...	12	M	1946-...	15340.00
FRANKDBA	000300	PHILIP	X	SMITH	E11	2095	1972-...	OPE...	14	M	1936-...	17750.00
FRANKDBA	000310	MAUDE	F	SETRIGHT	E11	3332	1964-...	OPE...	12	F	1931-...	15900.00
FRANKDBA	000320	RAMLAL	V	MEHTA	E21	9990	1965-...	FIE...	16	M	1932-...	19950.00
FRANKDBA	000330	WING		LEE	E21	2103	1976-...	FIE...	14	M	1941-...	25370.00
FRANKDBA	000340	JASON	R	GOUNOT	E21	5698	1947-...	FIE...	16	M	1926-...	23840.00
FRANKDBA	000350	STAN		HEFFNER	A00	3678	1965-...	PRE...	18	F	1933-...	46500.00

**VERIFY\_GROUP\_FOR\_USER(SESSION\_USER, 'DBATEAM') = 1)**  
**/\* DBA's see every row \*/**

## Row Permission – Employee table example

- MARYSEC – what data does she see?

**SELECT SESSION\_USER, A.\* FROM toystore7.employee A**



00001	EMPNO	FIRSTNME	M...	LASTNAME	WO...	P...	HIRE...	JOB	E...	..	BI...	SALARY
MARYSEC	000180	MARILYN	S	SCOUTTEN	D11	1682	1973-...	D...	17	F	194...	21340.00

**(USER\_PROFILE\_NAME = USER)**  
 /\* Random users can see their own row \*/

## Row Permission – Employee table example

- **JOEUSER** – what data does he see?

**SELECT SESSION\_USER, A.\* FROM toystore7.employee A**



select SESSION\_USER, A.\* from toystore7.employee A - Lp89ut27.rch.stglabs.ibm.com(Lp89ut27)

00001	EMPNO	FIRSTNME	M...	LASTNAME	WORKDEPT	P...	HIRE...	JOB	E...	..	B:
JOEUSER	000070	Joe	D	Smith	D21	7831	1980-...	MANAGER	16	F	19
JOEUSER	000230	JAMES	J	JEFFERSON	D21	2094	1966-...	CLERK	14	M	19
JOEUSER	000240	SALVATORE	M	MARINO	D21	3780	1979-...	CLERK	17	M	19
JOEUSER	000250	DANIEL	S	SMITH	D21	0961	1969-...	CLERK	15	M	19
JOEUSER	000260	SYBIL	P	JOHNSON	D21	8953	1975-...	CLERK	16	F	19
JOEUSER	000270	MARIA	L	PEREZ	D21	9001	1980-...	CLERK	15	F	19
JOEUSER	200240	ROBERT	M	MONTEVERDE	D21	3780	1979-...	CLERK	17	M	19

**(TOYSTORE7.manager\_of\_department = WORKDEPT)**  
**/\* Managers see their department members \*/**  
**OR**  
**(USER\_PROFILE\_NAME = USER)**  
**/\* Random users can see their own row \*/**

## Contrasting DB2 for i - Data Security

Technology	Field Procedures	Column Masks	Row Permissions	Views & Logical Files
<b>Use case</b>				
Supported IBM i OS releases	7.1, 7.2	7.2	7.2	6.1, 7.1, 7.2
Limit access to some/all data within a column	Yes	Yes	No	Yes
Limit access to rows	No	No	Yes	Yes
Security logic payload (customer experience)	External program (complex)	SQL rule (simple)	SQL rule (simple)	DDS or SQL (varies)
Software Vendor component	<ul style="list-style-type: none"> <li>• Townsend Security</li> <li>• Linoma</li> <li>• Enforcive</li> </ul>	None at this time	None at this time	N/A
Data encrypted at rest	Yes	No	No	No
Data encrypted in journal	Yes	No	No	No
Masked values apply to selection criteria	Yes	No	N/A	N/A
Data-Centric Solution	Yes	Yes	Yes	No
Success factors include: Strategy, Tuning & Consulting	Yes	Yes	Yes	No

## Other security oriented SQL statements

### ALTER TRIGGER

Triggers over files with active RCAC must be identified as SECURED

**ALTER TRIGGER Employee\_Insert\_Trigger <SECURED | NOT SECURED>**

**Pre-req for deployment of RCAC**

**ALTER TRIGGER Employee\_Insert\_Trigger <ENABLE | DISABLE>**

**Alternative to CL command for enabling / disabling triggers**

**Operations can be run under commitment control and rolled back**

### ALTER FUNCTION

Functions can be used in an RCAC rule, but they must be analyzed and approved by the Security administrator

**ALTER FUNCTION Return\_Name\_Function <SECURED | NOT SECURED>**

**Pre-req for deployment of RCAC**

Only the QIBM\_DB\_SECADM user can do these steps



## Other security oriented SQL statements

### TRANSFER OWNERSHIP

SQL statement that is similar to the CL command CHGOBJOWN

**TRANSFER OWNERSHIP OF TABLE mjatst.t1 TO USER paul  
PRESERVE PRIVILEGES**

Operation can be run under commitment control and rolled back

### Grant to GROUP and USER

Compatibility with DB2 Family

**GRANT ALL ON council TO USER frank WITH GRANT OPTION**

**GRANT ALL ON council TO GROUP marketing WITH GRANT OPTION**

Identifies whether the ID is a group or a user

# DB Application Development 7.2 Enhancements

## Named Arguments & Defaults for User-Defined Function Parameters

- Similar to Named & Default parameters for procedures (IBM i 7.1 → TR5), **IBM i 7.2 adds support for SQL and External User Defined Functions (UDFs)**
- This enhancement brings the usability found with CL Commands to UDFs/UDTFs
- Extend existing functions without fear of breaking existing callers!

```
CREATE OR REPLACE FUNCTION DEPTNAME (
  P_EMPID VARCHAR(6) , P_REQUESTED_IN_LOWER_CASE INTEGER DEFAULT 0
)
  RETURNS VARCHAR(30)
  LANGUAGE SQL
  D : BEGIN ATOMIC
  DECLARE V_DEPARTMENT_NAME VARCHAR ( 30 ) ;
  DECLARE V_ERR VARCHAR ( 70 ) ;
  SET V_DEPARTMENT_NAME = (
    SELECT CASE WHEN P_REQUESTED_IN_LOWER_CASE = 0 THEN D . DEPTNAME
      ELSE LOWER(D . DEPTNAME) END CASE
    FROM DEPARTMENT D , EMPLOYEE E
    WHERE E . WORKDEPT = D . DEPTNO AND
      E . EMPNO = P_EMPID ) ;
  IF V_DEPARTMENT_NAME IS NULL THEN
    SET V_ERR = 'Error: employee ' CONCAT P_EMPID CONCAT ' was not found'
  ;
  SIGNAL SQLSTATE '80000' SET MESSAGE_TEXT = V_ERR ;
  END IF ;
  RETURN V_DEPARTMENT_NAME;
  END D ;
```

```
VALUES ( DEPTNAME('000110' ),
        DEPTNAME('000110', 1 ),
        DEPTNAME('000110',
        P_REQUESTED_IN_LOWER_CASE=>1))
```

VALUES ( DEPTNAME('000110' ),	DEPTNAME('000110', 1 ),	DEPTNAME('000110', ... - Z1235p3.rch.stglabs.ibm.com(Z1235p3)
00001	00002	00003
SPIFFY COMPUTER SERVICE DIV.	spiffy computer service div.	spiffy computer service div.

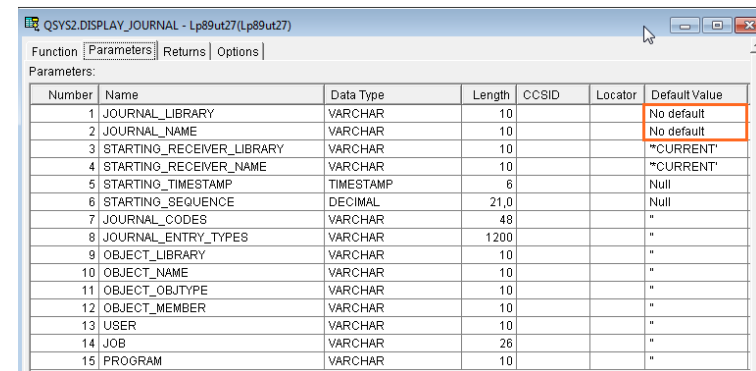
# Named Arguments and Defaults for User-Defined Function Parameters

Before 7.2 (must specify 15 parameters):

```

SELECT journal_code, journal_entry_type, object, object_type, X.*
FROM TABLE (
  QSYS2.Display_Journal(
    'PRODDATA', 'QSQJRN',           -- Journal library and name
    "", ""                          -- Receiver library and name
    , CAST(null as TIMESTAMP),      -- Starting timestamp
    CAST(null as DECIMAL(21,0)),    -- Starting sequence number
    "",                              -- Journal codes
    "",                              -- Journal entries
    "","",""                        -- Object library, Object name, Object type, Object member
    , 'SCOTT',                       -- User
    "",                              -- Job
    ""                              -- Program
  ) ) AS x
ORDER BY entry_timestamp DESC

```



Number	Name	Data Type	Length	CCSID	Locator	Default Value
1	JOURNAL_LIBRARY	VARCHAR	10			No default
2	JOURNAL_NAME	VARCHAR	10			No default
3	STARTING_RECEIVER_LIBRARY	VARCHAR	10			"CURRENT"
4	STARTING_RECEIVER_NAME	VARCHAR	10			"CURRENT"
5	STARTING_TIMESTAMP	TIMESTAMP	6			Null
6	STARTING_SEQUENCE	DECIMAL	21,0			Null
7	JOURNAL_CODES	VARCHAR	48			"
8	JOURNAL_ENTRY_TYPES	VARCHAR	1200			"
9	OBJECT_LIBRARY	VARCHAR	10			"
10	OBJECT_NAME	VARCHAR	10			"
11	OBJECT_OBJTYPE	VARCHAR	10			"
12	OBJECT_MEMBER	VARCHAR	10			"
13	USER	VARCHAR	10			"
14	JOB	VARCHAR	26			"
15	PROGRAM	VARCHAR	10			"

With 7.2 (leverage the optional parameters):

```

SELECT journal_code, journal_entry_type, object, object_type, X.*
FROM TABLE (
  QSYS2.Display_Journal(
    'PRODDATA', 'QSQJRN',           -- Journal library and name
    "USER" => 'SCOTT'              -- User
  ) ) AS x
ORDER BY entry_timestamp DESC

```


## Function resolution using casting rules

- Prior to 7.2, function resolution looked for an exact match
  - Match on function name
  - Match on # of parameters
  - Match on data type of parameters
- With 7.2, if DB2 for i doesn't find an exact match, it looks for the "best fit"
- Read the SQL Reference rules for details
- Basic rule, if CAST() is supported for the parameter data type mismatch, the function will be found
- Prior to this support, you would observe SQL0204 – Function not found

### For example:

```
CREATE OR REPLACE FUNCTION MY_CONCAT (
    FIRST_PART CHAR(10),
    SECOND_PART CHAR(50))
RETURNS VARCHAR(60)
LANGUAGE SQL
BEGIN
RETURN(FIRST_PART CONCAT SECOND_PART);
END;
```

**VALUES(MY\_CONCAT(123, 456789))**



VALUES(MY_CONCAT(123, 456789))
00001
123456789

## Function resolution using casting rules

- Character literal values are considered VARCHAR
- Passing character literal values to functions prior to 7.1 was difficult/annoying

**For example:**

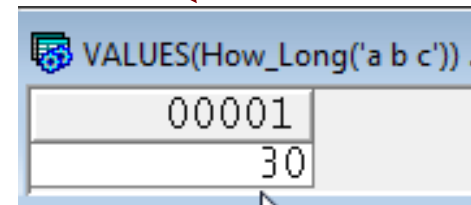
```
CREATE FUNCTION How_Long(NAME CHAR(30))  
RETURNS INT  
RETURN LENGTH(NAME);
```

**VALUES(How\_Long('a b c'))**

**Prior to 7.2**

**With 7.2**

```
> VALUES(How_Long('a b c'))  
SQL State: 42704  
Vendor Code: -204  
Message: [SQL0204] HOW_LONG in *LIBL type *N not found
```



VALUES(How_Long('a b c'))
00001
30

## Array Support in User-Defined Functions

Create a type that is an array

```
CREATE TYPE INTARRAY AS INTEGER ARRAY[20]
```

Create an SQL function that uses an the array type.

```
CREATE FUNCTION myfunction1 (Input_Identifiers INTARRAY)  
  RETURNS INTARRAY  
BEGIN  
  DECLARE ids intArray;  
  DECLARE c2 CURSOR FOR SELECT * FROM UNNEST(Input_Identifiers) AS x;  
  ...  
  SELECT ARRAY_AGG (name ORDER BY id) INTO ids FROM persons;  
  SET ids = ARRAY[5,6,7] ;  
  SET ids[4] = 8;  
  SET (maxcardo, cardo) = (MAX_CARDINALITY(ids), CARDINALITY(ids));  
  ...  
  RETURN ids;  
END
```

## Timestamp Precision

### Provides the ability to specify between 0 and 12 digits of precision

- Prior to IBM i 7.2, we only support 6 digits of timestamp precision
- For some applications this is no longer sufficient as systems get faster with many more processors.
- In other cases, this is more than needed
- Use ALTER TABLE to adjust existing tables
- Any precision between 0 and 12 is allowed

### CREATE TABLE x

**(C1 TIMESTAMP(12),** → Additional precision when 6 is not enough  
(moving from 6→12 consumes 3 additional bytes)

**C2 TIMESTAMP(0))** → Less precision (and storage) when 6 isn't needed  
(moving from 6→0 eliminates 3 bytes)



# Timestamp Precision → digging deeper

## Example: Compare the results of mixed precision time

```
create table corpdb.time_travel (
  old_time timestamp, /* identical to timestamp(6) */
  new_time timestamp(12), /* maximum precision */
  no_time timestamp(0),
  Last_Change TIMESTAMP NOT NULL IMPLICITLY HIDDEN FOR EACH ROW ON UPDATE AS ROW CHANGE TIMESTAMP)
insert into corpdb.time_travel values(current timestamp, current timestamp, current timestamp)
insert into corpdb.time_travel values(current timestamp, current timestamp(12), current timestamp)
```

```
select old_time, new_time, no_time, last_change from corpdb.time_travel
```

OLD_TIME	NEW_TIME	NO_TIME	LAST_CHANGE
2014-03-14 17:59:11.591834	2014-03-14 17:59:11.591834000000	2014-03-14 17:59:11	2014-03-14 17:59:11.616310
2014-03-14 17:59:12.560759	2014-03-14 17:59:12.560759566894	2014-03-14 17:59:12	2014-03-14 17:59:12.573743

```
select new_time - last_change as new_minus_last,
       new_time - old_time as new_minus_old,
       new_time - no_time as new_minus_no from corpdb.time_travel
```

NEW_MINUS_LAST	NEW_MINUS_OLD	NEW_MINUS_NO
-0.024476000000	0.000000000000	0.591834000000
-0.012983433106	0.000000566894	0.560759566894

The last change time occurs after the current timestamp is captured

Both the column precision & special register precision must change to achieve greater precision

DB2 for i support includes implicit data type and precision conversion

# TRUNCATE

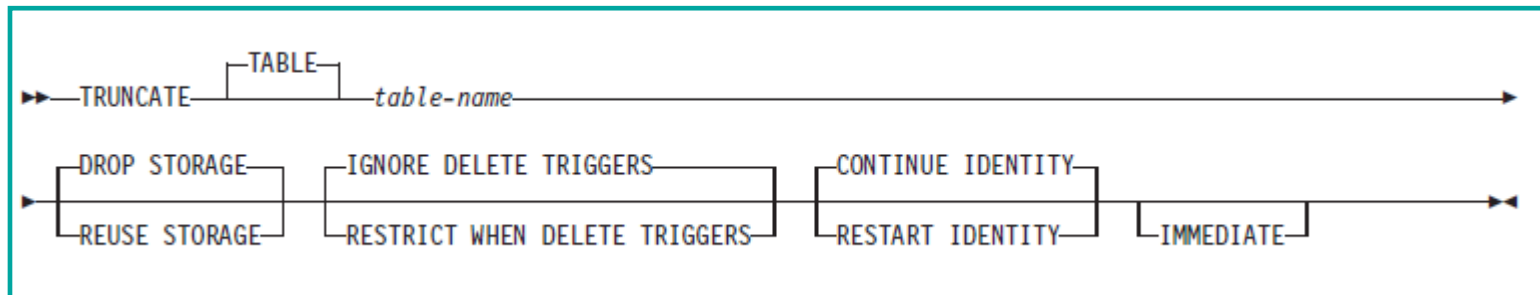
- Similar to “fast delete”
- Additional functions to
  - IGNORE or RESTRICT when delete triggers are present
  - CONTINUE or RESTART identity values
  - DROP or REUSE storage
  - IMMEDIATE performs the operation without commit even if running under commit

**TRUNCATE Order\_Table IGNORE DELETE TRIGGERS**

**TRUNCATE Order\_Table RESTRICT WHEN DELETE TRIGGERS IMMEDIATE**

**TRUNCATE Order\_Table CONTINUE IDENTITY**

**TRUNCATE Order\_Table RESTART IDENTITY IMMEDIATE**



## Built-in Global Variables

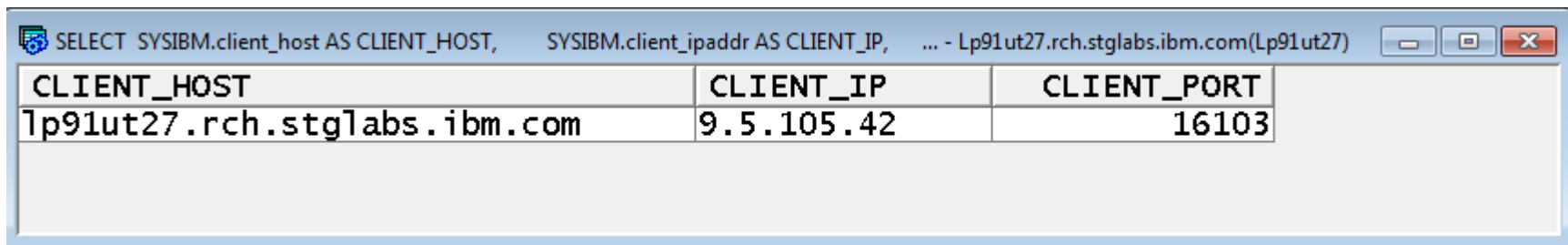
- Can be referenced anywhere a column name can be used
- DB2 for i maintains the value
- Can't be the targets of a data change operation (not settable)
- Will be set to NULL when not applicable

Variable name	Schema	Data Type	Size
CLIENT_IPADDR	SYSIBM	VARCHAR	128
CLIENT_HOST	SYSIBM	VARCHAR	255
CLIENT_PORT	SYSIBM	INTEGER	-
PACKAGE_NAME	SYSIBM	VARCHAR	128
PACKAGE_SCHEMA	SYSIBM	VARCHAR	128
PACKAGE_VERSION	SYSIBM	VARCHAR	64
ROUTINE_SCHEMA	SYSIBM	VARCHAR	128
ROUTINE_SPECIFIC_NAME	SYSIBM	VARCHAR	128
ROUTINE_TYPE	SYSIBM	CHAR	1

## Built-in Global Variables – Client information

- Two ways to extract the detail
- Global variables fit nicely into View definitions & RCAC masks/permissions

```
SELECT SYSIBM.client_host AS CLIENT_HOST,
       SYSIBM.client_ipaddr AS CLIENT_IP,
       SYSIBM.client_port AS CLIENT_PORT
FROM LP92UT27.SYSIBM.SYSDUMMY1
```

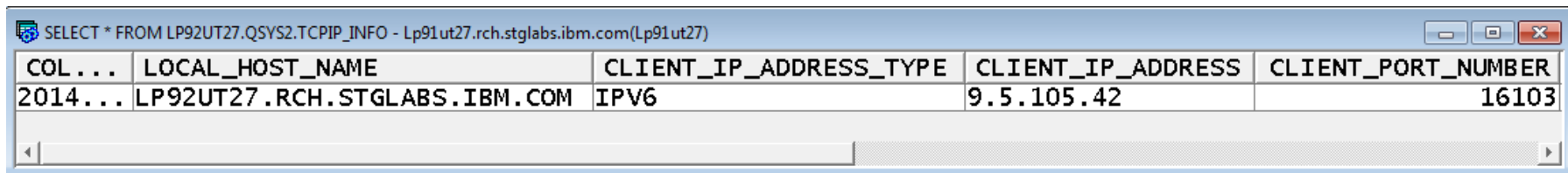


The screenshot shows a query window with the following SQL statement and result:

```
SELECT SYSIBM.client_host AS CLIENT_HOST,
       SYSIBM.client_ipaddr AS CLIENT_IP,
       SYSIBM.client_port AS CLIENT_PORT
FROM LP92UT27.SYSIBM.SYSDUMMY1
```

CLIENT_HOST	CLIENT_IP	CLIENT_PORT
lp91ut27.rch.stglabs.ibm.com	9.5.105.42	16103

```
SELECT * FROM LP92UT27.QSYS2.TCPIP_INFO
```



The screenshot shows a query window with the following SQL statement and result:

```
SELECT * FROM LP92UT27.QSYS2.TCPIP_INFO
```

COL ...	LOCAL_HOST_NAME	CLIENT_IP_ADDRESS_TYPE	CLIENT_IP_ADDRESS	CLIENT_PORT_NUMBER
2014...	LP92UT27.RCH.STGLABS.IBM.COM	IPV6	9.5.105.42	16103

## CURRENT\_USER special register

The CURRENT USER special register specifies the primary authorization ID that is being used for statement authorization. In other words, in a program that adopts authority, it will return the adopted profile name.

### Useful anywhere identity is helpful (masks, permissions, triggers, etc...)

When multiple authorization IDs have been adopted within a thread, the value of the **most recently adopted authorization ID** within the thread will be returned.

```
CREATE MASK SSN_MASK ON EMPLOYEE
FOR COLUMN SSN RETURN
CASE
  WHEN (VERIFY_GROUP_FOR_USER(CURRENT_USER,'PAYROLL') = 1)
    THEN SSN
  WHEN (VERIFY_GROUP_FOR_USER(CURRENT_USER,'MGR') = 1)
    THEN 'XXX-XX-' CONCAT SUBSTR(SSN,8,4)
  ELSE NULL
END
ENABLE;
```



Deploying Column Mask logic  
based upon Adopted authority

## Special registers – similar names, different purposes

**USER this, USER that... which one should I use?**

Special Register	Definition
<b>USER</b> or <b>SESSION_USER</b>	The <u>effective user</u> of the thread is returned.
<b>SYSTEM_USER</b>	The authorization ID that <u>initiated the connection</u> is returned.
<b>CURRENT_USER</b> or <b>CURRENT_USER</b>	The most recently <u>adopted authorization ID</u> within the thread will be returned.  When no adopted authority has occurred, the effective user of the thread is returned.

# Expressions in PREPARE and EXECUTE IMMEDIATE

Before:

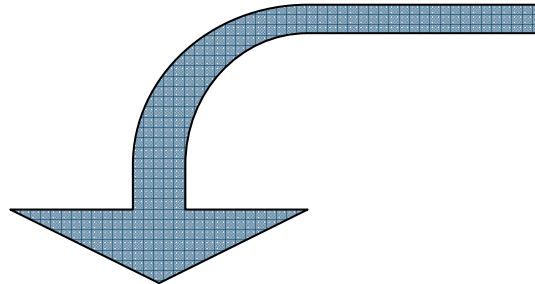
```
SET var_total_stmt = var_select_stmt CONCAT var_orderby;
PREPARE stmt1 FROM var_total_stmt;
```

After:

```
PREPARE stmt1 FROM var_select_stmt CONCAT var_orderby;
```

Achieve “Set at a Time” in a new way

One statement replaces many...



```
SET INSERT_STMT = 'INSERT INTO QTEMP.TMPIDXADV SELECT * FROM QSYS2.CONDENSEDINDEXADVICE WHERE ' ;
IF ( P_LIBRARY IS NOT NULL ) THEN
    SET WHERE_CLAUSE = ' TABLE_SCHEMA = ''' CONCAT
        RTRIM ( P_LIBRARY ) CONCAT ''' AND ' ;
ELSE
    SET WHERE_CLAUSE = ' ' ;
END IF ;
IF ( P_FILE IS NOT NULL ) THEN
    SET WHERE_CLAUSE = WHERE_CLAUSE CONCAT ' SYSTEM_TABLE_NAME = '''
    CONCAT RTRIM ( P_FILE ) CONCAT ''' AND ' ;
END IF ;
IF ( P_TIMES_ADVISED IS NOT NULL ) THEN
    SET WHERE_CLAUSE = WHERE_CLAUSE CONCAT ' TIMES_ADVISED >= '
    CONCAT P_TIMES_ADVISED CONCAT ' AND ' ;
END IF ;
IF ( P_MTI_USED IS NOT NULL ) THEN
    SET WHERE_CLAUSE = WHERE_CLAUSE CONCAT ' MTI_USED >= '
    CONCAT P_MTI_USED CONCAT ' AND ' ;
END IF ;
IF ( P_AVERAGE_QUERY_ESTIMATE IS NOT NULL ) THEN
    SET WHERE_CLAUSE = WHERE_CLAUSE CONCAT
        ' AVERAGE_QUERY_ESTIMATE >= ' CONCAT
        P_AVERAGE_QUERY_ESTIMATE CONCAT ' AND ' ;
END IF ;
SET WHERE_CLAUSE = WHERE_CLAUSE CONCAT ' NLSS_TABLE_NAME = '''*HEX''' ' ;
SET INSERT_STMT = INSERT_STMT CONCAT WHERE_CLAUSE ;
EXECUTE IMMEDIATE INSERT_STMT ;
```

```
EXECUTE IMMEDIATE 'INSERT INTO QTEMP.TMPIDXADV SELECT * FROM QSYS2.CONDENSEDINDEXADVICE WHERE ' CONCAT
CASE WHEN P_LIBRARY IS NOT NULL THEN ' TABLE_SCHEMA = ''' CONCAT RTRIM ( P_LIBRARY ) CONCAT ''' AND ' ELSE '' END CONCAT
CASE WHEN P_FILE IS NOT NULL THEN ' SYSTEM_TABLE_NAME = ''' CONCAT RTRIM ( P_FILE ) CONCAT ''' AND ' ELSE '' END CONCAT
CASE WHEN P_TIMES_ADVISED IS NOT NULL THEN ' TIMES_ADVISED >= ' CONCAT P_TIMES_ADVISED CONCAT ' AND ' ELSE '' END CONCAT
CASE WHEN P_MTI_USED IS NOT NULL THEN ' MTI_USED >= ' CONCAT P_MTI_USED CONCAT ' AND ' ELSE '' END CONCAT
CASE WHEN P_AVERAGE_QUERY_ESTIMATE IS NOT NULL THEN ' AVERAGE_QUERY_ESTIMATE >= ' CONCAT P_AVERAGE_QUERY_ESTIMATE CONCAT ' AND ' ELSE '' END CONCAT
' NLSS_TABLE_NAME = '''*HEX''' ' ;
```

# Obfuscation of SQL Triggers

- Obfuscation provides the capability of optionally obscuring proprietary SQL statements and logic within SQL procedures, functions & triggers
- **This support can be used to prevent others from seeing or changing SQL routines & triggers**

Generate SQL - Z1235p3.rch.stglabs.ibm.com(Z1235p3)

SQL will be generated for the following objects:

Name	Schema	Type
CL_TRIG1	BURNER1D	Trigger
DEFAULT_CLASS_END	BURNER1D	Trigger
GLOB_TEMP_TRIG	BURNER1D	Trigger
INSERT_EMPLOYEE	BURNER1D	Trigger
SHOW_SVPT_TRIG	BURNER1D	Trigger
SHOW_TRANS_TRIG	BURNER1D	Trigger
SHOW_TRANS_TRIG2	BURNER1D	Trigger
VALIDATE_SCHED	BURNER1D	Trigger

Output Options | Format

Standards

ANSI / ISO

DB2 family

Extensions

Output

Statements formatted for readability

SQL privilege statements

System names for objects

Schema qualify names for objects

Column CCSID values

Drop statements

Labels and comments

Associated constraints and triggers ( for table objects )

Informational messages

OR REPLACE clause

Obfuscate ( for SQL function, procedure, and trigger objects )



```
-- Generate SQL
-- Version: V7R2M0 140418
-- Generated on: 04/28/14 14:28:23
-- Relational Database: Z1235P3
-- Standards Option: DB2 for i
CREATE OR REPLACE TRIGGER BURNER1D.CL_TRIG1
WRAPPED QS0Q7020
aacxw8p1w8FrG8prG8VHG8Fr68VH68Vn18:d38FF3qpdw8pdw8phZ9ptj
Jx4dOLxXjXqbP5FuWetaWctaYG3Km2qs_euPemNwEOyNNQ5q41Tkent3j
83IJy2ATY8Np2mIe:HdfX7DGmeePjflIBwICJg72670tDg4BeIJ3Rwnqt
y07obdRL5TirawVVFGF05Ia5nDnETgUDDiSaIzezYrIR8QkFQGTPv:kRe
5icuopwbJFLZZrMy4bb28yam9uppSDz2CJ6dG3nf2:opWBtKuyn5l_DtP
oTOUH:d:BvqXjQHqjBukEEcJ0ziZcrW:jjp1P_N2q270G01uw_Sb9Ph4hx
5EK9yxYt2kXahN:If458Q3_M7CTwRtD0cJyaiOni dr:z8_9VQyw:FznZhf
t5wy5UvcVvIKXCj1jNtIXvPa7jLh2aQTjMGC8Lkz_YUJJ2FrVM8BXvLG
e30PIfiVRFQM2vSzzQBKQrL5duthWg4AOzPIWYqcbjKmM1UvsT1a72uP0
zjp5EkhtSJjimpYH0Bf5LlNoPVafv4c2d:5FTS0QIgvHjTaoqTSHMaDIV
refEIJDCDD0sQycVGQt3EzvLbzKkNLE:6TdhZFEHMo42mQ0AW441YCrA_
GcEYqHg3I_lBRQ2uFxpXcaEV10jQctmQbL0PG64yavEwwKeuSX7va6Gj
gueZzbIapzQBMwhezda05Zi5dY0vUPQDDo1KGfVhoWuJxqkUsdVwc_v_c
AiqrXYJ6Ihz8DTDMEihy1DMYca4RX1zEr0EuIjo7E34X9ZTT6x8wLHFG0
7dDrX:PyrPF5etEKnoPp1iTN:LKEtTqZ6SwKmV3Lhk1IDtGpzpbkVUBAU
ANpi04Dk4HwvDZc6e3mQA1oAwPip1sFShtGkJW_oF;

CREATE OR REPLACE TRIGGER BURNER1D.DEFAULT_CLASS_END
WRAPPED QS0Q7020
aacxw8p1w8FrG8prG8VHG8Fr68VH68Vn18:F18ph5qpdw8pdw8pdZ9:dK
u3rRixVh9ZhyLwWmkHXN_SXp10T58V10e17isGqBJTa7FF1fkvrEGZM0
T4Nmy0f48YyBGRDJvPvS6U4ogATNzxVtT3RRYqqEVsGi2NcAdvOpFzw79
01p5NyZDXAdJ04sjZBpBJdG_2Vnyk9AkmmL_9mYTErdcXM55nngAFQaEi
zR9m85_Fzf1tZ1djrS7iUQEFwLu6HhGQvcl714o1MvbjTjOfsjSZhy85j

CREATE OR REPLACE TRIGGER BURNER1D.GLOB_TEMP_TRIG
WRAPPED QS0Q7020
aacxw8p1w8FrG8prG8VHG8Fr68VH68Vn19phW8Vd5qpdw8pdw8pd09FhI
```

**Obfuscation of Procedures & Functions was PTF'd back to IBM i 7.1**



## Autonomous Procedures

An autonomous procedure is one that is executed in a unit of work that is independent from the calling application.

Similar to running **COMMIT(\*NONE)** except that you can do commit or rollback inside the autonomous procedure and the commit and rollback is independent of the calling application.

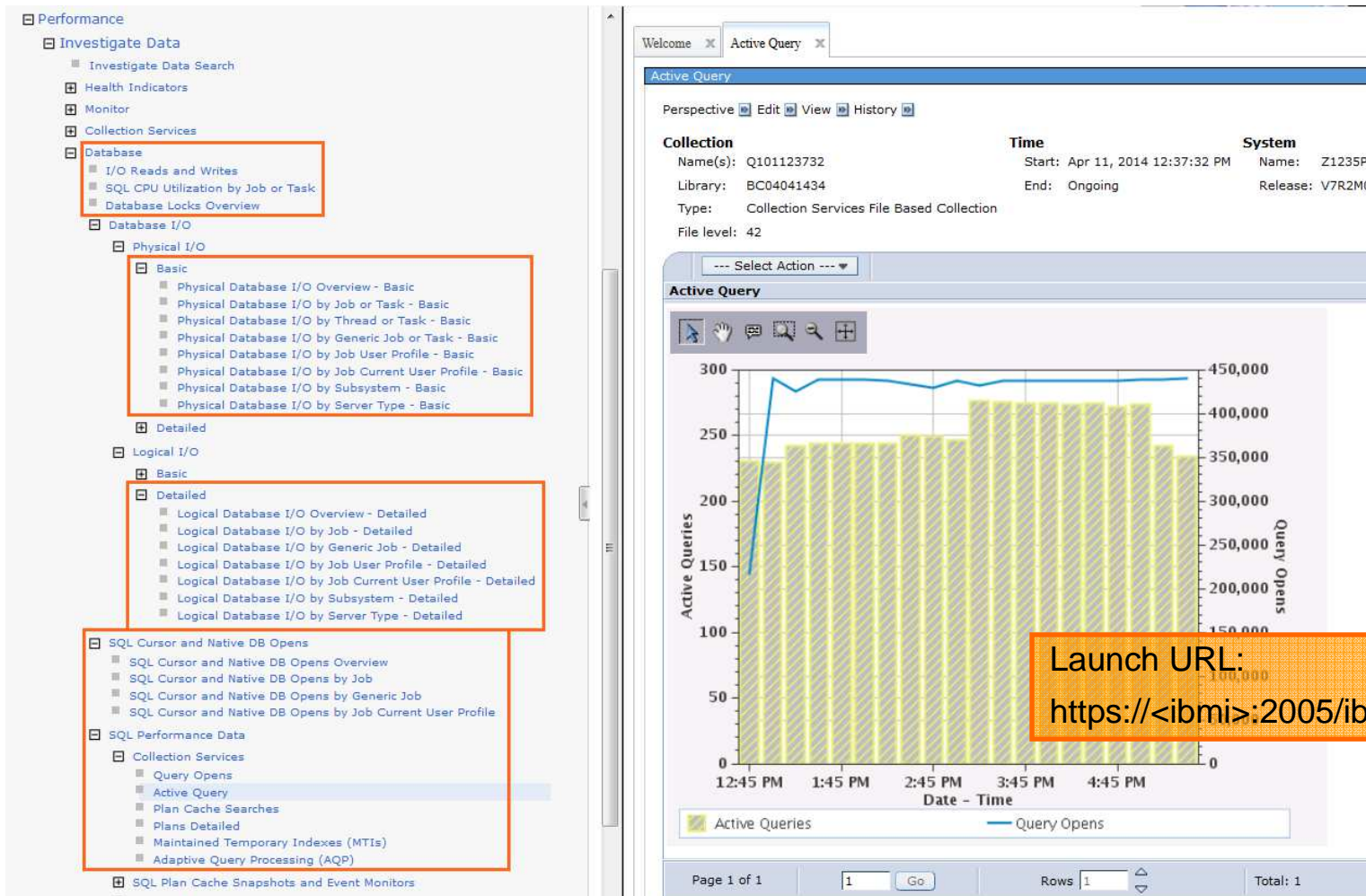
```
CREATE PROCEDURE writelog (loginfo VARCHAR(1000)  
AUTONOMOUS  
BEGIN  
...  
INSERT INTO SCOTT.TRACKING_TABLE VALUES(LOGINFO);  
...  
END
```

Autonomous procedures use the named activation group 'QSQAUTOAG'.

# DB Performance – 7.2 Enhancements

# Performance Data Investigator (PDI) and Database

- Abundant amount of new perspectives... helping you to quickly answer important questions



The screenshot shows the Performance Data Investigator (PDI) interface. On the left is a navigation tree under 'Performance' > 'Investigate Data'. Several items are highlighted with orange boxes:

- Database
  - I/O Reads and Writes
  - SQL CPU Utilization by Job or Task
  - Database Locks Overview
- Database I/O
  - Physical I/O
    - Basic
      - Physical Database I/O Overview - Basic
      - Physical Database I/O by Job or Task - Basic
      - Physical Database I/O by Thread or Task - Basic
      - Physical Database I/O by Generic Job or Task - Basic
      - Physical Database I/O by Job User Profile - Basic
      - Physical Database I/O by Job Current User Profile - Basic
      - Physical Database I/O by Subsystem - Basic
      - Physical Database I/O by Server Type - Basic
    - Detailed
  - Logical I/O
    - Basic
      - Detailed
        - Logical Database I/O Overview - Detailed
        - Logical Database I/O by Job - Detailed
        - Logical Database I/O by Generic Job - Detailed
        - Logical Database I/O by Job User Profile - Detailed
        - Logical Database I/O by Job Current User Profile - Detailed
        - Logical Database I/O by Subsystem - Detailed
        - Logical Database I/O by Server Type - Detailed
  - SQL Cursor and Native DB Opens
    - SQL Cursor and Native DB Opens Overview
    - SQL Cursor and Native DB Opens by Job
    - SQL Cursor and Native DB Opens by Generic Job
    - SQL Cursor and Native DB Opens by Job Current User Profile
  - SQL Performance Data
    - Collection Services
      - Query Opens
      - Active Query
      - Plan Cache Searches
      - Plans Detailed
      - Maintained Temporary Indexes (MTIs)
      - Adaptive Query Processing (AQP)
    - SQL Plan Cache Snapshots and Event Monitors

On the right, the 'Active Query' window shows details for a query with ID Q101123732. Below the details is a chart titled 'Active Query' showing 'Active Queries' (left Y-axis, 0-300) and 'Query Opens' (right Y-axis, 0-450,000) over time (Date - Time, 12:45 PM to 4:45 PM). The chart features a blue line for 'Active Queries' and a yellow hatched bar chart for 'Query Opens'. A legend at the bottom identifies the series. An orange callout box contains the text: 'Launch URL: https://<ibmi>:2005/ibm/console/logon.jsp'. The bottom status bar shows 'Page 1 of 1', '1' items, 'Rows 1', and 'Total: 1'.

# SQE - I/O Cost Model Enhancement

- **Motivation**
  - Query optimizer needs to know how much time it's going to take to access an object (scan a table, probe an index)
  - Original I/O Cost model assumption: 25 msec access time per I/O for all H/W
  - Hardware has changed *a lot* since V5R2 (e.g. faster and smaller HDDs, external storage, SSDs)
  - I/O implementation and execution algorithms diverged from model over time
  - Big Data paradigm means more dependency on I/O cost model correctness
- **Costing Change @ 7.2**
  - New method to **sample actual access times** rather than hard-code a fixed time; Every system will have unique I/O performance metrics tracked over time
  - Sampling enables optimizer to distinguish unique performance characteristics of internal, external, and solid state storage devices
- **Result**
  - **SQE has more accurate I/O detail when costing plans**



# SQE - I/O Cost Model Enhancement

- Typical access times for modern disks:

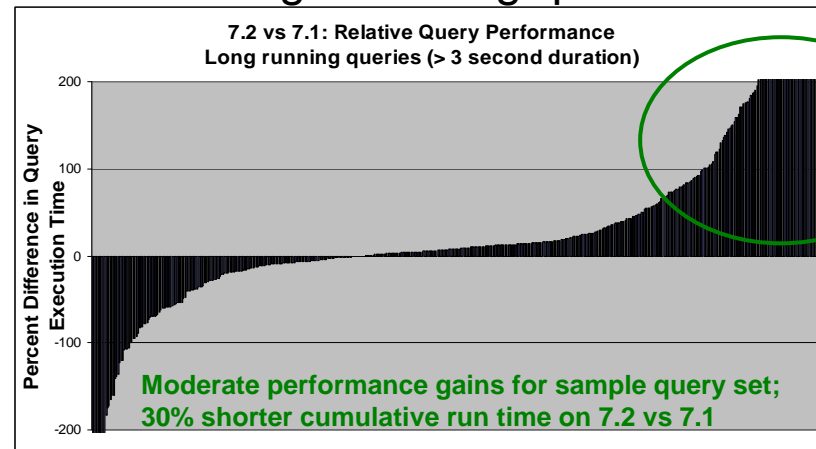
HDDs	4-10 msec
External Disks/SAN	1-6 msec
SSDs	< 1 msec
Original SQE Model	25 msec

- Relative cost of I/O is now lower; SQE processes I/O more aggressively

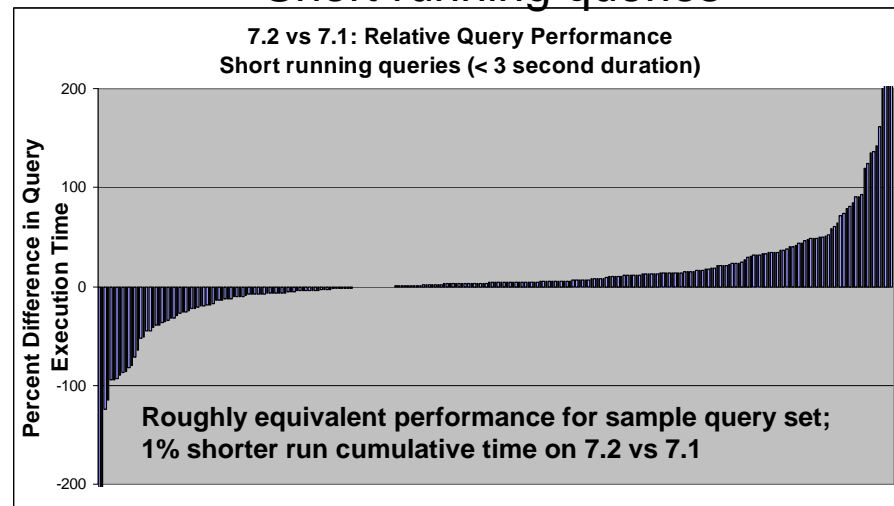
- **Potential for moderate performance gains on OLAP queries which drive significant I/O**

- Negligible benefit for short running OLTP queries which drive little I/O

## Longer running queries

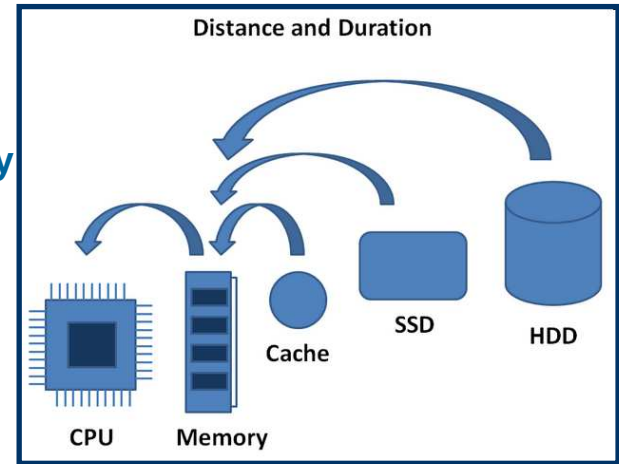


## Short running queries

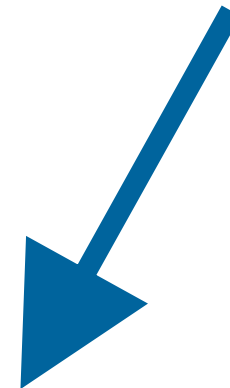


# DB2 for i & In-Memory controls

- **Set Object Access (SETOBJACC) command (tenured service)**
  - Target physical & logical files and programs
  - Object is brought into memory when the command is issued and can help with any form of access
  - Separate memory pools can be used, effectively **shielding the memory** from competing applications
  - The file attributes do not change
  - A **single thread** brings the object into memory
  - No guarantee that objects will remain in memory
- **CL Command level memory control (added in 7.1)**
  - Target **existing** DDS and SQL tables and views  
**CHGPF/CHGLF ... KEEPINMEM(\*YES|\*NO)**  
Database will bring the object into memory when **accessed using SQL**
  - **Parallel I/O** will be considered to bring the object into memory
  - Stored in the file attribute → survives IPLs, Save/Restore, etc.
  - No guarantee that objects will remain in memory, but the odds are good because it happens whenever rows are fetched
- **SQL KEEP IN MEMORY memory-attribute (new in 7.2)**
  - Target **new or existing** SQL tables & indexes  
**ALTER/CREATE TABLE ... KEEP IN MEMORY NO or YES**  
Database will bring the object into memory when **accessed using SQL**
  - Granular control for managing partition tables
  - SQL statements can participate in a transaction
  - Once set, behavior matches KEEPINMEM



“In Memory...” blog image



Blog thread: **In Memory...**  
<http://db2fori.blogspot.com/2013/10/in-memory.html>

# Temporary storage – A mystery revealed

Improved  
System Management  
with DB2 for i

- Observe System-wide Temporary storage consumption via a new DB2 for i Service: QSYS2/SYSTMPSTG
- Read all about it in IBM Knowledge Center: [www.ibm.com/support/knowledgecenter/ssw\\_ibm\\_i\\_72/rzajq/rzajqviewsystmpstg.htm](http://www.ibm.com/support/knowledgecenter/ssw_ibm_i_72/rzajq/rzajqviewsystmpstg.htm)

-- Which jobs are the top consumers of temporary storage?

```
SELECT bucket_current_size, bucket_peak_size,
rtrim(job_number) concat '/' concat rtrim(job_user_name) concat '/' concat
rtrim(job_name) as q_job_name
FROM QSYS2.SYSTMPSTG
WHERE job_status = '*ACTIVE'
ORDER BY
bucket_current_size desc
```



BUCKET_CURRENT_SIZE	BUCKET_PEAK_SIZE	Q_JOB_NAME
1236582400	1239851008	341402/QLWISVR/ADMIN2
706727936	789934080	342172/QDBTS/QJVAEXEC
465354752	482213888	367435/NTL/QPADEV000G
377368576	377368576	342174/QDBTS/QJVAEXEC
376946688	376946688	342175/QDBTS/QJVAEXEC
335908864	335908864	342176/QDBTS/QJVAEXEC
308379648	308379648	342177/QDBTS/QJVAEXEC
241729536	246112256	341120/QWEBADMIN/ADMIN4
226590720	2293952512	367463/QUSER/QZDASOINIT
193028096	194002944	341564/QLWISVR/SMART1113
183308288	183996416	341619/QLWISVR/SMART1114
178647040	178647040	341121/QLWISVR/ADMIN1
174456832	174456832	341266/QLWISVR/ADMIN3
167473152	167473152	341102/QYPSJSVR/QYPSJSVR
162492416	162689024	367429/OLSTAD/QDFTJOB
156450816	156450816	341651/QLWISVR/SMART1115
151515136	151560192	340925/QSYS/QTCPWRK
108703744	122335232	000000/QSYS/SCPF
98451456	114917376	368352/QUSER/QZDASOINIT

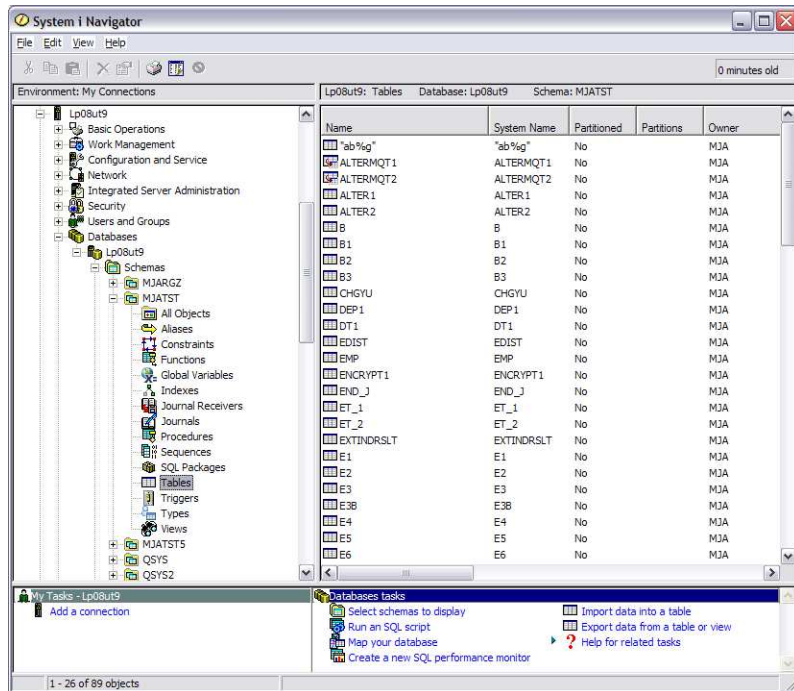
# DB Navigator – 7.2 Enhancements



## Navigator – what database users need to know

What are the choices?	<b>IBM i Navigator</b> (aka System i Navigator)	<b>IBM Navigator for i</b>
Where does it run?	<b>Windows PC Install</b>	<b>Browser</b> Served from IBM i 6.1, 7.1 & 7.2
Recent service level?	IBM i Access Windows Service Pack 7.1 – SI53584 → TR8	IBM HTTP SERVER FOR i PTF Group: 7.2 - SF99713 Level 1 7.1 - SF99368 Level 27 → TR8 6.1 - SF99115 Level 38
Database commonality	Most features are identical, including TRx enhancements	Most features are identical, including TRx enhancements
Database differences	Run SQL Scripts Visual explain	PDI Time-based performance metrics OmniFind administration
Webpage to watch	<a href="http://www-03.ibm.com/systems/power/software/i/access/windows_sp.html">www-03.ibm.com/systems/power/software/i/access/windows_sp.html</a>	<a href="http://www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99368">www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99368</a> <a href="http://www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99115">www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99115</a> <a href="http://www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99713">www-912.ibm.com/s_dir/SLINE003.NSF/PTFbyNumber/SF99713</a>
Next (planned) Update	December 31, 2014 → IBM i 7.1 TR9 & IBM i 7.2 TR1	December 31, 2014 → IBM i 7.1 TR9 & IBM i 7.2 TR1

# IBM i Navigator 7.2 Enhancements



IBM i Navigator.Ink

## Health Center

- *System Limits*

## Database Management

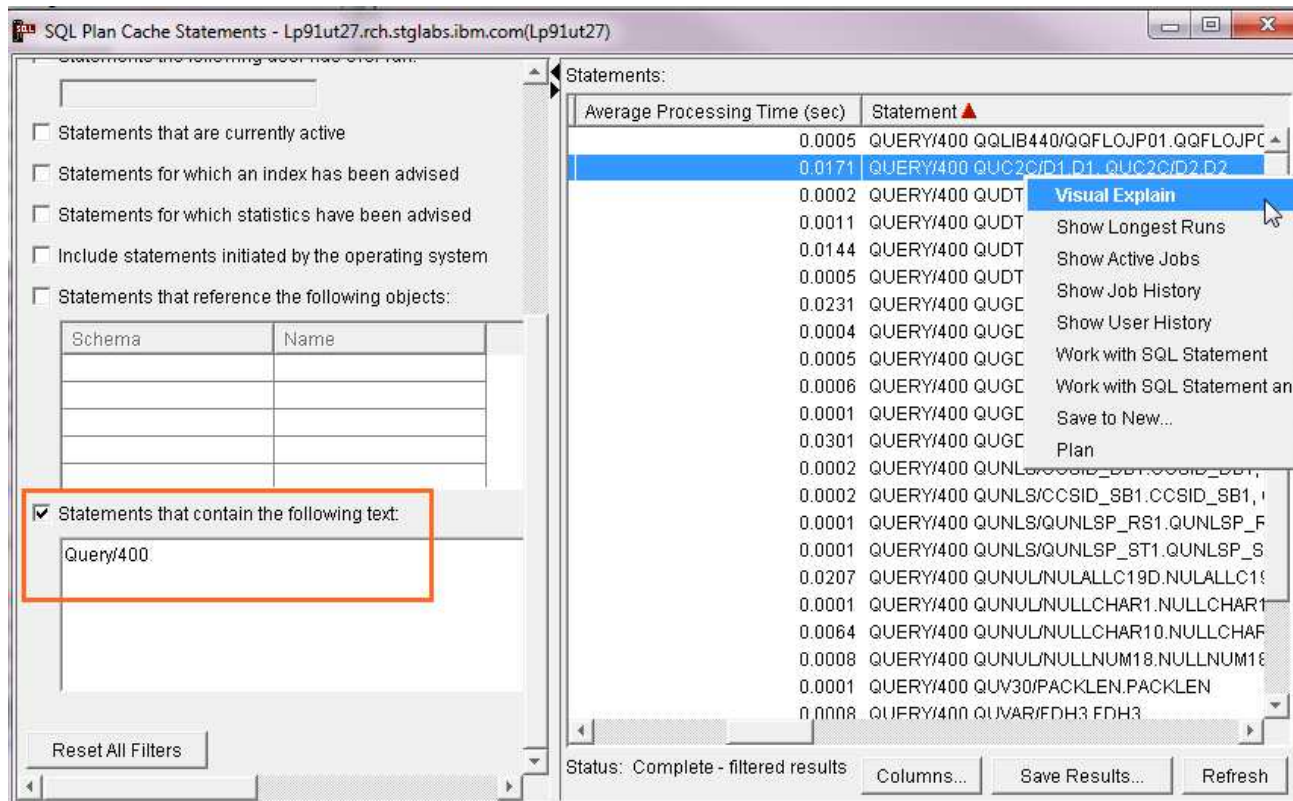
- *Support of all new SQL features*
  - *Permissions*
  - *Masks*
  - *Named arguments and parameter defaults*
  - *Obfuscation of Triggers*
  - *Arrays in user-defined functions*
  - *Create based ON*
- *Performance Data Investigator (PDI) Graphing and Charting*
- *Display Journal GUI (PTFed back to 7.1)*
- *and more...*

## On Demand Performance Center

- *Observance of OPNQRYP & Query/400 queries*
- *Advanced Compare*
- *Enhanced Plan Cache Filtering (For Index Advice)*
- *Filter Database monitor on SQLCODE and CQE*
- *Enhanced Show Statements (PTF back to 6.1)*

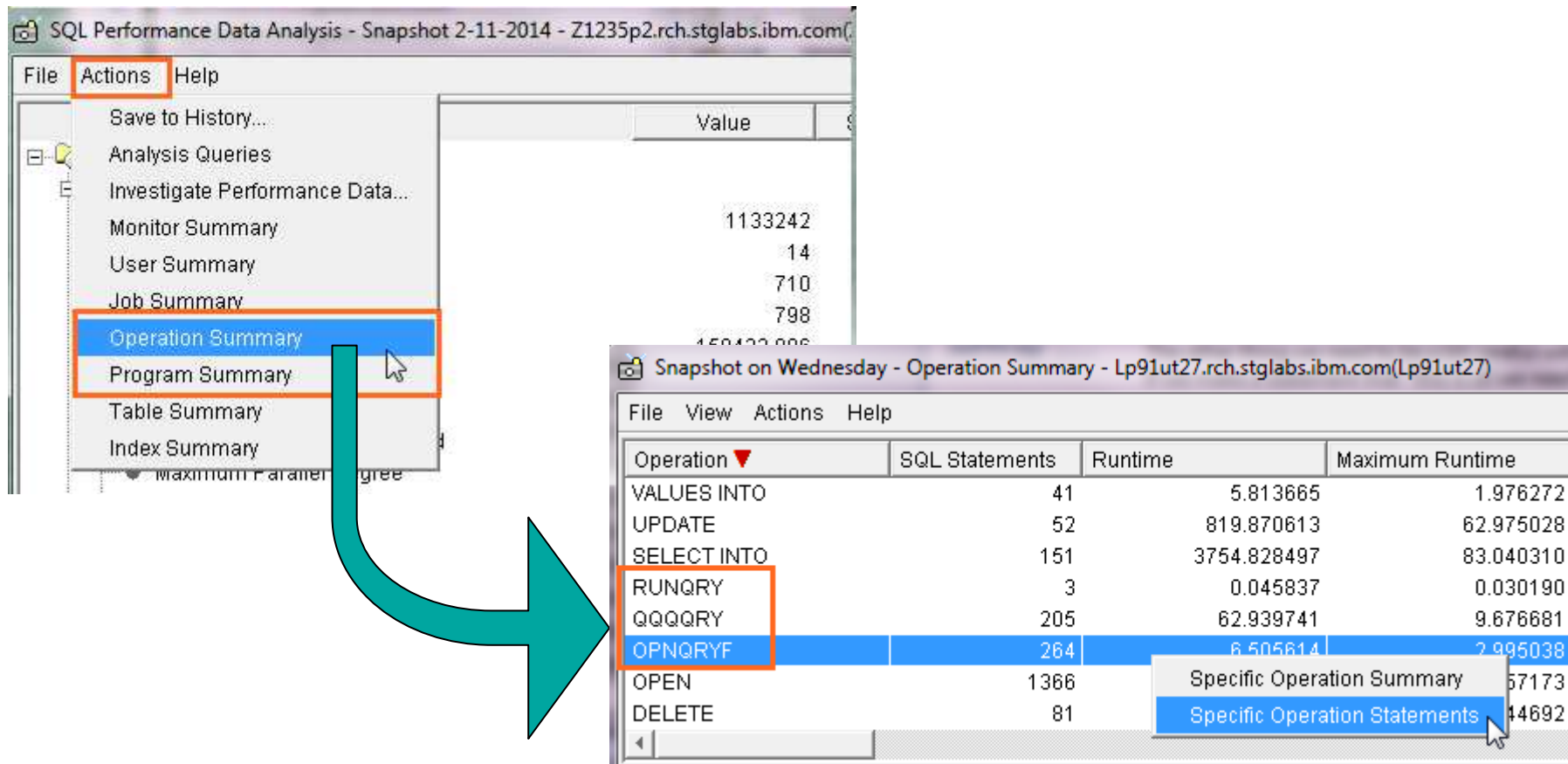
# SQL Plan Cache & 7.2

- Use 'Query/400' to find STRQRY, WRKQRY, RUNQRY activity



# SQL Plan Cache & 7.2

- Probe an SQL Plan Cache Snapshot via the ‘Operation Summary’



The screenshot shows the 'SQL Performance Data Analysis' application. The 'Actions' menu is open, with 'Operation Summary' highlighted. A large teal arrow points from this menu item to a secondary window titled 'Snapshot on Wednesday - Operation Summary'. This window displays a table with the following data:

Operation	SQL Statements	Runtime	Maximum Runtime
VALUES INTO	41	5.813665	1.976272
UPDATE	52	819.870613	62.975028
SELECT INTO	151	3754.828497	83.040310
RUNQRY	3	0.045837	0.030190
QQQGRY	205	62.939741	9.676681
OPNQRYF	264	6.505614	2.995038
OPEN	1366		57173
DELETE	81		14692

In the secondary window, the 'OPNQRYF' row is highlighted in blue. A context menu is open over this row, with 'Specific Operation Statements' selected.

**Thank You**

---

# SQL catalogs → Landscape view

## Landscape

## DB2 for i enhancements in IBM i 7.2

### Security

- Protect business critical data using data-centric design with RCAC
- Secure remote journaling with SSL

### Application development

- Improved ability to build, maintain and extend complex database application architectures

### Database Engineering (DBE)

- Timestamp precision control (0 thru 12)
- Partitioned tables automatically reposition a row when updated

### Performance

- SQL Query Engine (SQE) supports OPNQRYP & Query/400
- Other SQE enhancements
- Use SQL to see temporary storage consumption

Scalable SQE  
Data Centric  
RCAC  
Easy to use  
Bet your business on us  
Encoded Vector Indexes  
Open for Business  
Easy to maintain  
Intelligent SSD  
Secure Proven  
Reliable  
**DB2 for i**

**Catalogs**

**SYSCATALOGS**  
**INFORMATION\_SCHEMA\_CATALOG\_NAME**

**Schemas**

**SYSSCHEMAS**  
**SQLSCHEMAS**  
**SCHEMATA**

**Database Support**

**SQL\_FEATURES**  
**SQL\_LANGUAGES**  
**SQL\_SIZING**  
**CHARACTER\_SETS**

**Tables Views Indexes**

**SYSCOLUMNS**  
**SYSCOLUMNS2**  
**SYSFIELDS**  
**SYSINDEXES**  
**SYSKEYS**  
**SYSTABLEDEP**  
**SYSTABLES**  
**SYSVIEWDEP**  
**SYSVIEWS**  
**SQLCOLUMNS**  
**SQLSPECIALCOLUMNS**  
**SQLTABLES**  
**COLUMNS**  
**TABLES**  
**VIEWS**

**Constraints**

**SYSCHKCST**  
**SYSCST**  
**SYSCSTCOL**  
**SYSCSTDEP**  
**SYSKEYCST**  
**SYSREFCST**  
**SQLFOREIGNKEYS**  
**SQLPRIMARYKEYS**  
**CHECK\_CONSTRAINTS**  
**REFERENTIAL\_CONSTRAINTS**  
**TABLE\_CONSTRAINTS**

**Privileges**

**SYSCOLAUTH**  
**SYSCONTROLS**  
**SYSCONTROLSDEP**  
**SYSPACKAGEAUTH**  
**SYSROUTINEAUTH**  
**SYSSCHEMAAUTH**  
**SYSSEQUENCEAUTH**  
**SYSTABAUTH**  
**SYSUDTAUTH**  
**SYSVARIABLEAUTH**  
**SYSXSROBJECTAUTH**  
**SQLCOLPRIVILEGES**  
**SQLTABLEPRIVILEGES**  
**AUTHORIZATIONS**  
**ROUTINE\_PRIVILEGES**  
**UDT\_PRIVILEGES**  
**USAGE\_PRIVILEGES**  
**VARIABLE\_PRIVILEGES**

**Triggers**

**SYSTRIGCOL**  
**SYSTRIGDEP**  
**SYSTRIGGERS**  
**SYSTRIGUPD**

**Routines**

**SYSFUNCS**  
**SYSJARCONTENTS**  
**SYSJAROBJECTS**  
**SYSPARMS**  
**SYSPROCS**  
**SYSROUTINEDEP**  
**SYSROUTINES**  
**SQLFUNCTIONCOLS**  
**SQLFUNCTIONS**  
**SQLPROCEDURECOLS**  
**SQLPROCEDURES**  
**PARAMETERS**  
**ROUTINES**

**XML Schemas**

**XSRANNOTATIONINFO**  
**XSROBJECTCOMPONENTS**  
**XSROBJECTHIERARCHIES**  
**XSROBJECTS**

**Statistics**

**SYSCOLUMNSTAT**  
**SYSINDEXSTAT**  
**SYSMQTSTAT**  
**SYSPACKAGESTAT**  
**SYSPACKAGESTMTSTAT**  
**SYSPARTITIONDISK**  
**SYSPARTITIONINDEXES**  
**SYSPARTITIONINDEXDISK**  
**SYSPARTITIONINDEXSTAT**  
**SYSPARTITIONMQTS**  
**SYSPARTITIONSTAT**  
**SYSPROGRAMSTAT**  
**SYSPROGRAMSTMTSTAT**  
**SYSTABLEINDEXSTAT**  
**SYSTABLESTAT**  
**SQLSTATISTICS**

**Miscellaneous Objects**

**SYSPACKAGE**  
**SYSSEQUENCES**  
**SYSTYPES**  
**SYSVARIABLEDEP**  
**SYSVARIABLES**  
**SQLTYPEINFO**  
**SQLUDTS**  
**USER\_DEFINED\_TYPES**  
**SEQUENCES**

 DB2 for i catalog views (QSYS2)  
 ODBC and JDBC™ catalog views (SYSIBM)  
 ANS and ISO catalog views (QSYS2)

<http://www.ibm.com/systems/i/software/db2/>



**Health Center Procedures**

QSYS2.HEALTH\_ACTIVITY  
 QSYS2.HEALTH\_DATABASE\_OVERVIEW  
 QSYS2.HEALTH\_DESIGN\_LIMITS  
 QSYS2.HEALTH\_ENVIRONMENTAL\_LIMITS  
 QSYS2.HEALTH\_SIZE\_LIMITS  
 QSYS2.RESET\_ENVIRONMENTAL\_LIMITS

**Utility Procedures**

QSYS2.CANCEL\_SQL  
 QSYS2.DUMP\_SQL\_CURSORS  
 QSYS2.EXTRACT\_STATEMENTS  
 QSYS2.FIND\_AND\_CANCEL\_QSQSRVR\_SQL  
 QSYS2.FIND\_QSQSRVR\_JOBS  
 QSYS2.GENERATE\_SQL  
 QSYS2.RESTART\_IDENTITY  
 SYSTOOLS.CHECK\_CST  
 SYSTOOLS.CHECK\_SYSRoutine

**Plan Cache Procedures**

QSYS2.CHANGE\_PLAN\_CACHE\_SIZE  
 QSYS2.DUMP\_PLAN\_CACHE  
 QSYS2.DUMP\_PLAN\_CACHE\_PROPERTIES  
 QSYS2.DUMP\_PLAN\_CACHE\_topN  
 QSYS2/DUMP\_SNAP\_SHOT\_PROPERTIES  
 QSYS2.END\_ALL\_PLAN\_CACHE\_EVENT\_MONITORS  
 QSYS2.END\_PLAN\_CACHE\_EVENT\_MONITOR  
 QSYS2.START\_PLAN\_CACHE\_EVENT\_MONITOR (2)

**Performance Services**

SYSTOOLS.ACT\_ON\_INDEX\_ADVICE - PROCEDURE  
 SYSTOOLS.HARVEST\_INDEX\_ADVICE - PROCEDURE  
 QSYS2.OVERRIDE\_QAQINI - PROCEDURE  
 QSYS2.RESET\_TABLE\_INDEX\_STATISTICS - PROCEDURE  
 QSYS2.SYSIXADV - TABLE  
 SYSTOOLS.REMOVE\_INDEXES - PROCEDURE

**Application Services**

QSYS2.QCMDExc - PROCEDURE  
 QSYS2.OVERRIDE\_TABLE - PROCEDURE  
 QSYS2.DELIMIT\_NAME - UDF  
 SYSPROC.WLM\_SET\_CLIENT\_INFO - PROCEDURE

**Security Services**

QSYS2.FUNCTION\_INFO - VIEW  
 QSYS2.FUNCTION\_USAGE - VIEW  
 QSYS2.GROUP\_PROFILE\_ENTRIES - VIEW  
 SYSPROC.SET\_COLUMN\_ATTRIBUTE - PROCEDURE  
 QSYS2.SQL\_CHECK\_AUTHORITY - UDF  
 QSYS2.USER\_INFO - VIEW

**PTF Services**

QSYS2.PTF\_INFO - VIEW  
 QSYS2.GROUP\_PTF\_INFO - VIEW

**TCP/IP Services**

QSYS2.TCPIP\_INFO - VIEW  
 SYSIBMADM.ENV\_SYS\_INFO - VIEW

**Work Management Services**

QSYS2.SYSTEM\_VALUE\_INFO - VIEW  
 QSYS2.GET\_JOB\_INFO - UDTF

**Object Services**

QSYS2.OBJECT\_STATISTICS - UDTF

**Storage Services**



QSYS2.SYSDISKSTAT - VIEW  
 QSYS2.SYSTMPSTG - VIEW  
 QSYS2.USER\_STORAGE - VIEW

**Journal Services**

QSYS2.DISPLAY\_JOURNAL - UDTF

**System Health Services**

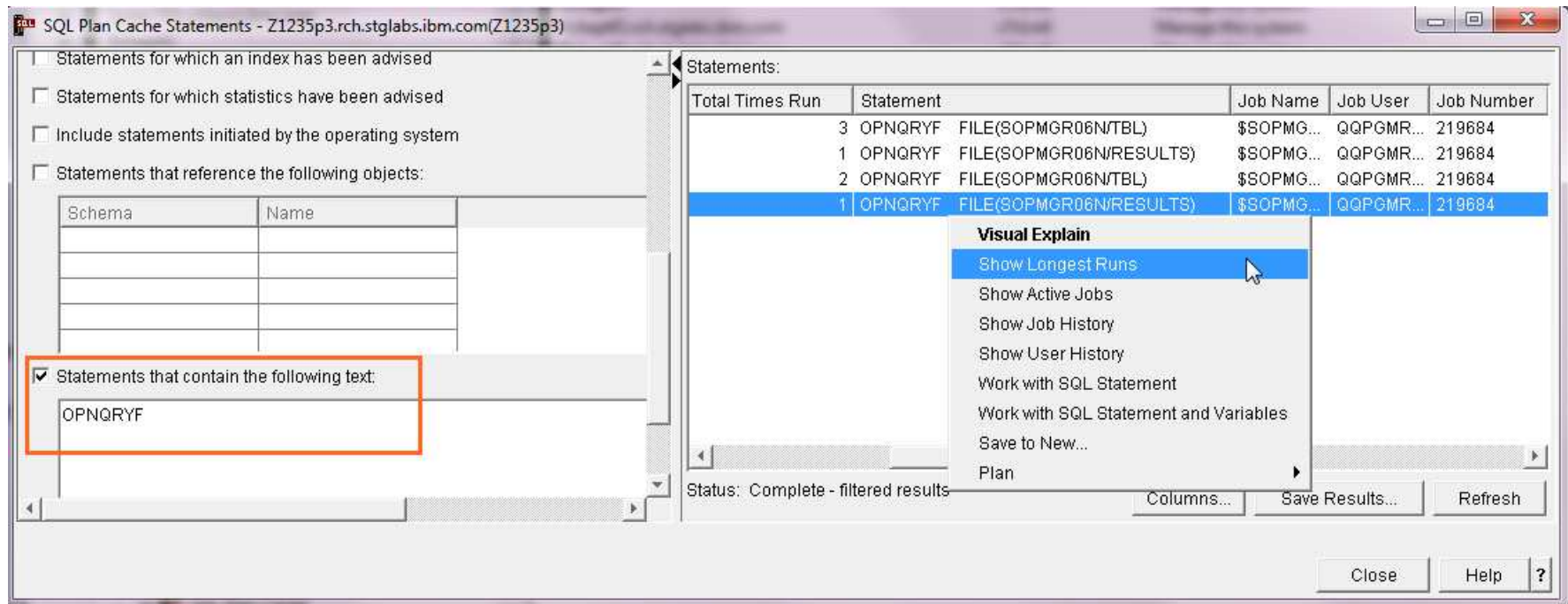
QSYS2.SYSLIMTBL - TABLE  
 QSYS2.SYSLIMITS - VIEW

 DB2 for i Services  
 IBM i Services

<http://www.ibm.com/developerworks/ibmi/db2>

# SQL Plan Cache & 7.2

- Use ‘OPNQRYF’ or ‘Query/400’ as a Statement Text filter
- Explore Visual Explain, Show longest runs, Index Advice, and more...



# Documentation

- With IBM i 7.2, these and other services will be documented within the “Database Performance and Optimization” book
- The Technology Updates wiki includes fact pages for these services

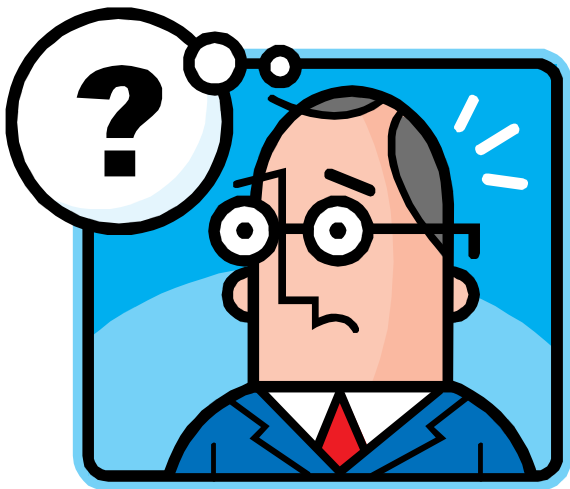
[www.ibm.com/developerworks/ibmi/techupdates/db2](http://www.ibm.com/developerworks/ibmi/techupdates/db2)

DB2 for i updates by category
<a href="#">DB2 for i Functional Enhancements</a>
<a href="#">DB2 for i Security Enhancements</a>
<a href="#">DB2 for i Performance Enhancements</a>
<a href="#">DB2 for i Database Management Enhancements</a>
<a href="#">DB2 for i Availability/Recovery Enhancements</a>
<a href="#">OmniFind for IBM i</a>
<a href="#">DB2 for i Services</a>

- IBM i: Performance and Query Optimization
  - Contents
  - Database performance and query optimization
    - What's new for IBM i 7.2
    - PDF file for Database performance and query optimization
    - Query engine overview
    - Data access methods
    - Processing queries: Overview
    - Optimizing query performance using query optimization tools
    - Creating an index strategy
    - Application design tips for database performance
    - Programming techniques for database performance
    - General DB2 for i performance considerations
  - DB2 for i Services
    - Application Services
    - Performance Services
    - Utility Services
  - IBM i Services
    - Application Services
    - Journal Services
    - Object Services
    - PTF Services
    - Security Services
    - Storage Services
    - OnDemand tracking of important system limits
    - TCP/IP Services
    - Work Management Services
  - SYSTOOLS
  - Database monitor formats
  - Query optimizer messages reference
  - Notices

DB2 for i Service	Type of Service	IBM i 7.2	IBM i 7.1	IBM i 6.1
<b>PTF Services</b>				
QSYS2.PTF_INFO	View	Base	SF99701 Level 23	SF99601 Level 29
QSYS2.GROUP_PTF_INFO	View	Base	SF99701 Level 6	SF99601 Level 19
<b>Security Services</b>				
QSYS2.USER_INFO	View	Base	Introduced: SF93701 Level 26 Enhanced: SF93701 Level 29	Introduced: SF93601 Level 31 Enhanced: SF93601 Level 32
QSYS2.FUNCTION_INFO	View	Base	SF93701 Level 26	SF93601 Level 31
QSYS2.FUNCTION_USAGE	View	Base	SF99701 Level 26	SF99601 Level 31
QSYS2.GROUP_PROFILE_ENTRIES	View	Base	SF99701 Level 23	SF99601 Level 29
QSYS2.SQL_CHECK_AUTHORITY()	UDF	Base	SF99701 Level 24	SF99601 Level 29
QSYS2.SET_COLUMN_ATTRIBUTE()	Procedure	Base	Base	SF99601 Level 8
<b>Work Management Services</b>				
QSYS2.SYSTEM_VALUE_INFO	View	Base	SF99701 Level 26	SF99601 Level 31
QSYS2.GET_JOB_INFO()	UDTF	Base	Introduced: SF93701 Level 26 Enhanced: SF93701 Level 29	Introduced: SF93601 Level 31 Enhanced: SF93601 Level 32
<b>TCP/IP Services</b>				
SYSBADM.ENV_SYS_INFO	View	Base	SF99701 Level 23	SF99601 Level 29
QSYS2.TCPIP_INFO	View	Base	SF99701 Level 6	SF99601 Level 19
<b>Storage Services</b>				
QSYS2.USER_STORAGE	View	Base	SF99701 Level 26	SF99601 Level 31
QSYS2.SYSTMPSTG	View	Base	-	-
QSYS2.SYSDISKSTAT	View	Base	SF99701 Level 12	SF99601 Level 21
<b>Object Services</b>				
QSYS2.OBJECT_STATISTICS()	UDTF	Base	SF99701 Level 3	SF99601 Level 16
<b>System Health Services</b>				
QSYS2.SYSLIMTBL	Table	Base	Introduced: SF93701 Level 23 Enhanced: SF93701 Level 26	Introduced: SF93601 Level 31 Enhanced: SF93601 Level 32
QSYS2.SYSLIMITS	View	Base	Introduced: SF93701 Level 23 Enhanced: SF93701 Level 26	Introduced: SF93601 Level 31 Enhanced: SF93601 Level 32
<b>Journal Services</b>				
QSYS2.DISPLAY_JOURNAL()	UDTF	Base	Introduced: Base Enhanced: SF93701 Level 26	Introduced: SF93601 Level 15 Enhanced: SF93601 Level 31
<b>Application Services</b>				
QSYS2.QCMDXCC()	Procedure	Base	Introduced: Base Enhanced: SF93701 Level 26	Introduced: SF93601 Level 15 Enhanced: SF93601 Level 31

- ➔ Are you experiencing performance problems?
- ➔ Are you using SQL?
- ➔ Are you getting the most out of DB2 for i?



**Need help?**

### *IBM DB2 for i Center of Excellence*


- ✓ Database modernization
- ✓ DB2 Web Query
- ✓ Database architecture and design
- ✓ DB2 SQL performance analysis and tuning
- ✓ Data warehousing and Business Intelligence
- ✓ DB2 for i education and training

Contact: Mike Cain [mcaain@us.ibm.com](mailto:mcaain@us.ibm.com)  
IBM Systems and Technology Group  
Rochester, MN USA

## Next steps for you...

- Education (practice, study, repeat) are the underpinnings to success
- Article: “SQL for the Systems Administrator”  
<http://iprodeveloper.com/sql/sql-systems-administrator>
- Blog thread: Advancing Your SQL Knowledge and Skills  
<http://db2fori.blogspot.com/2013/06/advancing-your-sql-knowledge-and-skills.html>
- And **engage** Mike’s CoE team if you want education or assistance  
([mcain@us.ibm.com](mailto:mcain@us.ibm.com))

Mike Cain



My blogs  
[DB2 for i](#)

About me

Mike Cain is the team leader of the IBM DB2 for i Center of Excellence in Rochester, Minnesota USA. Along with a team of highly skilled subject matter experts, Mike travels the world guiding, educating and supporting clients who want to get the most out of DB2 for IBM i. He specializes in SQL query performance and scalability, as well as very large database, business intelligence and analytics within the IBM i



## Education resources:

- IBM i 7.2 enhancements – landing page:  
<http://www.ibm.com/developerworks/ibmi/techupdates/i72>
- Technical articles coming soon 😊

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