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New DB2 10 for z/OS Security Features Help Satisfy Your Auditors

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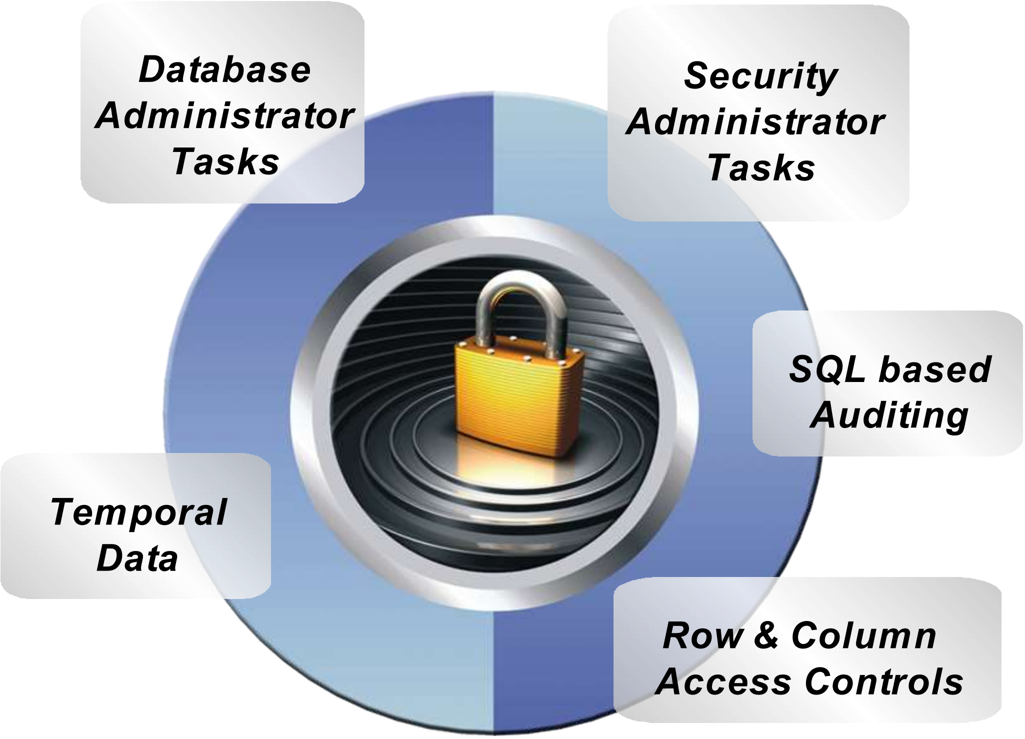
Satisfy Your Auditor: Plan, Protect and Audit

- Unauthorized Data Access
  - Minimize the use of a superuser authorities such as SYSADM
  - A different group should manage access to restricted data than the owner of the data
- Data Auditing
  - Any dynamic access or use of a privileged authority needs to be included in your audit trail
  - Maintain historical versions of data for years or during a business period
- Data Privacy
  - All dynamic access to tables containing restricted data needs to be protected


Database Administrator Tasks
Security Administrator Tasks
SQL based Auditing
Temporal Data
Row & Column Access Controls

Today's Mainframe:
The power of industry-leading security,
the simplicity of centralised management

Minimize the use of SYSADM

- New granular system authorities and install security parameters

Prior to DB2 10

- SYSADM
- DBADM
- DBCTRL
- DBMAINT
- SYSCTRL
- PACKADM
- SYSOPR

New in DB2 10

- Install SECADM
- **System DBADM**
- **ACCESSCTRL**
- **DATAACCESS**
- SQLADM
- EXPLAIN

Prevent SYSADM and SYSCTRL from granting or revoking privileges

- **New separate security install parameter**
- **New install SECADM has grant and revoke privilege**

Control cascading effect of revokes

- **New revoke dependent privileges install parameter**
- **New revoke dependent privileges SQL clause**

New authority for monitoring and tuning SQL without ability to change or access data

- SQLADM Authority
  - Allows the user to
    - Issue SQL EXPLAIN statements
    - Issue START, STOP, and DISPLAY PROFILE commands
  - Perform actions involving:
    - EXPLAIN privilege
    - STATS privilege on all user databases
    - MONITOR2 privilege
  - Execute DB2-supplied stored procedures and routines
  - Cannot access data, perform DDL or execute

New privilege to validate SQL before moving to production

- EXPLAIN privilege
  - Programmer can issue SQL EXPLAIN ALL statement without having the privileges to execute that SQL statement.
  - Programmer can issue SQL PREPARE and DESCRIBE TABLE statements without requiring any privileges on the object.
  - Programmer can specify new BIND EXPLAIN(ONLY) and SQLERROR(CHECK) options
  - Programmer can explain dynamic SQL statements executing under new special register, CURRENT EXPLAIN MODE = EXPLAIN

Satisfy Your Auditor:
Audit Policies provide needed flexibility and functionality

- New auditing capability allow you to comply without expensive external data collectors
  - New audit policies managed in catalog
  - Audit privileged users
  - Audit SQL activity against a table
  - Audit (non-z/OS) distributed identities

New Audit Policy Feature

- SECADM maintains system audit policies in new catalog table

- Auditor can audit access to specific tables for specific programs during day
  1) Audit policy does not require AUDIT clause to be specified to enable table auditing
  2) Audit policy generate records for all read and update access not just first access in transaction
  3) Audit policy includes additional records identifying the specific SQL statements reading or updating an audited UTS table
  4) Audit policy provides wildcarding of table names

- Auditor can can identify any unusual use of a privileged authority during day
  - Records each use of a system authority
  - Audit records written only when authority is used for access
  - External collectors only report users with a system authority

Satisfy Your Auditor:

Additional features to improve security and ensure a more accurate audit trail

- Support distributed identities introduced in z/OS V1R11
  - A distributed identity is a mapping between a RACF user ID and one or more distributed user identities, as they are known to application servers
- Support client certificates and password phrases introduced in z/OS V1R10
  - AT-TLS secure handshake accomplishes identification and authentication when the client presents its certificate as identification and its proof-of-possession as authentication
  - A password phrase is a character string made up of mixed-case letters, numbers, special characters, and is between 9 to 100 characters long
- Support connection level security enforcement
  - Enforces all connections must use strong authentication to access DB2
  - All userids and passwords encrypted using AES, or connections accepted on a port which ensures AT-TLS policy protection or protected by an IPSec encrypted tunnel

Satisfy Your Auditor:

New SQL access controls to protect against unplanned and all dynamic access

- Define additional data controls at the table level
  - Security policies are defined using SQL providing flexibility
  - Separate security logic from application logic
- Security policies based on real time session attributes
  - Protects against SQL injection attacks
  - Determines how column values are returned
  - Determines which rows are returned

- No need to remember various view or application names
  - No need to manage many views; no view update or audit issues
- All access including adhoc query tools, report generation tools is protected
- Policies can be added, modified, or removed to meet current company rules without change to applications

New controls to protect access to individual rows

- Establish a row policy for a table
  - Filter rows out of answer set
  - Policy can use session information like the SQL ID is in what group or user is using what role to control when row is returned in result set
  - Applicable to SELECT, INSERT, UPDATE, DELETE, & MERGE
  - Defined as a row permission:

    CREATE PERMISSION policy-name ON table-name

    FOR ROWS WHERE search-condition

    ENFORCED FOR ALL ACCESS ENABLE;

Optimizer inserts search condition in all SQL statements accessing table. If row satisfies search-condition, row is returned in answer set

New controls to protect access to sensitive columns

- Establish a column policy for a table
  - Mask column values in answer set
  - Policy can use session information to mask value like the SQL ID is in what group or user is using what role
  - Applicable to the output of outermost subselect
  - Defined as column masks :

```
CREATE MASK  mask-name ON table-name
 FOR  COLUMN  column-name RETURN CASE-expression
   ENABLE;
```

Optimizer inserts case statement in all SQL accessing table to determine mask value to return in answer set

Define a column or row policy based on who is accessing the table

- **SESSION_USER**
  - Primary authorization ID of the process
- **CURRENT SQLID**
  - SQL authorization ID of the process
  - SET CURRENT SQLID = string-constant;
- **VERIFY_GROUP_FOR_USER**
  - Get authorization IDs for the value in SESSION_USER
    - Primary and secondary authorization IDs
  - Return 1 if any of those authorization IDs is in the argument list

```
WHERE
  VERIFY_GROUP_FOR_USER (SESSION_USER, ‘MGR’, ‘PAYROLL’) = 1
```

- **VERIFY_ROLE_FOR_USER**
  - Get the role for the value in SESSION_USER
  - Return 1 if the role is in the argument list

```
WHERE
    VERIFY_ROLE_FOR_USER (SESSION_USER, ’MGR’, ‘PAYROLL’) = 1
```

Row and Column Access Control

- When activated row and column access controls:
  - Make row permissions and column masks become effective in all DML
    - All row permissions are connected with ‘OR’ to filter out rows
    - All column masks are applied to mask output
  - **All access to the table is prevented if no user-defined row permissions**

```
ALTER  TABLE   table-name
     ACTIVATE ROW LEVEL  ACCESS  CONTROL
     ACTIVATE COLUMN LEVEL ACCESS CONTROL;
```

- When deactivated row and column access controls:
  - Make row permissions and column masks become ineffective in DML
  - **Opens all access to the table**

```
ALTER  TABLE   table-name
     DEACTIVATE ROW LEVEL ACCESS  CONTROL
     DEACTIVATE COLUMN LEVEL ACCESS CONTROL;
```

Example – A simple banking scenario

- Only allow customer service representatives to see customer data but with masked income
- Table: CUSTOMER

Account	Name	Phone	Income	Branch
1111-2222-3333-4444	Alice	111-1111	22,000	A
2222-3333-4444-5555	Bob	222-2222	71,000	B
3333-4444-5555-6666	Louis	333-3333	123,000	B
4444-5555-6666-7777	David	444-4444	172,000	C

Row and Column Access Control Banking Scenario

- Set up access control policy for customer service representatives
  - Allow access to all customers of the bank (a row permission)
  - Mask all INCOME values (a column mask)
    - Return value 0 for incomes of 25000 and below
    - Return value 1 for incomes between 25000 and 75000
    - Return value 2 for incomes between 75000 and 150000
    - Return value 3 for incomes above 150000
  - Customer service reps are in the CSR group (who)

- Create a row permission for customer service representatives

```
CREATE  PERMISSION  CSR_ROW_ACCESS  ON  CUSTOMER
    FOR  ROWS  WHERE

        VERIFY_GROUP_FOR_USER (SESSION_USER, ’CSR’) = 1

ENFORCED FOR ALL ACCESS;
```

Banking Scenario

- Create a column mask on INCOME column for customer service representative

```
CREATE  MASK  INCOME_COLUMN_MASK  ON  CUSTOMER

     FOR  COLUMN  INCOME  RETURN

        CASE WHEN (VERIFY_GROUP_FOR_USER (SESSION_USER, ‘CSR’) = 1)

                          THEN  CASE  WHEN (INCOME > 150000) THEN  3
                                      WHEN (INCOME > 75000)   THEN  2
                                      WHEN (INCOME > 25000)   THEN  1
                                      ELSE  0
                                END

                    ELSE NULL
          END
ENABLE;
```

Banking Scenario

- Activate Row-level and Column-level Access Control

```
ALTER  TABLE  CUSTOMER
    ACTIVATE ROW LEVEL ACCESS CONTROL
    ACTIVATE COLUMN LEVEL ACCESS CONTROL;
COMMIT;
```

- What happens in DB2?
  - A default row permission is created implicitly to prevent all access to table CUSTOMER (WHERE 1=0) except for users in the CSR group
  - All packages and cached statements that reference table CUSTOMER are invalidated

Banking Scenario

- **SELECT ACCOUNT, NAME, INCOME, PHONE FROM CUSTOMER;**

ACCOUNT	NAME	INCOME	PHONE
1111-2222-3333-4444	Alice	**0**	111-1111
2222-3333-4444-5555	Bob	**1**	222-2222
3333-4444-5555-6666	Louis	**2**	333-3333
4444-5555-6666-7777	David	**3**	444-4444

INCOME automatically masked by DB2!

Banking Scenario

- DB2 effectively evaluates the following revised query:

```
SELECT  ACCOUNT, NAME,

          CASE WHEN (VERIFY_GROUP_FOR_USER (SESSION_USER, ‘CSR’) = 1)
                   THEN CASE  WHEN (INCOME > 150000) THEN 3
                              WHEN (INCOME > 75000)   THEN 2
                              WHEN (INCOME > 25000)   THEN 1
                              ELSE  0
                         END
                ELSE NULL
          END  INCOME,
          PHONE
FROM  CUSTOMER
WHERE  VERIFY_GROUP_FOR_USER (SESSION_USER, ‘CSR’) = 1  OR
          1 = 0 ;
;
```

Satisfy Your Auditor: Problem of managing different versions of application data

- Application programmers and database administrators have struggled for years with managing different versions of application data.
- New regulatory laws require maintaining historical versions of data for years.
- Every update and delete of data requires copying old data to history tables.
- Existing approaches to application level data versioning complicate table design, add complexity and are error prone for applications.

New Temporal Table allows DB2 to automatically maintain different versions

- Two types of time sequences of table rows are supported through the introduction of database defined time periods

  - **SYSTEM_TIME** is used for system maintained history for a new concept of “versioning” which archives old rows into a history table

  - **BUSINESS_TIME** is a period that represents when a row is valid to the user or application. The BUSINESS_TIME period can be used to model data in the past, present, and future as the data values are controlled by the application

  - A unique index can be defined for a BUSINESS_TIME period to enforce non-overlapping time periods
  - A bitemporal table includes both periods

Defining System Versioning on a table

- System versioning is implemented by altering an existing or creating a table with two timestamps, a history table, and defining the versioning relationship between tables
- System period temporal table must have:
  - SYSTEM_TIME is defined as two TIMESTAMP(12) NOT NULL columns
  - First column defines the row begin time
  - Second column defines the row end time
  - Third column defined as TIMESTAMP(12) for the transaction that created row
    - example of period definition: PERIOD SYSTEM_TIME(col1, col2)
- History table must have:
  - Same number of columns as the system period temporal table
  - All columns must have the same corresponding names, data type, null attribute, ccsid, subtype, hidden attribute and fieldproc as the system period temporal table

Add System Versioning to a table

- After the two tables are appropriately defined:
  - ALTER TABLE table-name ADD VERSIONING is specified on the base table that is to be versioned, not the history table
- To query historical data, the table-reference of the FROM clause is extended to request historical data
  - DB2 rewrites the user’s query to include data from the history table with a UNION ALL operator
- New FROM SYSTEM_TIME clauses:
  - table-name FOR SYSTEM_TIME AS OF timestamp-expression
  - table-name FOR SYSTEM_TIME FROM timestamp-expression1 TO timestamp-expression2
    - Note: the second timestamp-expression is not inclusive
  - table-name FOR SYSTEM_TIME BETWEEN timestamp-expression1 AND timestamp-expression2
    - Note: the second timestamp-expression is inclusive

SYSTEM_TIME Period Example

Sample DDL to create a base and history table

```
CREATE TABLE        policy_info
(policy_id   CHAR(4)                NOT NULL,
coverage     INT                    NOT NULL,

sys_start    TIMESTAMP(12)          NOT NULL     GENERATED ALWAYS AS ROW BEGIN,
sys_end      TIMESTAMP(12)          NOT NULL     GENERATED ALWAYS AS ROW END,
create_id    TIMESTAMP(12)                        GENERATED ALWAYS AS TRANSACTION START ID,
PERIOD       SYSTEM_TIME(sys_start, sys_end));

CREATE TABLE        hist_policy_info
(policy_id   CHAR(4)                NOT NULL,
coverage     INT                    NOT NULL,
sys_start    TIMESTAMP(12)          NOT NULL,
sys_end      TIMESTAMP (12)         NOT NULL,
create_id    TIMESTAMP(12));

ALTER TABLE policy_info
ADD VERSIONING USE HISTORY TABLE hist_policy_info;
```

INSERT SYSTEM_TIME Example

At timestamp '2009-01-05-12:12:12.001122000000',

```
INSERT INTO policy_info (policy_id, coverage)
VALUES('A123', 12000);
```

Policy_info

Policy ID	Coverage	Sys_start	Sys_end
A123	12000	2009-01-05-12.12.12.001122000000	9999-12-31-24.00.00.000000000000

Hist_policy_info

Policy ID	Coverage	Sys_start	Sys_end

UPDATE SYSTEM_TIME Example

At timestamp '2009-01-09-12:12:12.012345000000',

```
UPDATE policy_info SET coverage = 15000
WHERE policy_id = 'A123';
```

Policy_info

Policy ID	Coverage	Sys_start	Sys_end
A123	15000	2009-01-09-12.12.12.0123450000000	9999-12-31-24.00.00.000000000000

Hist_policy_info

Policy ID	Coverage	Sys_start	Sys_end
A123	12000	2009-01-05-12.12.12.001122000000	2009-01-09-12.12.12.012345000000

SELECT SYSTEM_TIME Example

SELECT policy_id, coverage FROM policy_info
FOR SYSTEM_TIME AS OF '2009-01-08-00:00:00.000000000000';

returns a row of
('A123', 12000)

Policy_info

Policy ID	Coverage	Sys_start	Sys_end
A123	15000	2009-01-09-12.12.12.012345000000	9999-12-31-24.00.00.000000000000

Hist_policy_info

Policy ID	Coverage	Sys_start	Sys_end
A123	12000	2009-01-05-12.12.12.001122	2009-01-09-12.12.12.012345000000

Adding a Business Period to a table

- To create a temporal table with BUSINESS_TIME period, the table needs to be defined with:
  - Begin column defined as TIMESTAMP or DATE
  - End column defined as TIMESTAMP or DATE
  - BUSINESS_TIME time defined on the two above columns
    - example of period specification: PERIOD BUSINESS_TIME(col1, col2)
- The temporal table with BUSINESS_TIME period can also be defined to have a unique key that is unique for a period of time.
- For example:
    - UNIQUE (col1, BUSINESS_TIME WITHOUT OVERLAPS)
    - PRIMARY KEY (col1,col2, BUSINESS_TIME WITHOUT OVERLAPS)
- It will add, in ascending order, the end column and begin column of the period BUSINESS_TIME to the key and have special support to enforce that there are no overlaps in time given the rest of the key expressions.
- The enforcement of uniqueness over a period of time is the important functionality delivered with temporal tables with BUSINESS_TIME periods

BUSINESS_TIME Period

- To query a temporal table with a BUSINESS_TIME period
  - table-name FOR BUSINESS_TIME AS OF expression
  - table-name FOR BUSINESS_TIME FROM expression1 TO expression2
    - note that the second expression is not inclusive
  - table-name FOR BUSINESS_TIME BETWEEN expression1 expression2
    - note that the second expression is inclusive

BUSINESS_TIME UPDATE and DELETE Semantics

- Temporal tables with BUSINESS_TIME period, UPDATE and DELETE based upon a period of time
- New clause is specified as follows:
  - FOR PORTION OF BUSINESS_TIME FROM expression1 TO expression2
  - expression is a date or timestamp expression depending on period definition
- New update or delete clause updates/deletes rows as usual if the period for the row is totally contained in the period specified in the FROM and TO clause
- When a row is not contained within the period, only the part of the row that is contained between the FROM and TO values are updated or deleted
  - This may cause additional inserts of rows into the table as the original row is split into multiple rows to reflect the old values for the period that are not affected by the update or delete

BUSINESS_TIME Period Example

Sample DDL to create establish business time for a table

```
CREATE TABLE     policy_info
(policy_id       CHAR(4)       NOT NULL,
coverage         INT           NOT NULL,
bus_start        DATE          NOT NULL,
bus_end          DATE          NOT NULL,
PERIOD           BUSINESS_TIME(bus_start, bus_end);

CREATE UNIQUE INDEX ix_policy
ON policy_info (policy_id, BUSINESS_TIME WITHOUT
   OVERLAPS);
```

BUSINESS_TIME Period INSERT Example

```
INSERT INTO policy_info VALUES
('A123', 12000, '01-01-2008', '07-01-2008');
```

Policy_info

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
Insert	**A123**	**12000**	**01-01-2008**	**07-01-2008**

BUSINESS_TIME Period INSERT Example

```
INSERT INTO policy_info VALUES
('A123',12000, '07-01-2008', '01-01-2009');
```

Policy_info

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
	A123	**12000**	**01-01-2008**	**07-01-2008**
Insert	**A123**	**12000**	**07-01-2008**	**01-01-2009**

INSERT BUSINESS_TIME Example

```
INSERT INTO policy_info VALUES
('A123',14000, '06-01-2008','08-01-2008');
```

ERROR, policy is not unique over time.

Policy_info (no change)

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
	A123	**12000**	**01-01-2008**	**07-01-2008**
	A123	**12000**	**07-01-2008**	**01-01-2009**

UPDATE BUSINESS_TIME Example

```
UPDATE policy_info
         FOR PORTION OF BUSINESS_TIME
         FROM '06-01-2008' TO '08-01-2008'
         SET coverage = 14000
         WHERE policy_id = 'A123';
```

Policy_info

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
Insert	**A123**	**12000**	**01-01-2008**	**06-01-2008**
Update	**A123**	**14000**	**06-01-2008**	**07-01-2008**
Update	**A123**	**14000**	**07-01-2008**	**08-01-2008**
Insert	**A123**	**12000**	**08-01-2008**	**01-01-2009**

DELETE BUSINESS_TIME Example

```
DELETE FROM policy_info
            FOR PORTION OF BUSINESS_TIME
            FROM '06-15-2008' TO '08-15-2008'
            WHERE policy_id = 'A123';
```

Policy_info

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
	A123	**12000**	**01-01-2008**	**06-01-2008**
Delete				
Insert	**A123**	**14000**	**06-01-2008**	**06-15-2008**
Delete				
Insert	**A123**	**12000**	**08-15-2008**	**01-01-2009**

SELECT BUSINESS_TIME Example

```
SELECT policy_id, coverage FROM policy_info
FOR BUSINESS_TIME AS OF '06-01-2008';
```

returns a row of
('A123', 14000)

Policy_info

DB Action	Policy ID	Coverage	Bus_strt	Bus_end
	A123	**12000**	**01-01-2008**	**06-01-2008**
Select	**A123**	**14000**	**06-01-2008**	**06-15-2008**
	A123	**12000**	**08-15-2008**	**01-01-2009**

Satisfy Your Auditor:
Temporal Table Benefits

- SYSTEM_TIME period
  - Provides database managed row begin and row end timestamp maintenance providing non-overlapping time periods with no gaps in time
  - Provides automatic management of data movement from system period temporal table to history table
  - Provides automatic rewrite of queries on system period temporal table to include a UNION ALL to history table
  - Minimizes performance impact of temporal support when no rows requested from a historical perspective
- BUSINESS_TIME period
  - Provides a clause for a unique index to prevent overlapping time periods for a business key
  - Provides database management of the temporal data when an UPDATE or a DELETE statement is executed with a FOR PORTION OF BUSINESS_TIME clause that does not exactly align with respect to time for existing rows
- BITEMPORAL table
  - Combines all of the features provided for SYSTEM_TIME period and BUSINESS_TIME period

Summary
Help Satisfy Your Auditors using DB2 10

- More granular authorities to reduce use of SYSADM
- Improved auditing at SQL statement level
- New SQL row and column access controls
- New temporal data support
  - System period supporting data versioning
  - Business period supporting business time