DB2 11 for z/OS

Managing Security

SC19-4061-00

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Note
Before using this information and the product it supports, be sure to read the general information under "Notices" at the end of this information.

First edition (October 2013)

This edition applies to DB2 11 for z/OS (product number 5615-DB2), DB2 11 for z/OS Value Unit Edition (product number 5697-P43), and to any subsequent releases until otherwise indicated in new editions. Make sure you are using the correct edition for the level of the product.

Specific changes are indicated by a vertical bar to the left of a change. A vertical bar to the left of a figure caption indicates that the figure has changed. Editorial changes that have no technical significance are not noted.

Contents

About this information

This information provides guidance that you can use to manage security in a DB2® for z/OS® environment.

This information assumes that your DB2 subsystem is running in Version 11 new-function mode. Generally, new functions that are described, including changes to existing functions, statements, and limits, are available only in new-function mode, unless explicitly stated otherwise. Exceptions to this general statement include optimization and virtual storage enhancements, which are also available in conversion mode unless stated otherwise.

Who should read this information

This information is primarily intended for security, system, and database administrators. It assumes that the user is familiar with the basic concepts and facilities of DB2 for z/OS (DB2), z/OS, RACF®, and Structured Query Language (SQL).

DB2 Utilities Suite

Important: In this version of DB2 for z/OS, the DB2 Utilities Suite is available as an optional product. You must separately order and purchase a license to such utilities, and discussion of those utility functions in this publication is not intended to otherwise imply that you have a license to them.

The DB2 Utilities Suite can work with DB2 Sort and the DFSORT program, which you are licensed to use in support of the DB2 utilities even if you do not otherwise license DFSORT for general use. If your primary sort product is not DFSORT, consider the following informational APARs mandatory reading:

- II14047/II14213: USE OF DFSORT BY DB2 UTILITIES
- II13495: HOW DFSORT TAKES ADVANTAGE OF 64-BIT REAL ARCHITECTURE

These informational APARs are periodically updated.

Related information

DB2 utilities packaging (Utility Guide)

Terminology and citations

When referring to a DB2 product other than DB2 for z/OS, this information uses the product's full name to avoid ambiguity.

The following terms are used as indicated:

DB2 Represents either the DB2 licensed program or a particular DB2 subsystem.

OMEGAMON®
Refers to any of the following products:
- IBM® Tivoli® OMEGAMON XE for DB2 Performance Expert on z/OS
- IBM Tivoli OMEGAMON XE for DB2 Performance Monitor on z/OS
- IBM DB2 Performance Expert for Multiplatforms and Workgroups

- IBM DB2 Buffer Pool Analyzer for z/OS

C, C++, and C language
Represent the C or C++ programming language.

CICS® Represents CICS Transaction Server for z/OS.

IMS™ Represents the IMS Database Manager or IMS Transaction Manager.

MVS™ Represents the MVS element of the z/OS operating system, which is equivalent to the Base Control Program (BCP) component of the z/OS operating system.

RACF Represents the functions that are provided by the RACF component of the z/OS Security Server.

Accessibility features for DB2 11 for z/OS

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use information technology products successfully.

Accessibility features

The following list includes the major accessibility features in z/OS products, including DB2 11 for z/OS. These features support:

- Keyboard-only operation.
- Interfaces that are commonly used by screen readers and screen magnifiers.
- Customization of display attributes such as color, contrast, and font size

Tip: The Information Management Software for z/OS Solutions Information Center (which includes information for DB2 11 for z/OS) and its related publications are accessibility-enabled for the IBM Home Page Reader. You can operate all features using the keyboard instead of the mouse.

Keyboard navigation

You can access DB2 11 for z/OS ISPF panel functions by using a keyboard or keyboard shortcut keys.

For information about navigating the DB2 11 for z/OS ISPF panels using TSO/E or ISPF, refer to the *z/OS TSO/E Primer*, the *z/OS TSO/E User's Guide*, and the *z/OS ISPF User's Guide*. These guides describe how to navigate each interface, including the use of keyboard shortcuts or function keys (PF keys). Each guide includes the default settings for the PF keys and explains how to modify their functions.

Related accessibility information

Online documentation for DB2 11 for z/OS is available in the Information Management Software for z/OS Solutions Information Center, which is available at the following website: http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/index.jsp

IBM and accessibility

See the *IBM Accessibility Center* at http://www.ibm.com/able for more information about the commitment that IBM has to accessibility.

How to send your comments

Your feedback helps IBM to provide quality information. Please send any comments that you have about this book or other DB2 for z/OS documentation. You can use the following methods to provide comments:

- Send your comments by email to db2zinfo@us.ibm.com and include the name of the product, the version number of the product, and the number of the book. If you are commenting on specific text, please list the location of the text (for example, a chapter and section title or a help topic title).
- You can also send comments by using the **Feedback** link at the footer of each page in the Information Management Software for z/OS Solutions Information Center at http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/index.jsp.

How to read syntax diagrams

Certain conventions apply to the syntax diagrams that are used in IBM documentation.

Apply the following rules when reading the syntax diagrams that are used in DB2 for z/OS documentation:

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

  The ►►— symbol indicates the beginning of a statement.

  The —► symbol indicates that the statement syntax is continued on the next line.

  The ►— symbol indicates that a statement is continued from the previous line.

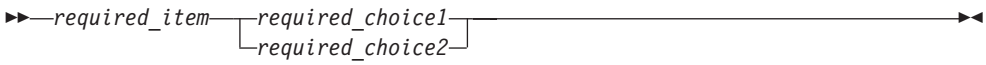
  The —►◄ symbol indicates the end of a statement.
- Required items appear on the horizontal line (the main path).

- Optional items appear below the main path.

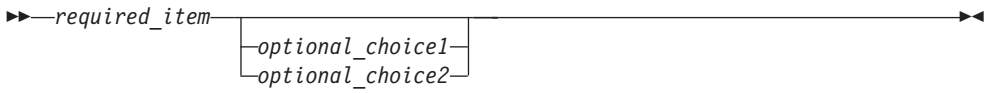
  If an optional item appears above the main path, that item has no effect on the execution of the statement and is used only for readability.

- If you can choose from two or more items, they appear vertically, in a stack.

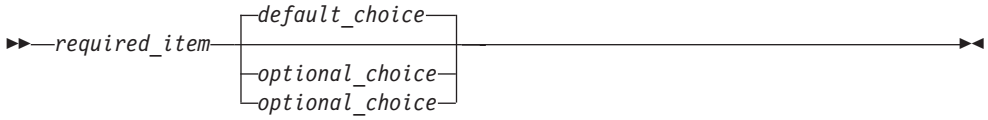
  If you *must* choose one of the items, one item of the stack appears on the main path.



  If choosing one of the items is optional, the entire stack appears below the main path.

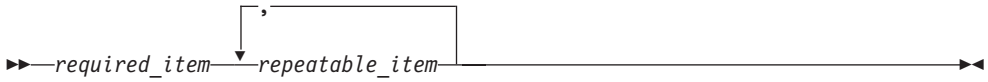


If one of the items is the default, it appears above the main path and the remaining choices are shown below.



- An arrow returning to the left, above the main line, indicates an item that can be repeated.

If the repeat arrow contains a comma, you must separate repeated items with a comma.



A repeat arrow above a stack indicates that you can repeat the items in the stack.

- Sometimes a diagram must be split into fragments. The syntax fragment is shown separately from the main syntax diagram, but the contents of the fragment should be read as if they are on the main path of the diagram.

fragment-name:

- With the exception of XPath keywords, keywords appear in uppercase (for example, `FROM`). Keywords must be spelled exactly as shown. XPath keywords are defined as lowercase names, and must be spelled exactly as shown. Variables appear in all lowercase letters (for example, *column-name*). They represent user-supplied names or values.
- If punctuation marks, parentheses, arithmetic operators, or other such symbols are shown, you must enter them as part of the syntax.

Chapter 1. Getting started with DB2 security

DB2 *security* refers to the protection of sensitive data and system resources by controlling access to DB2 objects, subsystems, and other assets.

DB2 security is set through a security plan, implemented through privilege and authority management, and reinforced through the audit of accesses to protected data. A *security plan* defines the security objectives of your organization and specifies the policies and techniques that you use to meet these objectives. A *security audit* traces all data access and determines whether your security plan works as designed and implemented.

If you are new to DB2 security, skim through the succeeding topics for a brief overview of the techniques that you can use to manage access to your DB2 and protect your data before reading the scenario.

DB2 security solutions

With each new release, DB2 gets faster and more secure.

Over the years, DB2 recognizes and addresses the following security problems:

- Privilege theft or mismanagement
- Application or application server tampering
- Data or log tampering
- Storage media theft
- Unauthorized access to objects

DB2 offers the following security solutions to address the problems:

- Authentication
- Authorization
- Data integrity
- Confidentiality
- System integrity
- Audit

What's new in DB2 11 for z/OS security?

DB2 11 for z/OS provides critical enhancements to security and auditing. These enhancements strengthen DB2 security in the z/OS environment.

DB2 data access control

Access to data can originate from users through interactive terminal sessions, local or remote stored procedures, utilities, or IMS or CICS transactions. It can also originate from application programs that run in batch mode, remote applications that use DDF or CLI and JDBC drivers, or web-based applications supported by WebSphere® Application Servers.

Given the variety of access originators, the term *process* is used to represent all access to data. For example, within a DB2 subsystem, a process can be a primary authorization ID, one or more secondary IDs, a role, or an SQL ID.

A process can gain access to DB2 data through several routines. As shown in the following diagram, DB2 provides different ways for you to control access from all but the data set protection route.

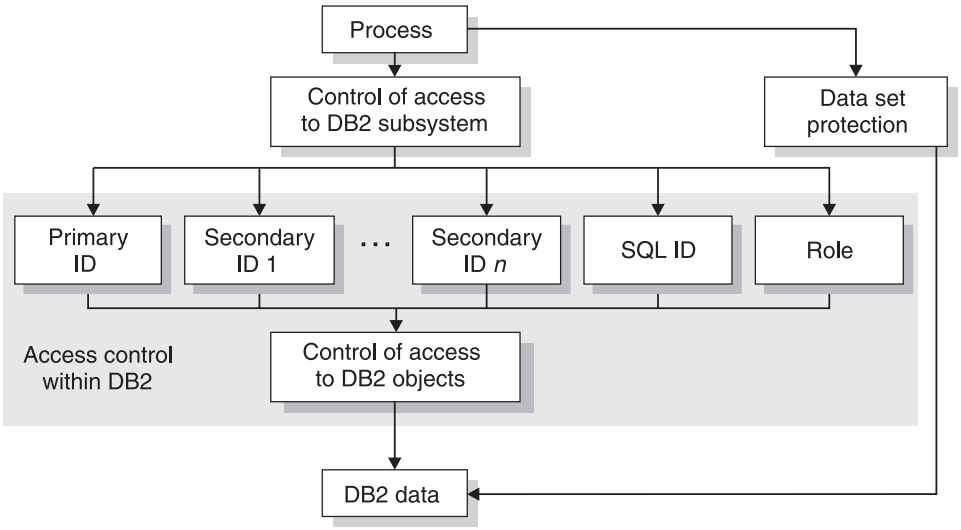


Figure 1. DB2 data access control

One of the ways that DB2 controls access to data is by using authorization IDs or roles. DB2 relies on IDs or roles to determine whether to allow or prohibit certain processes. DB2 assigns privileges and authorities to IDs or roles so that the owning users can take actions on objects. In this sense, it is an ID or a role, not a user, that owns an object. In other words, DB2 does not base access control on a specific user or person who need access. For example, if you allow other users to use your IDs, DB2 recognizes only the IDs, not the people or programs that use them.

Related concepts:

"DB2 subsystem access control" on page 4

ID-based access control within DB2

DB2 provides a wide range of granularity when you grant privileges to an ID within DB2. You can grant privileges and authorities to groups, secondary IDs, or to roles.

For example, you could, separately and specifically, grant to an ID the privilege to retrieve data from the table, to insert rows, to delete rows, or to update specific columns. By granting or not granting privileges on views of the table, you can specify exactly what an ID can do to the table, down to the granularity of specific fields. You can also grant to an ID specific privileges on databases, plans, packages, and the entire DB2 subsystem. If you grant or revoke privileges on a procedure or procedure package, all versions of that procedure or procedure package have those privileges.

DB2 also defines sets of related privileges, called *administrative authorities.* When you grant one of the administrative authorities to a person's ID, that person has all

of the privileges that are associated with that administrative authority. You can efficiently grant many privileges by granting one administrative authority.

You can also efficiently grant multiple privileges by granting the privilege to execute an application plan or a package. When an ID executes a plan or package, the ID implicitly uses all of the privileges that the owner needed when binding the plan or package. Therefore, granting to an ID the privilege to execute a plan or package can provide a finely detailed set of privileges and can eliminate the need to grant other privileges separately.

Example: Assume that an application plan issues the INSERT and SELECT statements on several tables. You need to grant INSERT and SELECT privileges only to the plan owner. However, any authorization ID that is later granted the EXECUTE privilege on the plan can perform those same INSERT and SELECT statements by executing the plan. You do not need to explicitly grant the INSERT and SELECT privileges to the ID.

Recommendation: Instead of granting privileges to many primary authorization IDs, consider associating each of those primary IDs with the same secondary ID or a role if running in a trusted context. Then grant the privileges to the secondary ID or role. You can associate a primary ID with one or more secondary IDs or roles when the primary ID gains access to the DB2 subsystem. DB2 makes the association within an exit routine. The assignment of privileges to the secondary ID or role is controlled entirely within DB2.

Related concepts:

"Role-based access control within DB2"

"Ownership-based access control within DB2"

Role-based access control within DB2

A *privilege* enables the user of an ID to execute certain SQL statements or to access the objects of another user. A *role* groups the privileges together so that they can be simultaneously granted to and revoked from multiple users.

A role is a database object that is created in DB2. It is defined through the SQL CREATE ROLE statement and a trusted connection. A role cannot be used outside of a trusted context unless the user in a role grants privileges to an ID.

Related concepts:

"ID-based access control within DB2" on page 2

"Ownership-based access control within DB2"

Ownership-based access control within DB2

Object ownership carries with it a set of related privileges on the object. DB2 provides separate controls for creation and ownership of objects.

If you want to prevent users from obtaining implicit privileges from object ownership, you can make a DB2 role the owner of the object. To do this, you need to create the object in a trusted context that is defined with the ROLE AS OBJECT OWNER AND QUALIFIER clause.

Related concepts:

"ID-based access control within DB2" on page 2

"Role-based access control within DB2" on page 3

Related tasks:

"Changing object ownership" on page 79

Access control through multilevel security

Multilevel security, also known as label-based access control, allows you to classify objects and users with security labels. The security labels are based on hierarchical security levels and non-hierarchical security categories.

DB2 multilevel security solution uses the multilevel security feature in the z/OS operating system. It prevents unauthorized users from accessing information at a higher classification than their authorization. It also prevents users from declassifying information.

Using multilevel security with row-level granularity, you can define strong security for DB2 objects and perform security checks, including row-level security checks. Row-level security checks allow you to control which users have authorization to view, modify, or perform other actions on specific rows of data.

Related reference:

"Implementing multilevel security with DB2" on page 108

Access control external to DB2

You can control access to DB2 by using a DB2-supplied exit routine or an exit routine that you write.

If your installation uses one of the access control authorization exit routines, you can use it to control authorization and authentication checking, instead of using other techniques and methods.

Related concepts:

"Access control authorization exit routine" on page 257

DB2 subsystem access control

You can control whether a process can gain access to a specific DB2 subsystem from outside of DB2. A common approach is to grant access through RACF or a similar security system.

A RACF system provides several advantages. For example, you can use RACF for the following objectives:

- Identify and verify the identifier that is associated with a process
- Connect those identifiers to RACF group names
- Log and report unauthorized attempts to access protected resources

Profiles for access to DB2 from various environments and DB2 address spaces are defined as resources to RACF. Each request to access DB2 is associated with an ID. RACF determines whether the ID is authorized for DB2 resources. If the ID is authorized, RACF permits access to DB2.

You can also consider using the security capabilities of IMS or CICS to manage access to DB2:

- *IMS terminal security* lets you limit the entry of a transaction code to a particular logical terminal (LTERM) or group of LTERMs in the system. To protect a particular program, you can authorize a transaction code that is to be entered only from any terminal on a list of LTERMs. Alternatively, you can associate each LTERM with a list of the transaction codes that a user can enter from that LTERM. IMS then passes the validated LTERM name to DB2 as the initial primary authorization ID
- *CICS transaction code security* works with RACF to control the transactions and programs that can access DB2. Within DB2, you can use the ENABLE and DISABLE options of the bind operation to limit access to specific CICS subsystems.

Related concepts:

"DB2 data access control" on page 1

Managing access requests from local applications

If you request access to a local DB2 subsystem, your request is often subject to several checks before you are granted access.

If you run DB2 under TSO and use the TSO logon ID as the DB2 primary authorization ID, TSO verifies your ID when you log on. When you gain access to DB2, you can use a self-written or IBM-supplied DSN3@ATH exit routine that is connected to DB2 to perform the following actions:

- Check the authorization ID again
- Change the authorization ID
- Associate the authorization ID with secondary IDs

After these actions are performed, the authorization ID can use the services of an external security system again.

Managing access requests from remote applications

You can require remote users to pass several access checks before they reach DB2. You can use RACF or a similar security subsystem to control access from a remote location.

While controlling access from a remote locations, RACF can do the following tasks:

- Verify an ID that is associated with a remote attachment request and check the ID with a password
- Generate *PassTickets* on the sending side. PassTickets can be used instead of passwords. A PassTicket lets a user gain access to a host system without sending the RACF password across the network.
- Verify a Kerberos ticket if your distributed environment uses Kerberos to manage user access and perform user authentication

You can also control access authentication by using the *DB2 communications database* (CDB). The CDB is a set of tables in the DB2 catalog that are used to establish conversations with remote database management systems. The CDB can translate IDs before it sends them to the remote system.

You can use the RACF DSNR general resource class for DB2 for access authentication. With RACF DSNR, you can control access to the DB2 server by the IDs that are defined to the ssnm.DIST profile with READ. In addition, you can use the port of entry (POE) checking by RACF and the z/OS communications server to protect against unauthorized remote connections to DB2.

Data set protection

The data in a DB2 subsystem is contained in data sets. The data sets can be accessed without going through DB2. To protect your data, you need to control all access routes by using different access control methods and mechanisms. For example, you can determine who can use offline utilities by assigning appropriate access.

RACF for data protection

If you use RACF, or an equivalent security system, to control access to DB2, consider controlling access to your data sets.

If you want to use RACF for data set protection outside of the DB2 subsystem, define RACF profiles for data sets and permit access to the data sets for certain DB2 IDs.

Data encryption

If your data is very sensitive, consider encrypting the data. Encryption protects against unauthorized access to data sets and to backup copies outside of the DB2 subsystem.

You have the following encryption options for protecting sensitive data:

- IBM System Storage® DS8000® support for data encryption with the IBM Full Disk Encryption drives
- IBM System Storage TS1130 encryption solution
- Secure Socket Layer (SSL) protocol through the z/OS Communications Server IP Application Transparent Transport Layer (AT-TLS) service
- IBM Encryption Facility for z/OS
- Advanced Encryption Standard (AES) for encrypting userids and passwords over network connections
- DB2 edit procedures or field procedures, which can use the Integrated Cryptographic Service Facility (ICSF)
- IBM Data Encryption for IMS and DB2 Databases tool
- Encryption tools and facilities that used outside of DB2

You can consider compressing your data sets before encrypting the data. Data compression is not a substitute for encryption. In some cases, the compression method does not actually shorten the data. In those cases, the data is left uncompressed and readable. If you encrypt and compress your data, compress it first. After you obtain the maximum compression, encrypt the result. When you retrieve your data, first decrypt the data. After the data is decrypted, decompress the result.

Scenario: Securing data access at Spiffy Computer

This scenario describes a simple approach to securing local and remote access to the sensitive data of employees, payroll operations, and payroll management at Spiffy Computer Company. It shows how to enforce a security plan by using authorization IDs, roles, privileges, authorities, and the audit trace.

You should base your security plan, techniques, and procedures on your actual security objectives; do not view this sample security plan as an exact model for

your security needs. Instead, use it to understand various possibilities and address problem areas that you might encounter when you implement your security plan.

Determining security objectives

An important step in defining and implementing an effective security plan is to determine your security objectives.

About this task

Suppose that the Spiffy Computer Company management team determines the following security objectives:

- Managers can see, but not update, all of the employee data for members of their own departments.
- Managers of managers can see all of the data for employees of departments that report to them.
- The employee table resides at a central location. Managers at remote locations can query the data in the table.
- The payroll operations department makes changes to the employee table. Members of the payroll operations department can update any column of the employee table except for the salary, bonus, and commission columns.
- Members of payroll operations can update any row except for rows that are for members of their own department. Because changes to the table are made only from a central location, distributed access does not affect payroll operations.
- Changes to the salary, bonus, and commission columns are made through a process that involves the payroll update table. When an employee's compensation changes, a member of the payroll operations department can insert rows in the payroll update table. For example, a member of the payroll operations department might insert a row in the compensation table that lists an employee ID and an updated salary. Next, the payroll management group can verify inserted rows and transfer the changes to the employee table.
- No one else can see the employee data. The security plan cannot fully achieve this objective because some ID must occasionally exercise SYSADM authority. While exercising SYSADM authority, an ID can retrieve any data in the system. The security plan uses the trace facility to monitor the use of that power.

Securing manager access to employee data

As a security measurement, the Spiffy Computer Company sets clear restrictions on how its managers can access employee data.

Specifically, it imposes the following security restrictions on managers:

- Managers can retrieve, but not change, all information in the employee table for members of their own departments.
- Managers of managers have the same privileges for their own departments and for the departments that directly report to them.

Creating views of employee data

The Spiffy security planners decide to use views for implementing the restrictions on managers' access to employee data.

Procedure

To create a view of employee data for every employee that reports to a manager, the Spiffy security planners perform the following steps:

1. Add a column that contains manager IDs to DSN8910.DEPT, as shown in the following statement:

```
ALTER TABLE DSN8B10.DEPT
   ADD MGRID CHAR(8) FOR SBCS DATA NOT NULL WITH DEFAULT;
```

2. Create a view that selects employee information about employees that work for a given manager, as shown in the following statement:

```
CREATE VIEW DEPTMGR AS
   SELECT * FROM DSN8B10.EMP, DSN8B10.DEPT
      WHERE WORKDEPT = DEPTNO
      AND MGRID = USER;
```

3. Ensure that every manager has the SELECT privilege on the view.

Granting managers the SELECT privilege

The security planners for Spiffy Computer Company can take an "individual" approach or a "functional" approach when they grant the SELECT privilege on a view to managers.

About this task

With an individual approach, they can grant privileges to individual IDs and revoke them if the user of the ID leaves the company or transfers to another position. With a functional approach, they can create RACF groups, and grant privileges to the group IDs, with the intention of never revoking them. When an individual ID needs those privileges, connect that ID to the group; disconnect the ID when its user leaves or transfers.

The Spiffy security planners know that the functional approach is usually more convenient in the following situations:

- Each function, such as the manager function, requires many different privileges. When functional privileges are revoked from one user, they must be granted to another user.
- Several users need the same set of privileges.
- The privileges are given with the grant option, or the privileges let users create objects that must persist after their original owners leave or transfer. In both cases, revoking the privileges might not be appropriate. The revokes cascade to other users. To change ownership, you might need to drop objects and re-create them.

Some of the Spiffy requirements for securing manager access suggest the functional approach. However, in this case, the function needs only one privilege. The privilege does not carry the grant option, and the privilege does not allow new objects to be created.

Therefore, the Spiffy security planners choose the individual approach, and plan to re-examine their decision later. Spiffy security planners grant all managers the SELECT privilege on the views for their departments.

Example

To grant the SELECT privilege on the DEPTMGR view to the manager with ID EMP0060, the planners use the following GRANT statement:

```
GRANT SELECT ON DEPTMGR TO EMP0060;
```

Managing distributed access

Some Spiffy managers must use views to query data in the central employee table from remote locations. The security plan must ensure that this type of distributed access is secure. Therefore, security administrators must implement a sound plan for distributed access.

Planning for distributed access:

The Spiffy security planners need to determine how the managers can securely access employee data in a distributed environment.

About this task

To secure distributed access to employee data, the Spiffy security planners must address the following questions:

- Which IDs should hold privileges on which views?
- How do the central location and the remote locations divide security responsibilities for IDs?

The Spiffy security planners answer those questions with the following decisions:

- IDs that are managed at the central location hold privileges on views for departments that are at remote locations. For example, the ID MGRD11 has the SELECT privilege on the view DEPTD11.
- If the manager of Department D11 uses a remote system, the ID at that system must be translated to MGRD11. Then a request is sent to the central system. All other IDs are translated to CLERK before they are sent to the central system.
- The communications database (CDB) manages the translated IDs, like MGRD11.
- An ID from a remote system must be authenticated on any request to the central system.

Implementing distributed access at the central server:

To enable distributed access to sensitive employee data, the Spiffy security plan requires certain security measures to be implemented at the central server location.

About this task

The following actions must occur at the central server location:

- The central DB2 subsystem must authenticate every incoming ID with RACF.
- For SNA connections, the Spiffy security planners must include an entry in table SYSIBM.LUNAMES in the CDB; the entry in the LUNAME column identifies the LU name of every remote location. The entry must specify that connections must be verified.

  Example: The following table shows an entry in SYSIBM.LUNAMES for LUREMOTE.

Table 1. The SYSIBM.LUNAMES table at the central location

LUNAME	USERNAMES	SECURITY_IN	ENCRYPTPSWDS
LUREMOTE	blank	V	N

The value of V for SECURITY_IN indicates that incoming remote connections must include verification. The value of N for ENCRYPTPSWDS indicates that passwords are not in internal RACF encrypted format.

The security plan treats all remote locations alike, so it does not require encrypted passwords. The option to require encrypted passwords is available only between two DB2 subsystems that use SNA connections.

- For TCP/IP connections, the Spiffy security planners must set the TCP/IP ALREADY VERIFIED field of installation panel DSNTIP5 to NO. This setting ensures that the incoming requests that use TCP/IP are not accepted without authentication.
- The Spiffy security planners must grant all privileges and authorities that are required by the manager of Department D11 to the ID, MGRD11. The security planners must grant similar privileges to IDs that correspond to the remaining managers.

Implementing distributed access at remote locations:

To enable distributed access to sensitive employee data, the Spiffy security plan requires certain security measures to be implemented at the remote locations.

About this task

The following actions must occur at the remote locations to enable distributed access for the Spiffy security plan:

- For SNA connections, the Spiffy security planners must include an entry in table SYSIBM.LUNAMES for the LU name of the central location. The entry must specify an outbound ID translation for attachment requests to that location.

  For example, the following table shows an entry in SYSIBM.LUNAMES for LUCENTRAL.

Table 2. The SYSIBM.LUNAMES table at the remote location

LUNAME	USERNAMES	SECURITY_OUT
LUCENTRAL	O	P

  The value of O for USERNAMES indicates that translation checking is performed on outbound IDs, but not on inbound IDs. The value of P for SECURITY_OUT indicates that outbound connection requests contain a user password and a RACF PassTicket.

- For TCP/IP connections, the Spiffy security planners must include an entry in table SYSIBM.IPNAMES for the LU name that is used by the central location. The content of the LUNAME column is used to generate RACF PassTickets. The entry must specify outbound ID translation for requests to that location.

  For example, the following table shows an entry in SYSIBM.IPNAMES for LUCENTRAL.

Table 3. The SYSIBM.IPNAMES table at the remote location

LINKNAME	USERNAMES	SECURITY_OUT	IPADDR
LUCENTRAL		R	central.vnet.ibm.com

- The Spiffy security planners must include entries in table SYSIBM.USERNAMES to translate outbound IDs.

  For example, the following table shows two entries in SYSIBM.USERNAMES.

Table 4. The SYSIBM.USERNAMES table at the remote location

TYPE	AUTHID	LINKNAME	NEWAUTHID
O	MEL1234	LUCENTRAL	MGRD11

Table 4. The SYSIBM.USERNAMES table at the remote location (continued)

TYPE	AUTHID	LINKNAME	NEWAUTHID
O	blank	LUCENTRAL	CLERK

MEL1234 is translated to MGRD11 before it is sent to the LU that is specified in the LINKNAME column. All other IDs are translated to CLERK before they are sent to that LU.

Exception: For a product other than DB2 for z/OS, the actions at the remote location might be different. If you use a different product, check the documentation for that product. The remote product must satisfy the requirements that are imposed by the central subsystem.

Auditing manager access

The Spiffy payroll data is extremely sensitive. The security plan requires the audit trace to be automatically started for all classes whenever DB2 is started.

About this task

To ensure that an audit record exists for every access to the employee table, the Spiffy security planners create an audit policy for the employee table. Every week, the security planners scan the records and determine the number of accesses by each manager.

The report highlights any number of accesses outside an expected range. The Spiffy system operator makes a summary of the reports every two months, and scans it for unusual patterns of access. A large number of accesses or an unusual pattern might reveal use of a manager's logon ID by an unauthorized employee.

Related concepts:

Chapter 10, “Auditing access to DB2,” on page 305

“DB2 audit policy” on page 313

Securing access to payroll operations and management

As a security measurement, the Spiffy security plan sets clear restrictions on how members of the payroll operations department access and handle sensitive payroll information.

The plan imposes the following restrictions on members of the payroll operations department:

- Members of the payroll operations department can update any column of the employee table except for SALARY, BONUS, and COMM.
- Members of payroll operations can update any row except for rows that are for members of their own department.

Because changes to the table are made only from the central location, distributed access does not affect payroll operations.

Creating views of payroll operations

The Spiffy security planners decide to use views for implementing the security objectives for members of the payroll operations department.

About this task

The PAYDEPT view shows all the columns of the employee table except for job, salary, bonus, and commission. The view does not show the rows for members of the payroll operations department.

Example: The WORKDEPT value for the payroll operations department is P013. The owner of the employee table uses the following statement to create the PAYDEPT view:

```
CREATE VIEW PAYDEPT AS
  SELECT EMPNO, FIRSTNME, MIDINIT, LASTNAME, WORKDEPT,
         PHONENO, HIREDATE, JOB, EDLEVEL, SEX, BIRTHDATE
    FROM DSN8B10.EMP
    WHERE WORKDEPT<>'P013'
  WITH CHECK OPTION;
```

The CHECK OPTION ensures that every row that is inserted or updated through the view conforms to the definition of the view.

A second view, the PAYMGR view, gives Spiffy payroll managers access to any record, including records for the members of the payroll operations department.

Example: The owner of the employee table uses the following statement to create the PAYMGR view:

```
CREATE VIEW PAYMGR AS
  SELECT EMPNO, FIRSTNME, MIDINIT, LASTNAME, WORKDEPT,
         PHONENO, HIREDATE, JOB, EDLEVEL, SEX, BIRTHDATE
    FROM DSN8B10.EMP
  WITH CHECK OPTION;
```

Neither PAYDEPT nor PAYMGR provides access to compensation amounts. When a row is inserted for a new employee, the compensation amounts remain null. An update process can change these values at a later time. The owner of the employee table creates, owns, and grants privileges on both views.

Securing compensation accounts with update tables

The Spiffy security plan does not allow members of payroll operations to update compensation amounts directly. Instead, a separate payroll update table contains the employee ID, job, salary, bonus, and commission.

About this task

Members of payroll operations make all job, salary, and bonus changes to the payroll update table, except those for their own department. After they verify the prospective changes, the managers of payroll operations run an application program. The program reads the payroll update table and makes the corresponding changes to the employee table. Only the payroll update program has the privilege of updating job, salary, and bonus in the employee table.

The Spiffy Computer Company calculates commission amounts separately by using a complicated formula. The formula considers the employee's job, department, years of service with the company, and responsibilities for various projects. The formula is embedded in the commission program, which is run regularly to insert new commission amounts in the payroll update table. The plan owner must have the SELECT privilege on the employee table and other tables to run the commission program.

Securing compensation updates with other measures

By separating potential salary changes into the payroll update table, the Spiffy security planners allow payroll management to verify changes before they go into effect.

About this task

At Spiffy Computer Company, managers check the changes against a written change request that is signed by a required level of management. The Spiffy security planners consider that check to be the most important control on salary updates, but the plan also includes the following controls:

- The employee ID in the payroll update table is a foreign key column that refers to the employee ID in the employee table. Enforcing the referential constraint prevents an employee ID from being changed to an invalid value.
- The employee ID in the payroll update table is also a primary key for that table. Therefore, the values in the employee ID column must be unique. Because of enforced uniqueness, every change that is made for any one employee during a given operating period must appear in the same row of the table. No two rows can carry conflicting changes.

The Spiffy security plan documents an allowable range of salaries, bonuses, and commissions for each job level. To keep the values within the allowable ranges, the Spiffy security planners use table check constraints for the salaries, bonuses, and commissions. The planners use this approach because it is both simple and easy to control.

In a similar situation, you might also consider the following ways to ensure that updates and inserts stay within certain ranges:

- Keep the ranges in a separate DB2 table. To verify changes, query the payroll update table and the table of ranges. Retrieve any rows for which the planned update is outside the allowed range.
- Build the ranges into a validation routine. Apply the validation routine to the payroll update table to automatically reject any insert or update that is outside the allowed range.
- Embody the ranges in a view of the payroll table, using WITH CHECK OPTION, and make all updates to the view. The ID that owns the employee table also owns the view.
- Create a trigger to prevent salaries, bonuses, and commissions from increasing by more than the percent that is allowed for each job level.

Granting privileges to payroll operations and management

The Spiffy security plan strongly suggests the functional approach for the payroll operations department.

About this task

The functional approach meets the security needs of the payroll operations for the following reasons:

- Payroll operations members require several privileges, including the SELECT, INSERT, UPDATE, and DELETE privileges on the PAYDEPT view.
- Several members of the department require the same set of privileges.
- If members of the department leave, others are hired or transferred to replace the departing members.

Therefore, the security plan calls for the creation of two RACF groups, with one for the payroll operations and another for the payroll management.

Creating a RACF group for payroll operations:

The Spiffy security plan calls for the creation of a RACF group for the payroll operations department. DB2USER can define the group and retain its ownership, or it can assign the ownership to an ID that is used by payroll management.

About this task

The owner of the employee table can grant the privileges that the group requires. The owner grants all required privileges to the group ID, with the intent not to revoke them. The primary IDs of new members of the department are connected to the group ID, which becomes a secondary ID for each of them. The primary IDs of members who leave the department are disconnected from the group ID.

Example

The following statement grants the SELECT, INSERT, UPDATE, and DELETE privileges on the PAYDEPT view to the payroll operations group ID PAYOPS:

```
GRANT SELECT, INSERT, UPDATE, DELETE ON PAYDEPT TO PAYOPS;
```

This statement grants the privileges without the GRANT OPTION to keep members of payroll operations from granting privileges to other users.

Creating a RACF group for payroll management:

The Spiffy payroll managers require different privileges and a different RACF group ID. The security planners add a RACF group for payroll managers and name it PAYMGRS.

About this task

The security planners associate the payroll managers' primary IDs with the PAYMGRS secondary ID. Next, privileges on the PAYMGR view, the compensation application, and the payroll update application are granted to PAYMGRS. The payroll update application must have the appropriate privileges on the update table.

Example

The following statement grants the SELECT, INSERT, UPDATE, and DELETE privileges on the PAYMGR view to the payroll managers' group ID PAYMGRS:

```
GRANT SELECT, INSERT, UPDATE, DELETE ON PAYMGR TO PAYMGRS;
```

The following statement grants the EXECUTE privilege on the compensation application:

```
GRANT EXECUTE ON PLAN COMPENS TO PAYMGRS;
```

Auditing payroll operations and management

You can create an audit policy for the payroll update table to audit payroll operation and management activities.

About this task

The audit trace records the number of accesses by the payroll operations and payroll management groups. The Spiffy security planners scan the reports of payroll access for large numbers or unusual patterns of access.

Related concepts:

Chapter 10, "Auditing access to DB2," on page 305

"DB2 audit policy" on page 313

Managing access privileges of other authorities

In addition to the privileges for the managers and the payroll operation and management personnel, the security plan considers the privileges for other roles.

Managing access by the DBADM authority

An ID with the DBADM authority on a database has many privileges on that database and its tables. These privileges include the SELECT, INSERT, DELETE, UPDATE, and ALTER statements on any table in the database. They also include the CREATE and DROP statements on indexes for those tables.

About this task

For security reasons, the Spiffy security planners prefer not to grant all of the privileges that come with DBADM authority on DSN8D11A. DSN8D11A is the database that holds the employee table and the payroll update table.

The Spiffy security planners prefer to grant DBCTRL authority on the database because granting DBCTRL authority does not expose as many security risks as granting DBADM authority. DBCTRL authority allows an ID to support the database without allowing the ID to retrieve or change the data in the tables. However, database DSN8D11A contains several additional tables. These additional tables require some of the privileges that are included in DBADM authority but not included in DBCTRL authority.

The Spiffy security planners decide to compromise between the greater security of granting DBCTRL authority and the greater flexibility of granting DBADM authority. To balance the benefits of each authority, the Spiffy security planners create an administrative ID with some, but not all of the DBADM privileges. The security plan calls for a RACF group ID with the following authorities and privileges:

- DBCTRL authority over DSN8D81A
- The INDEX privilege on all tables in the database except the employee table and the payroll update table
- The SELECT, INSERT, UPDATE, and DELETE privileges on certain tables, excluding the employee table and the payroll update table

An ID with SYSADM authority grants the privileges to the group ID.

In a similar situation, you also might consider putting the employee table and the payroll update table in a separate database. Then you can grant DBADM authority on DSN8D11A, and grant DBCTRL authority on the database that contains the employee table and the payroll update table.

Related reference:

"System DBADM" on page 38

"DBADM" on page 36

Managing access by the SYSADM authority

An ID with SYSADM authority can access data from any table in the entire DB2 subsystem, including the employee table and the payroll update table. The Spiffy security planners want to minimize the security risk by granting the SYSADM authority to as few users as possible.

About this task

The planners know that the subsystem might require SYSADM authority only for certain tasks and only for relatively short periods. They also know that the privileges that are associated with the SYSADM authority give an ID control over all of the data in a subsystem.

To limit the number of users with SYSADM authority, the Spiffy security plan grants the authority to DB2OWNER, the ID that is responsible for DB2 security. That does not mean that only IDs that are connected to DB2OWNER can exercise privileges that are associated with SYSADM authority. Instead, DB2OWNER can grant privileges to a group, connect other IDs to the group as needed, and later disconnect them.

The Spiffy security planners prefer to have multiple IDs with SYSCTRL authority instead of multiple IDs with SYSADM authority. IDs with SYSCTRL authority can exercise most of the SYSADM privileges and can assume much of the day-to-day work. IDs with SYSCTRL authority cannot access data directly or run plans unless the privileges for those actions are explicitly granted to them. However, they can run utilities, examine the output data sets, and grant privileges that allow other IDs to access data. Therefore, IDs with SYSCTRL authority can access some sensitive data, but they cannot easily access the data. As part of the Spiffy security plan, DB2OWNER grants SYSCTRL authority to selected IDs.

The Spiffy security planners also use ROLEs, RACF group IDs, and secondary IDs to relieve the need to have SYSADM authority continuously available. SYSADM grants the necessary privileges to a ROLE, RACF group ID, or secondary ID. IDs that have this ROLE, RACF group ID, or secondary ID can then bind plans and packages it owns.

Managing access by object owners

The Spiffy security plan must consider the ID that owns and grants privileges on the tables, views, and programs. The ID that owns these objects has many implicit privileges on the objects. The owner of the objects can also grant privileges on the objects to other users.

About this task

The Spiffy security planners want to limit the number of IDs that have privileges on the employee table and the payroll update table to the smallest convenient value. To meet that objective, they decide that the owner of the employee table should issue all of the CREATE VIEW and GRANT statements. They also decide to have the owner of the employee table own the plans and packages that are associated with employee data. The employee table owner implicitly has the following privileges, which the plans and packages require:

- The owner of the payroll update program must have the SELECT privilege on the payroll update table and the UPDATE privilege on the employee table.
- The owner of the commission program must have the UPDATE privilege on the payroll update table and the SELECT privilege on the employee table.
- The owners of several other payroll programs must have the proper privileges to do payroll processing, such as printing payroll checks, writing summary reports, and so on.

To bind these plans and packages, an ID must have the BIND or BINDADD privileges. The list of privileges that are required by the owner of the employee table suggests the functional approach. The Spiffy security planners create a RACF group for the owner of the employee table.

Managing access by other users

Users must be authorized to access the employee table or the payroll table. Exceptions occur when any unauthorized user tries to access the tables.

About this task

The following users are authorized to access the employee and payroll tables:
- Department managers
- Members of the payroll operations department
- Payroll managers
- The payroll update program

The audit report lists each exception in full. Auditors check each exception to determine whether it was a planned operation by the users with SYSADM or DBADM authority, or the employee table owner.

The audit report also lists denials of access to the tables. Those denials represent attempts by unauthorized IDs to use the tables. Some are possibly accidental; others can be attempts to violate the security system.

After running the periodic reports, the security planners archive the audit records. The archives provide a complete audit trail of access to the employee data through DB2.

Chapter 2. Managing access through authorization IDs and roles

DB2 controls access to its objects and data through authorization identifiers (IDs) and roles and the privileges that are assigned to them. Each privilege and its associated authorities enable you to take specific actions on an object. Therefore, you can manage access to DB2 objects through authorization IDs and roles.

As the following diagram shows, you can grant privileges and authorities to IDs or roles and control access to data and processes in several primary ways:

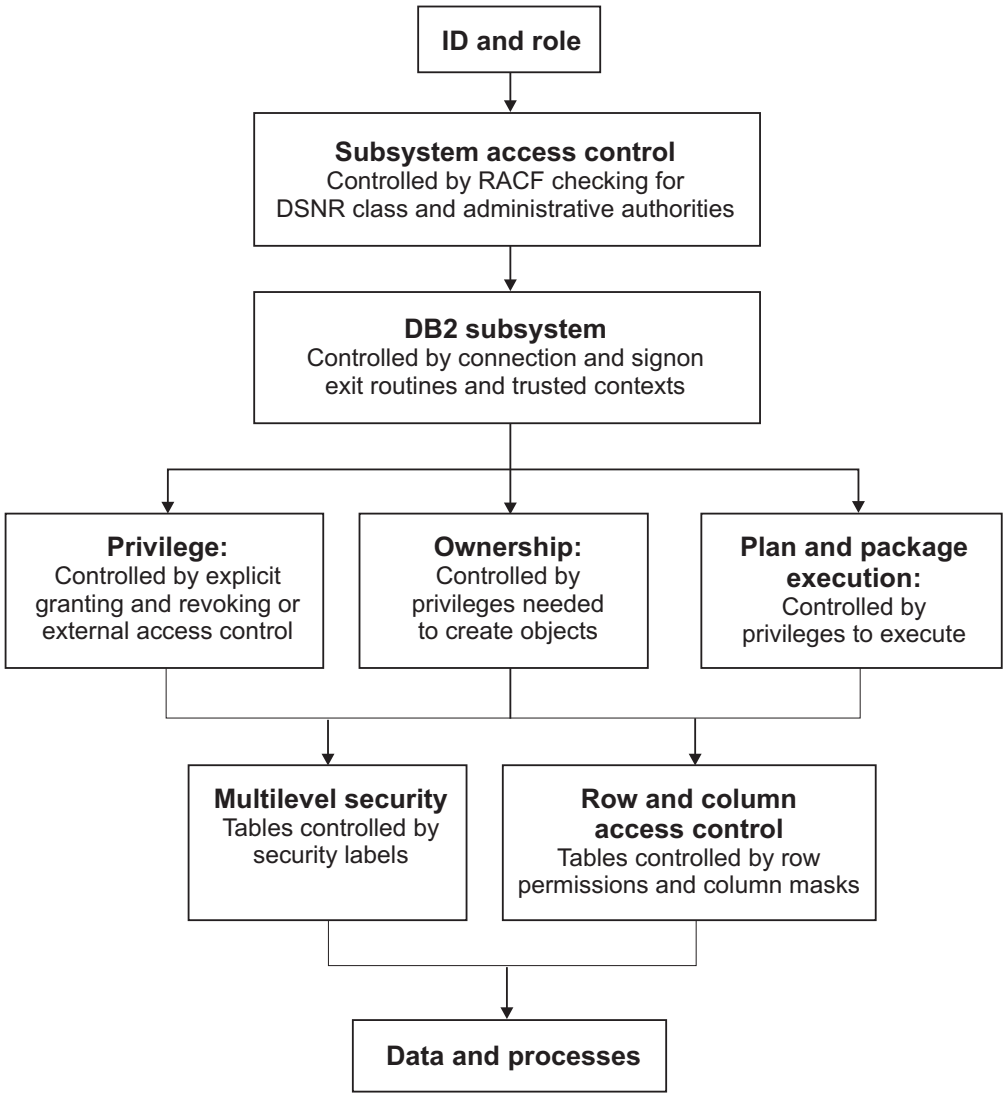


Figure 2. Access to objects and data within DB2

1. Managing access to DB2 through RACF and subsystem access authorization.
2. Managing access to DB2 subsystem through connection and sign-on routines or trusted contexts.

3. Granting and revoking explicit privileges through authorization IDs and roles or through external access control.

   DB2 has primary authorization IDs, secondary authorization IDs, roles, and SQL IDs. Some privileges can be exercised by only one type of ID or a role; other privileges can be exercised by multiple IDs or roles. The DB2 catalog records the privileges that IDs are granted and the objects that IDs own.
4. Managing implicit privileges through ownership of objects other than plans and packages.
5. Managing implicit privileges through ownership of plans and packages.
6. Controlling access through security labels on tables.
7. Activating and deactivating row and column access control on tables.

Certain privileges and authorities are assigned when you install DB2. You can reassign these authorities by changing the DSNZPARM subsystem parameter.

As a security planner, you must be aware of these ways to manage privileges and authorities through authorization IDs and roles before you write a security plan. After you decide how to authorize access to data, you can implement it through your security plan.

Authorization IDs and roles

You can control access to DB2 objects by assigning privileges and authorities to an authorization ID or a role.

Authorization IDs

Every process that connects to or signs on to DB2 is represented by one or more DB2 short identifiers (IDs), which are called *authorization IDs*. Authorization IDs are assigned to a process by default procedures or by user-written exit routines.

When authorization IDs are assigned, every process receives exactly one ID that is called the *primary authorization ID*. All other IDs are *secondary authorization IDs*. Furthermore, one ID (either primary or secondary) is designated as the current *SQL ID*. You can change the value of the SQL ID during your session. More details about these IDs are as follows:

Role A role is available within a trusted context. You can define a role and assign it to authorization IDs in a trusted context. When associated with a role and using the trusted connection, an authorization ID inherits all the privileges granted to that role.

Primary authorization ID
Generally, the primary authorization ID identifies a process. For example, statistics and performance trace records use a primary authorization ID to identify a process.

Secondary authorization ID
A secondary authorization ID, which is optional, can hold additional privileges that are available to the process. For example, a secondary authorization ID can be a Resource Access Control Facility (RACF) group ID.

SQL ID
An SQL ID holds the privileges that are exercised when certain dynamic SQL statements are issued. The SQL ID can be set equal to the primary ID or any of the secondary IDs. If an authorization ID of a process has the

SYSADM authority and if the SEPARATE SECURITY system parameter on panel DSNTIPP1 is set to NO during installation, the process can set its SQL ID to any authorization ID. If the SEPARATE SECURITY parameter is set to YES, the SYSADM authority can set it to one of the secondary IDs only. This rule applies even when SET CURRENT SQLID is a static statement. CURRENT SQLID cannot be set to a role.

RACF ID

The RACF ID is generally the source of the primary and secondary authorization IDs (RACF groups). When you use the RACF Access Control Module or multilevel security, the RACF ID is used directly.

Roles in a trusted context

A *role* is a database entity that groups one or more privileges together in a trusted context. System administrators can use roles to control access to enterprise objects in a way that parallels the structure of the enterprise.

A role is available only in a trusted context. A *trusted context* is an independent database entity that you can define based on a system authorization ID and connection trust attributes. The trust attributes specify a set of characteristics about a specific connection. These attributes include the IP address, domain name, or SERVAUTH security zone name of a remote client and the job or task name of a local client.

DB2 for z/OS extends the trusted context concept to allow for the assignment of a role to a trusted context. An authorization ID that uses the trusted context can inherit the privileges that are assigned to this role, in addition to the privileges that are granted to the ID. An authorization ID can have only one role in a trusted context at any given time.

Using roles provides the flexibility for managing context-specific privileges and simplifies the processing of authorization. Specific roles can be assigned to the authorization IDs that use the trusted connection. When your authorization ID is associated with an assigned role in the trusted context, you inherit all privileges that are granted by that role, instead of those by the default role, because the role-based privileges override the privileges that are associated with the default role.

Related concepts:

"Trusted contexts" on page 219

"Trusted connections" on page 220

Related tasks:

"Defining trusted contexts" on page 220

"Creating local trusted connections" on page 221

"Establishing remote trusted connections by DB2 for z/OS requesters" on page 222

"Establishing remote trusted connections to DB2 for z/OS servers" on page 223

Privileges and authorities

You can control access within DB2 by granting or revoking privileges and related authorities that you assign to authorization IDs or roles. A *privilege* enables its holder to perform a specific operation, sometimes on a specific object.

Privileges can be explicit or implicit. An *explicit privilege* is a specific type of privilege. Each explicit privilege has a name and is the result of a GRANT statement or a REVOKE statement.

An *implicit privilege* comes from the ownership of objects, including plans and packages. For example, users are granted implicit privileges on objects that are referenced by a plan or package when they are authorized to execute the plan or package.

An administrative *authority* is a set of privileges, often covering a related set of objects. Authorities often include privileges that are not explicit, have no name, and cannot be specifically granted. For example, when an ID is granted the SYSOPR administrative authority, the ID is implicitly granted the ability to terminate any utility job.

Explicit privileges

You can explicitly grant privileges on objects to authorization IDs or roles.

You can explicitly grant privileges on the following objects:
- Collections
- Databases
- Distinct types or JAR
- Functions or procedures
- Packages
- Plans
- Routines
- Schemas
- Sequences
- Systems
- Tables and views
- Usage
- Use

Related concepts:

"Privileges by authorization ID and authority" on page 43

Related reference:

"Implicit privileges through object ownership" on page 28

"Administrative authorities" on page 29

"Utility authorities for DB2 catalog and directory" on page 42

Explicit collection privileges

You can explicitly grant privileges on collections.

GUPI

DB2 supports the following collection privileges:

Table 5. Explicit collection privileges

Collection privilege	Operations allowed for a named package collection
CREATE IN	The BIND PACKAGE subcommand, to name the collection

GUPI

Explicit database privileges

You can explicitly grant privileges on databases.

GUPI

DB2 supports the following database privileges:

Table 6. Explicit database privileges

Database privilege	Operations allowed on a named database
CREATETAB	The CREATE TABLE statement, to create tables in the database.
CREATETS	The CREATE TABLESPACE statement, to create table spaces in the database
DISPLAYDB	The DISPLAY DATABASE command, to display the database status
DROP	The DROP and ALTER DATABASE statements, to drop or alter the database
IMAGCOPY	The QUIESCE, COPY, and MERGECOPY utilities, to prepare for, make, and merge copies of table spaces in the database; the MODIFY RECOVERY utility, to remove records of copies
LOAD	The LOAD utility, to load tables in the database
RECOVERDB	The RECOVER, REBUILD INDEX, and REPORT utilities, to recover objects in the database and report their recovery status
REORG	The REORG utility, to reorganize objects in the database
REPAIR	The REPAIR and DIAGNOSE utilities (except REPAIR DBD and DIAGNOSE WAIT) to generate diagnostic information about, and repair data in, objects in the database
STARTDB	The START DATABASE command, to start the database
STATS	The RUNSTATS, CHECK, LOAD, REBUILD INDEX, REORG INDEX, and REORG TABLESPACE, and MODIFY STATISTICS utilities, to gather statistics, check indexes and referential constraints for objects in the database, and delete unwanted statistics history records from the corresponding catalog tables
STOPDB	The STOP DATABASE command, to stop the database

Database privileges that are granted on DSNDB04 apply to all implicitly created databases. For example, if you have the DBADM authority on DSNDB04, you can select data from any table in any implicitly created database. If you have the STOPDB privilege on DSNDB04, you can stop any implicitly created database. However, you cannot grant the same authorities or privileges to others on any implicitly created database.

GUPI

Explicit package privileges

You can explicitly grant privileges on packages.

GUPI

DB2 supports the following package privileges:

Table 7. Explicit package privileges

Package privilege	Operations allowed for a named package
BIND	The BIND, REBIND, and FREE PACKAGE subcommands, and the DROP PACKAGE statement, to bind or free the package, and, depending on the installation option BIND NEW PACKAGE, to bind a new version of a package
COPY	The COPY option of BIND PACKAGE, to copy a package
EXECUTE	Inclusion of the package in the PKLIST option of BIND PLAN
GRANT ALL	All package privileges

GUPI

Explicit plan privileges

You can explicitly grant privileges on plans.

GUPI

DB2 supports the following plan privileges:

Table 8. Explicit plan privileges

Plan privilege	Subcommands allowed for a named application plan
BIND	BIND, REBIND, and FREE PLAN, to bind or free the plan
EXECUTE	RUN, to use the plan when running the application

GUPI

Explicit routine privileges

You can explicitly grant privileges on routines.

GUPI

DB2 supports the following routine privileges:

Table 9. Explicit routine privileges

Routine privileges	Objects available for usage
EXECUTE ON FUNCTION	A user-defined function
EXECUTE ON PROCEDURE	A stored procedure

GUPI

Explicit schema privileges

You can explicitly grant privileges on schemas.

GUPI

DB2 supports the following schema privileges:

Table 10. Explicit schema privileges

Schema privileges	Operations available for usage
CREATEIN	Create distinct types, user-defined functions, triggers, and stored procedures in the designated schemas
ALTERIN	Alter user-defined functions or stored procedures, or specify a comment for distinct types, user-defined functions, triggers, and stored procedures in the designated schemas
DROPIN	Drop distinct types, user-defined functions, triggers, and stored procedures in the designated schemas

GUPI

Explicit system privileges

You can explicitly grant privileges on systems.

GUPI

DB2 supports the following system privileges:

Table 11. Explicit system privileges

System privilege	Operations allowed on the system
ARCHIVE	The ARCHIVE LOG command, to archive the current active log, the DISPLAY ARCHIVE command, to give information about input archive logs, the SET LOG command, to modify the checkpoint frequency specified during installation, and the SET ARCHIVE command, to control allocation and deallocation of tape units for archive processing.
BINDADD	The BIND subcommand with the ADD option, to create new plans and packages
BINDAGENT	The BIND, REBIND, and FREE subcommands, and the DROP PACKAGE statement, to bind, rebind, or free a plan or package, or copy a package, on behalf of the grantor. The BINDAGENT privilege is intended for separation of function, not for added security. A bind agent with the EXECUTE privilege might be able to gain all the authority of the grantor of BINDAGENT.
BSDS	The RECOVER BSDS command, to recover the bootstrap data set
CREATEALIAS	The CREATE ALIAS statement, to create an alias for a table or view name
CREATEDBA	The CREATE DATABASE statement, to create a database and have DBADM authority over it
CREATEDBC	The CREATE DATABASE statement, to create a database and have DBCTRL authority over it
CREATESG	The CREATE STOGROUP statement, to create a storage group
CREATE_SECURE_OBJECT	The CREATE and ALTER statements, to create secure objects, such as a secure trigger or a user-defined function. If a trigger is defined for tables that are enforced with row or column access control, it must be secure. If a user-defined function is referenced in the definition of a row permission or column mask, it must be secure. In addition, if a user-defined function is invoked in a query and its arguments reference columns with column masks, the user-defined function must be secure.

Table 11. Explicit system privileges (continued)

System privilege	Operations allowed on the system
CREATETMTAB	The CREATE GLOBAL TEMPORARY TABLE statement, to define a created temporary table
DEBUGSESSION	The DEBUGINFO connection attribute, to control debug session activity for SQL stored procedures, non-inline SQL functions, and Java™ stored procedures
DISPLAY	The DISPLAY ARCHIVE, DISPLAY BUFFERPOOL, DISPLAY DATABASE, DISPLAY LOCATION, DISPLAY LOG, DISPLAY THREAD, and DISPLAY TRACE commands, to display system information
EXPLAIN	• The SQL EXPLAIN PLAN and EXPLAIN ALL statements, to issue the statements without requiring additional privileges • The SQL PREPARE and DESCRIBE TABLE statements, to prepare and describe the statements without requiring additional privileges on the object • The BIND command, to allow users to specify the EXPLAIN(ONLY) and SQLERROR(CHECK) options without creating a plan or package • Dynamic SQL statements that have the special register CURRENT EXPLAIN MODE set to EXPLAIN, to allow the capture of information about the statements, without executing them An authorization ID or role with any of the following authority or privilege can grant the EXPLAIN privilege: • The SECADM authority • The ACCESSCTRL authority • The SYSADM authority if the SEPARATE SECURITY system parameter is set to NO at the installation • The EXPLAIN privilege with the WITH GRANT OPTION.
MONITOR1	Receive trace data that is not potentially sensitive
MONITOR2	Receive all trace data
RECOVER	The RECOVER INDOUBT command, to recover threads
STOPALL	The STOP DB2 command, to stop DB2
STOSPACE	The STOSPACE utility, to obtain data about space usage
TRACE	The START TRACE, STOP TRACE, and MODIFY TRACE commands, to control tracing

GUPI

Explicit table and view privileges

You can explicitly grant privileges on tables and views.

GUPI

DB2 supports the following table and view privileges:

Table 12. Explicit table and view privileges

Table or view privilege	SQL statements allowed for a named table or view
ALTER	ALTER TABLE, to change the table definition
DELETE	DELETE, to delete rows
INDEX	CREATE INDEX, to create an index on the table
INSERT	INSERT, to insert rows
REFERENCES	ALTER or CREATE TABLE, to add or remove a referential constraint that refers to the named table or to a list of columns in the table
SELECT	SELECT, to retrieve data
TRIGGER	CREATE TRIGGER, to define a trigger on a table
UPDATE	UPDATE, to update all columns or a specific list of columns
GRANT ALL	SQL statements of all privileges

GUPI

Explicit usage privileges

You can explicitly grant privileges on usage.

GUPI

DB2 supports the following usage privileges:

Table 13. Explicit usage privileges

Usage privileges	Objects available for usage
USAGE ON DISTINCT TYPE	A distinct type
USAGE ON JAR (Java class for a routine)	A Java class
USAGE ON SEQUENCE	A sequence

GUPI

Explicit use privileges

You can explicitly grant privileges on use.

GUPI

DB2 supports the following use privileges:

Table 14. Explicit use privileges

Use privileges	Objects available for use
USE OF BUFFERPOOL	A buffer pool
USE OF STOGROUP	A storage group
USE OF TABLESPACE	A table space

GUPI

Implicit privileges through object ownership

When you create a DB2 object by issuing an SQL statement, you establish its name and its ownership. By default, the owner implicitly holds certain privileges on the object.

GUPI However, this general rule does not apply to a plan or package that is not created with SQL CREATE statements. In other words, when you own an object other than a plan or package, you have implicit privileges over the object. The following table describes the implicit privileges of ownership for each type of object:

Table 15. Implicit privileges of ownership by object type

Object type	Implicit privileges of ownership
Alias	To drop the alias
Database	DBCTRL or DBADM authority over the database, depending on the privilege (CREATEDBC or CREATEDBA) that is used to create it. DBCTRL authority does **not** include the privilege to access data in tables in the database.
Distinct type	To use or drop a distinct type
Index	To alter, comment on, or drop the index
JAR (Java class for a routine)	To replace, use, or drop the JAR
Package	To bind, rebind, free, copy, execute, drop, or comment on the package
Plan	To bind, rebind, free, execute, or comment on the plan
Role	To create, alter, commit, drop, or comment on the role
Sequence	To alter, comment on, use, or drop the sequence
Storage group	To alter or drop the group and to name it in the USING clause of a CREATE INDEX or CREATE TABLESPACE statement
Stored procedure	To execute, alter, drop, start, stop, or display a stored procedure
Synonym	To use or drop the synonym
Table	• To alter or drop the table or any indexes on it • To lock the table, comment on it, or label it • To create an index or view for the table • To select or update any column (if there is no row permission or column mask defined or if the row permission and the column mask definition allows the access) • To insert, delete, select, or update any row (if there is no row permission defined or if the row permission definition allows the access) • To use the LOAD utility for the table • To define referential constraints on any table or set of columns • To create a trigger on the table • To comment on the table
Table space	To alter or drop the table space and to name it in the IN clause of a CREATE TABLE statement
Trusted context	To create, alter, commit, revoke, or comment on the trusted context
User-defined functions	To execute, alter, drop, start, stop, or display a user-defined function

Table 15. Implicit privileges of ownership by object type (continued)

Object type	Implicit privileges of ownership
View	• To drop, comment on, or label the view, or to select any row or column • To execute UPDATE, INSERT, or DELETE on the view if the view is defined with the INSTEAD OF TRIGGER clause

GUPI

Related concepts:

"Explicit privileges" on page 22

"Privileges by authorization ID and authority" on page 43

Related reference:

"Administrative authorities"

"Utility authorities for DB2 catalog and directory" on page 42

Administrative authorities

Within DB2, privileges are grouped into administrative authorities, and each administrative authority is vested with a specific set of privileges.

GUPI

The following table lists all of the DB2 for z/OS administrative authorities and the grantable privileges that each of them has.

Table 16. Administrative authorities and grantable privileges

Authority	Included authorities	Additional grantable privileges

ACCESSCTRL	None	Privileges on all catalog tables:
		`SELECT`
		
		Privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES):
		`DELETE INSERT UPDATE`
		
		Privileges on security:
		`GRANT REVOKE`

Table 16. Administrative authorities and grantable privileges (continued)

Authority	Included authorities	Additional grantable privileges

DATAACCESS	None	System privileges:
		`DEBUGSESSION`
		
		Privileges on all user tables, views, and MQTs:
		`DELETE INSERT SELECT UPDATE`
		
		Privileges on all plans, packages, and routines:
		`EXECUTE`
		
		Privileges on all user databases:
		`LOAD RECOVERDB REORG REPAIR`
		
		Privileges on all JARs:
		`USAGE`
		
		Privileges on all sequences:
		`USAGE`
		
		Privileges on all distinct types:
		`USAGE`
		
		Privileges on all catalog tables:
		`SELECT`
		
		Privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES):
		`DELETE INSERT UPDATE`

DBADM	DBCTRL, DBMAINT	Privileges on tables in a database:
		`ALTER DELETE INDEX INSERT`
		`REFERENCES SELECT TRIGGER UPDATE`

DBCTRL	DBMAINT	Privileges on a database:
		`DROP LOAD RECOVERDB REORG`
		`REPAIR`

DBMAINT	None	Privileges on a database:
		`CREATETAB CREATETS DISPLAYDB`
		`IMAGCOPY STATS STARTDB STOPDB`

Installation SYSADM	SYSADM, SYSCTRL, DBADM, Installation SYSOPR, SYSOPR, PACKADM, DBCTRL, DBMAINT, SECADM, System DBADM, SQLADM, ACCESSCTRL, DATAACCESS	Privileges on security: `GRANT REVOKE`
Installation SYSOPR	SYSOPR	Privileges: `ARCHIVE STARTDB`*`(cannot alter access mode)`*

Table 16. Administrative authorities and grantable privileges (continued)

Authority	Included authorities	Additional grantable privileges

PACKADM	None	Privileges on a collection:
		`CREATEIN`
		
		Privileges on all packages in a collection:
		`BIND COPY EXECUTE`

SECADM	ACCESSCTRL	Privileges on all catalog tables:
		`SELECT`
		
		Privileges on all updatable catalog tables:
		`DELETE INSERT UPDATE`
		
		Privileges on security:
		`GRANT REVOKE`
		
		Privileges on security-related objects:
		`ALTER CREATE DROP`

SQLADM	None	System privileges:
		`EXPLAIN MONITOR1 MONITOR2`
		
		Privileges on all catalog tables:
		`SELECT`
		
		Privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES):
		`DELETE INSERT UPDATE`

SYSADM	SYSCTRL, DBADM, Installation SYSOPR, SYSOPR, PACKADM, DBCTRL, DBMAINT, SECADM, System DBADM, SQLADM, ACCESSCTRL, DATAACCESS	Privileges on all plans:
		`EXECUTE`
		
		Privileges on all routines:
		`EXECUTE`
		
		Privileges on all packages:
		`All privileges`
		
		Privileges on distinct types:
		`USAGE`
		
		Privileges on sequences:
		`USAGE`
		
		System privileges:
		`DEBUGSESSION`
		
		EXPLAIN privilege

Table 16. Administrative authorities and grantable privileges (continued)

Authority	Included authorities	Additional grantable privileges

SYSCTRL	Installation SYSOPR, SYSOPR, DBCTRL, DBMAINT, ACCESSCTRL (except the ability to grant certain authorities, such as DBADM, SYSADM, PACKADM, and certain privileges, such as DELETE, INSERT, SELECT, and UPDATE on user tables or views, EXECUTE on plans, packages, functions, or stored procedures, PACKADM on collections, and USAGE on distinct types, JARs, and sequences)	System privileges:
		`BINDADD BINDAGENT DBDS`
		`CREATEALIAS CREATEDBA CREATEDBC`
		`CREATESG CREATETMTAB MONITOR1`
		`MONITOR2 STOSPACE`
		
		Privileges on all tables:
		`ALTER INDEX REFERENCES TRIGGER`
		
		Privileges on all catalog tables:
		`SELECT`
		
		Privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES):
		`DELETE INSERT UPDATE`
		
		Privileges on all plans:
		`BIND`
		
		Privileges on all packages:
		`BIND COPY`
		
		Privileges on all collections:
		`CREATEIN`
		
		Privileges on all schemas:
		`ALTERIN CREATEIN DROPIN`
		
		Privileges on use:
		`BUFFERPOOLS STOGROUP TABLESPACE`

SYSOPR	None	Privileges:
		`DISPLAY RECOVER STOPALL TRACE`
		
		Privileges on routines:
		`DISPLAY START STOP`

Table 16. Administrative authorities and grantable privileges (continued)

Authority	Included authorities	Additional grantable privileges

System DBADM	SQLADM	System privileges:
		`BINDADD BINDAGENT CREATEALIAS`
		`CREATEDBA CREATEDBC CREATETMTAB`
		`DISPLAY EXPLAIN MONITOR1`
		`MONITOR2 SQLADM STOPALL`
		`TRACE`
		
		Privileges on all collections:
		`CREATEIN`
		
		Privileges on all user databases:
		`CREATETAB CREATETS DISPLAYDB`
		`DROP IMAGCOPY RECOVERDB`
		`STARTDB STOPDB`
		
		Privileges on all user tables (except for those defined with row permissions or column masks):
		`ALTER INDEX REFERENCES TRIGGER`
		
		Privileges on all packages:
		`BIND COPY`
		
		Privileges on all plans:
		`BIND`
		
		Privileges on all schemas:
		`ALTERIN CREATEIN DROPIN`
		
		Privileges on all sequences:
		`ALTER`
		
		Privileges on all distinct types:
		`USAGE`
		
		Privileges on use:
		`TABLESPACE`
		
		Privileges on all catalog tables:
		`SELECT`
		
		Privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES):
		`DELETE INSERT UPDATE`

GUPI

Related concepts:

"Explicit privileges" on page 22

"Privileges by authorization ID and authority" on page 43

Related reference:

"Implicit privileges through object ownership" on page 28

"Utility authorities for DB2 catalog and directory" on page 42

Installation SYSADM

Installation SYSADM authority is assigned to one or two IDs when DB2 is installed; it cannot be assigned to a role. These IDs have all the privileges of the SYSADM authority.

GUPI No other IDs can revoke the installation SYSADM authority; you can remove the authority only by changing the module that contains the subsystem initialization parameters (typically DSNZPARM).

In addition, DB2 does not record the installation SYSADM authority in the catalog. Therefore, the catalog does not need to be available to check installation SYSADM authority. The authority outside of the catalog is crucial. For example, if the directory table space DBD01 is stopped, DB2 might not be able to check the authority to start it again. In this case, only an installation SYSADM can start it.

IDs with the installation SYSADM authority can also perform the following actions:

- Run the CATMAINT utility
- Access DB2 when the subsystem is started with ACCESS(MAINT)
- Start databases DSNDB01 and DSNDB06 when they are stopped or in restricted status
- Run the DIAGNOSE utility with the WAIT statement
- Start and stop the database that contains the application registration table (ART) and the object registration table (ORT).
- Grant, revoke, and manage security-related objects regardless of the setting of the SEPARATE_SECURITY system parameter. GUPI

SYSADM

The SYSADM authority includes all the privileges, including system privileges, for creating objects and accessing all data. Depending on the setting of the SEPARATE_SECURITY system parameter, the SYSADM authority can also create security objects and grant and revoke privileges.

GUPI Regardless of the SEPARATE_SECURITY setting, an authorization ID or role with the SYSADM authority can perform the following actions. If SEPARATE_SECURITY is set to NO, it can also grant other IDs the required privileges to perform the same actions.

- Use all the privileges of DBADM over any database
- Use EXECUTE privileges on all packages
- Use EXECUTE privileges on all routines
- Use USAGE privilege on distinct types, JARs, and sequences
- Use BIND on any plan and COPY on any package
- Use privileges over views that are owned by others

- Create and drop synonyms and views for other IDs on any table
- Drop database DSNDB07

An authorization ID or role with the SYSADM authority can also perform the following actions but cannot grant other IDs the privileges to perform them:
- Drop or alter any DB2 object, except system databases
- Issue a COMMENT ON statement for any table, view, index, column, package, plan
- Issue a LABEL ON statement for any table or view
- Terminate any utility job
- Create roles and trusted contexts (if SEPARATE_SECURITY is set to NO)
- Set the current SQL ID to any valid value (if SEPARATE_SECURITY is set to NO)
- Use any valid value for OWNER in BIND or REBIND (if SEPARATE_SECURITY is set to NO)

Although an authorization ID or role with the SYSADM authority cannot grant the preceding privileges explicitly, it can accomplish this goal by granting to other IDs the SYSADM authority.

Regardless of the SEPARATE_SECURITY setting, an authorization ID or role with the SYSADM authority can revoke any privileges that were granted by itself. When SEPARATE_SECURITY is set to NO, the same ID or role can also revoke privileges that were granted by others. However, when SEPARATE_SECURITY is set to YES, the same ID or role cannot revoke privileges that were granted by others. GUPI

SYSCTRL

The SYSCTRL authority is designed for administering a system that contains sensitive data. With the SYSCTRL authority, you have nearly complete control of the DB2 subsystem. However, you cannot access user data directly unless you are explicitly granted the privileges to do so.

GUPI Regardless of the SEPARATE_SECURITY setting, an authorization ID or role with the SYSCTRL authority can perform the following actions:
- Act as installation SYSOPR (when the catalog is available) or DBCTRL over any database
- Run any allowable utility on any database
- Issue a COMMENT ON, LABEL ON, or LOCK TABLE statement for any table
- Create a view on any catalog table for itself or for other IDs
- Create tables and aliases for itself or for others IDs
- Bind a new plan or package and name any ID as the owner of the plan or package
- Create roles (only if SEPARATE_SECURITY is set to NO)
- Use any valid value for OWNER in BIND or REBIND (only if SEPARATE_SECURITY is set to NO)
- Has implicit ACCESSCTRL authority to grant most privileges (only if SEPARATE_SECURITY is set to NO)

However, you cannot perform the following actions without the required additional privileges:
- Execute SQL statements that change data in any user tables or views
- Run plans or packages

- Set the current SQL ID to a value that is not one of its primary or secondary IDs
- Start or stop the database that contains the application registration table (ART) and the object registration table (ORT)
- Act fully as SYSADM or as DBADM over any database
- Access DB2 when the subsystem is started with ACCESS(MAINT)

The SYSCTRL authority is intended to separate system control functions from administrative functions. However, SYSCTRL is not a complete solution for a high-security system. If any plans have their EXECUTE privilege granted to PUBLIC, an ID or role with the SYSCTRL authority can grant itself the SYSADM authority. The only control over such actions is to audit the activity of IDs with high levels of authority. GUPI

Installation SYSOPR

Installation SYSOPR authority is assigned to one or two IDs when DB2 is installed; it cannot be assigned to a role. These IDs have all the privileges of the SYSOPR authority.

GUPI No IDs can revoke the installation SYSOPR authority; you can remove it only by changing the module that contains the subsystem initialization parameters (typically DSNZPARM).

In addition, the installation SYSOPR authority is not recorded in the DB2 catalog. Therefore, the catalog does not need to be available to check the installation SYSOPR authority.

IDs with the installation SYSOPR authority can perform the following actions:

- Access DB2 when the subsystem is started with ACCESS(MAINT).
- Run all allowable utilities on the directory and catalog databases (DSNDB01 and DSNDB06).
- Run the REPAIR utility with the DBD statement.
- Start and stop the database that contains the application registration table (ART) and the object registration table (ORT).
- Issue dynamic SQL statements that are not controlled by the DB2 governor.
- Issue a START DATABASE command to recover objects that have LPL entries or group buffer pool RECOVERY-pending status. These IDs cannot change the access mode. GUPI

SYSOPR

A user with the SYSOPR authority can issue all DB2 commands except ARCHIVE LOG, START DATABASE, STOP DATABASE, and RECOVER BSDS.

GUPI In addition, that user can run the DSN1SDMP utility and terminate any utility job. With the GRANT option, that user can grant these privileges to others. GUPI

DBADM

The DBADM authority includes the DBCTRL privileges over a specific database. A user with the DBADM authority can access any tables in a specific database by using SQL statements.

GUPI With the DBADM authority, you can also perform the following actions:

- Drop or alter any table space, table, or index in the database
- Issue a COMMENT, LABEL, or LOCK TABLE statement for any table in the database
- Issue a COMMENT statement for any index in the database

If the value of the DBADM CREATE AUTH field on the DSNTIPP installation panel is set to YES during the DB2 installation, an ID with the DBADM authority can create the following objects:

- A view for another ID. The view must be based on at least one table, and that table must be in the database under DBADM authority.
- An alias for another ID on any table in the database.

An ID with DBADM authority on one database can create a view on tables and views in that database and other databases only if the ID has all the privileges that are required to create the view. For example, an ID with DBADM authority cannot create a view on a view that is owned by another ID.

If a user has the DBADM authority with the GRANT option, that user can grant these privileges to others. GUPI

DBCTRL

The DBCTRL authority includes the DBMAINT privileges on a specific database. A user with the DBCTRL authority can run utilities that can change the data.

GUPI If the value of the DBADM CREATE AUTH field on the DSNTIPP installation panel is set to YES during the DB2 installation, an ID with DBCTRL authority can create an alias for another user ID on any table in the database.

If a user has the DBCTRL authority with the GRANT option, that user can grant those privileges to others. GUPI

DBMAINT

A user with the DBMAINT authority can grant the privileges on a specific database to an ID.

GUPI With the DBMAINT authority, that user can perform the following actions within that database:

- Create objects
- Run utilities that don't change data
- Issue commands
- Terminate all utilities on the database except DIAGNOSE, REPORT, and STOSPACE

If a user has the DBMAINT authority with the GRANT option, that user can grant those privileges to others. GUPI

PACKADM

The PACKADM authority has the package privileges on all packages in specific collections and the CREATE IN privilege on these collections.

GUPI If the BIND NEW PACKAGE installation option is set to BIND, the PACKADM authority also has the privilege to add new packages or new versions of existing packages.

If a user has the PACKADM authority with the GRANT option, that user can grant those privileges to others. GUPI

System DBADM

The system DBADM authority allows an administrator, an authorization ID or a role, to manage databases across a DB2 subsystem, while having no access to the data in the databases. In other words, the system DBADM authority enables you to create, alter, and drop DB2 objects and issue commands for a DB2 subsystem, but does not give you the authority to access the data or the ability to grant or revoke privileges.

GUPI With the system DBADM authority, you can issue SQL statements to perform the following tasks:

- Create and drop aliases, auxiliary tables, and distinct types
- Create, alter, and drop databases, tables, global temporary tables, table spaces, and sequences
- Create triggers, functions, indexes, procedures, and views with additional required privileges
- Comment on all but security-related objects (i.e., roles, trusted contexts)
- Issue other SQL statements, such as the EXPLAIN, LABEL, PREPARE, and RENAME statements

You can also issue DB2 commands to perform the following tasks:

- Display status, configuration, and resource information
- Start and stop procedures and profiles
- Start, stop, and access databases
- Start, stop, and modify traces
- Bind, rebind, and free packages and plans
- Set the OWNER in BIND or REBIND to any ID (if SEPARATE_SECURITY is set to NO)
- Alter and terminate the execution of DB2 utility job steps
- Recover threads that are left in an indoubt state or complete backout processing for units of recovery that are left incomplete during an earlier restart

With the system DBADM authority, you can also run certain DB2 utilities. The utilities include CHECK INDEX, CHECK LOB, COPY, COPYTOCOPY, DIAGNOSE, MODIFY RECOVERY, MODIFY STATISTICS, QUIESCE, REBUILD INDEX, RECOVER, REPORT, and RUNSTATS. In addition, you have implicit SELECT access on all catalog tables and implicit INSERT, DELETE, and UPDATE privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES).

The system DBADM authority allows you to execute system-defined routines (recorded in the SYSIBM.SYSROUTINES catalog table), including stored procedures or functions, and any packages executed within the routines. It also allows you to drop non-security objects without requiring the ownership or other privileges to drop.

Only an authorization ID or a role with the SECADM authority can grant or revoke the system DBADM authority. By default, the system DBADM has all the privileges of the DATAACCESS and ACCESSCTRL authorities. If you do not want a user (an authorization ID or role) with the system DBADM authority to grant any explicit privileges, you can specify the WITHOUT ACCESSCTRL clause in the GRANT statement when you grant the authority. If you do not want a user with the system DBADM authority to access any user data in the databases, you can specify the WITHOUT DATAACCESS clause in the GRANT statement when you grant the authority. If necessary, you can still grant explicit privileges (i.e., SELECT) to the system DBADM user to access data or perform grants. GUPI

SECADM

The SECADM authority enables you to manage security-related objects in DB2 and control access to all database resources. It does not have any inherent privilege to access data stored in the objects, such as tables.

GUPI With the SECADM authority, you can perform the following tasks:

- Create, alter, drop, and comment on row permissions
- Create, alter, drop, and comment on column masks
- Activate and deactivate row access control
- Activate and deactivate column access control
- Create, drop, and comment on roles
- Create, alter, drop, and comment on trusted contexts
- Create and comment on secure triggers and user-defined functions
- Alter the SECURED or NOT SECURED clause on triggers and user-defined functions
- Create audit policies by inserting rows into the SYSIBM.SYSAUDITPOLICIES catalog table
- Access and update the SYSIBM.SYSAUDITPOLICIES catalog table which records audit policy definitions
- Has implicit SELECT access on all catalog tables and implicit INSERT, DELETE, and UPDATE privileges on updatable catalog tables
- Grant and revoke all grantable privileges and authorities
- Issue the TRACE command to start, stop, and display a trace

If the SEPARATE_SECURITY system parameter is set to YES, no other authority can grant the ACCESSCTRL, System DBADM, and DATAACCESS authorities or the CREATE_SECURE_OBJECT privilege, not even SYSADM. For example, only SECADM, not SYSADM or DBADM, can activate or deactivate row or column access control for a table. GUPI

Related reference:

Protection panel 2: DSNTIPP1 (DB2 Installation and Migration)

ACCESSCTRL

The ACCESSCTRL authority allows you to grant explicit privileges to authorization IDs or roles by issuing SQL GRANT statements. It enables you to grant privileges on all objects and resources, except the CREATE_SECURE_OBJECT privilege and the system DBADM, DATAACCESS, and ACCESSCTRL authorities.

GUPI With the ACCESSCTRL authority, you can use the BY clause to revoke explicitly granted privileges from authorization IDs or roles, except the CREATE_SECURE_OBJECT privilege and the system DBADM, DATAACCESS, and ACCESSCTRL authorities. In addition, you have implicit SELECT access on all catalog tables and implicit INSERT, DELETE, and UPDATE privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES).

Only an authorization ID or a role with the SECADM authority can grant or revoke the ACCESSCTRL authority. Revoking the ACCESSCTRL authority does not revoke the privileges that it has already granted. GUPI

DATAACCESS

The DATAACCESS authority allows you to access and update data in user tables, views, and materialized query tables in a DB2 subsystem. It also allows you to execute plans, packages, functions, and procedures.

Only an authorization ID or a role with the SECADM authority can grant or revoke the DATAACCESS authority. With the DATAACCESS authority, you have implicit SELECT access on all catalog tables and implicit INSERT, DELETE, and UPDATE privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES).

SQLADM

The SQLADM authority allows you to issue the SQL EXPLAIN statements, execute the PROFILE commands, run the RUNSTATS and MODIFY STATISTICS utilities on all user databases, and execute system-defined routines, such as stored procedures or functions, and any packages that are executed within the routines.

Only an authorization ID or a role with the SECADM or ACCESSCTRL authority can grant or revoke the SQLADM authority. With the SQLADM authority, you have implicit SELECT access on all the catalog tables and implicit INSERT, DELETE, and UPDATE privileges on updatable catalog tables (except SYSIBM.SYSAUDITPOLICIES).

Common DB2 administrative authorities

Several DB2 administrative authorities provide the same functionality in DB2 for z/OS and DB2 for Linux, UNIX, and Windows. With these authorities, administrators who manage DB2 on multiple operating systems can manage their database environments in a consistent approach.

GUPI The following authorities provide the same administrative functionality in DB2 for z/OS and DB2 for Linux, UNIX, and Windows:

Table 17. Common DB2 administrative authorities

Administrative authority	Capabilities
System DBADM	• Manages resources in all databases • Does not have access to data or the ability to grant and revoke privileges • Executes system-defined routines (i.e., stored procedures or functions) and any package within the routines • Has implicit SELECT access on all catalog tables

Table 17. Common DB2 administrative authorities (continued)

Administrative authority	Capabilities
SECADM	• Controls access to all database resources • Manages security-related objects (i.e., roles, trusted contexts, row permissions, and column masks) • Grants and revokes explicit privileges that are granted by itself and others • Has implicit SELECT access on all catalog tables
ACCESSCTRL	• Grants privileges on all but security-related objects and resources • Revokes privileges on all but security-related objects and resources that are granted by itself or others • Does not grant the system DBADM, DATAACCESS, or ACCESSCTRL authority • Has implicit SELECT access on all catalog tables
DATAACCESS	• Has the ability to access data in all user tables, views, and materialized query tables • Has the ability to execute all plans, packages, functions, and procedures • Has implicit SELECT access on all catalog tables
SQLADM	• Issues EXPLAIN SQL statements and PROFILE commands • Executes RUNSTATS and MODIFY STATISTICS utilities on all user databases • Performs tasks that require EXPLAIN and MONITOR2 privileges • Executes system defined routines (i.e., stored procedures or functions) and any package executed within the routines • Has implicit SELECT access on all the catalog tables

DB2 for z/OS provides both the system DBADM authority and the DBADM authority, with each having a set of privileges. The system DBADM authority allows you to manage objects in all databases across a DB2 subsystem, but doesn't give you access to the data in the databases. In addition, with the system DBADM authority, you can perform administrative tasks and issue commands for a DB2 subsystem, but you don't have the authority to execute objects or the ability to grant or revoke privileges.

Unlike the system DBADM authority, the DBADM authority allows you to manage objects in a specific database and gives you access to the data in that database. You also get the privileges of the DBCTRL and DBMAINT authorities over the same database. GUPI

Related reference:

"System DBADM" on page 38
"SECADM" on page 39
"ACCESSCTRL" on page 39
"DATAACCESS" on page 40
"SQLADM" on page 40

Utility authorities for DB2 catalog and directory

The DB2 catalog is in the DSNDB06 database. Authorities that are granted on DSNDB06 also cover database DSNDB01, which contains the DB2 directory.

An ID with the ACCESSCTRL or SECADM authority can control access to the catalog in the following ways:

- By granting privileges or authorities on that database or on its tables or views
- By binding plans or packages that access the catalog

An ID with the ACCESSCTRL or SECADM authority can control access to the directory by granting privileges to run utilities on DSNDB06, but that ID cannot grant privileges on DSNDB01 directly.

The following table shows the utilities IDs with different authorities that can run on the DSNDB01 and DSNDB06 databases. Do not run REPAIR DBD against DSNDB01 and DSNDB06 because they are system databases; you will receive a system restriction violation message if you do. Also, you can use the LOAD utility to add lines to SYSIBM.SYSSTRINGS, but you cannot run it on other DSNDB01 or DSNDB06 tables.

Table 18. Utility privileges on the DB2 catalog and directory

Utilities	Installation SYSOPR, SYSCTRL, SYSADM, Installation SYSADM	DBCTRL, DBADM on DSNDB06	DBMAINT on DSNDB06	System DBADM	DATAACCESS	SQLADM
LOAD	No	No	No	No	No	No
REPAIR DBD	No	No	No	No	No	No
CHECK DATA	Yes	No	No	No	Yes	No
CHECK LOB	Yes	No	No	Yes	No	No
REORG TABLESPACE	Yes	No	No	No	Yes	No
STOSPACE	Yes	No	No	No	No	No
REBUILD INDEX	Yes	Yes	No	Yes	Yes	No
RECOVER	Yes	Yes	No	Yes	Yes	No
REORG INDEX	Yes	Yes	No	No	Yes	No
REPAIR	Yes	Yes	No	No	Yes	No
REPORT	Yes	Yes	No	Yes	Yes	No
CHECK INDEX	Yes	Yes	Yes	Yes	No	No
COPY	Yes	Yes	Yes	Yes	No	No

Table 18. Utility privileges on the DB2 catalog and directory (continued)

Utilities	Installation SYSOPR, SYSCTRL, SYSADM, Installation SYSADM	DBCTRL, DBADM on DSNDB06	DBMAINT on DSNDB06	System DBADM	DATAACCESS	SQLADM
MERGECOPY	Yes	Yes	Yes	Yes	No	No
MODIFY	Yes	Yes	Yes	Yes	No	No
QUIESCE	Yes	Yes	Yes	Yes	No	No
RUNSTATS	Yes	Yes	Yes	Yes	No	Yes

Related concepts:

"Explicit privileges" on page 22

"Privileges by authorization ID and authority"

Related reference:

"Implicit privileges through object ownership" on page 28

"Administrative authorities" on page 29

Privileges by authorization ID and authority

When a process gains access to DB2, it has a primary authorization ID, one or more secondary authorization IDs, an SQL ID, and perhaps a specific role if it runs in a trusted context. To be able to perform certain actions, an authorization ID or role must hold the required privileges. To perform other actions, a set of IDs or roles must hold the required privileges.

For better performance, consider limiting the number of secondary IDs in your catalog table. A process can have up to 1012 secondary IDs. The more secondary IDs that must be checked, the longer the check takes. Also, make sure that the role and the current SQL ID have the necessary privileges for dynamic SQL statements. Because the role and the current SQL ID are checked first, the operation is fastest if they have all the necessary privileges.

Related concepts:

"Explicit privileges" on page 22

Related reference:

"Implicit privileges through object ownership" on page 28

"Administrative authorities" on page 29

"Utility authorities for DB2 catalog and directory" on page 42

Privileges required for common job roles and tasks

The labels of the administrative authorities often suggest the job roles and responsibilities of the users who are empowered with the authorities.

GUPI For example, you might expect a system administrator to have the SYSADM authority. However, some organizations do not divide job responsibilities in the same way. The following table lists some of common job roles, the tasks that usually accompany them, and the DB2 authorities or privileges that are needed to perform those tasks.

Table 19. Required privileges for common jobs and tasks

Job title	Tasks	Required privileges
System operator	Issues commands to: • Start and stop DB2 • Control traces • Display databases and threads • Recover indoubt threads • Start, stop, and display routines	SYSOPR authority
System administrator	Performs emergency backup, with access to all data.	SYSADM authority
Security administrator	Authorizes other users, for some or all levels below.	• SYSCTRL authority (if SEPARATE_SECURITY is set to NO) • SECADM authority • ACCESSCTRL authority
Database administrator	Designs, creates, loads, reorganizes, and monitors databases, tables, and other objects in the database.	• DBADM authority on a database. The DBADM authority on DSNDB04 allows you access to objects in all implicitly created databases. • Use of storage groups and buffer pools
Database administrator	• Designs and creates databases, tables, and other objects • Administers all databases in the subsystem	System DBADM authority
Database administrator	Manages data and executes plans and packages in a DB2 subsystem	DATAACCESS authority
Database administrator	Manages access to data in a DB2 subsystem	ACCESSCTRL authority
System programmer	• Installs a DB2 subsystem. • Recovers the DB2 catalog. • Repairs data.	Installation SYSADM, which is assigned when DB2 is installed. (Consider securing the password for an ID with this authority so that the authority is available only when needed.)
Application programmer	• Develops and tests DB2 application programs. • Creates tables of test data.	• BIND on existing plans or packages, or BINDADD • CREATE IN on some collections • Privileges on some objects • CREATETAB on some database, with a default table space provided • CREATETAB on DSNDB04. It enables you to create tables in DSNDB04 and all implicitly created databases • Privileges on some objects with the SQLADM authority
Production binder	Binds, rebinds, and frees application packages and plans	A ROLE, secondary ID, or RACF group of which the binder has BINDADD, CREATE IN on collections privileges required by application packages and plans
Package administrator	Manages collections and the packages in them, and delegates the responsibilities.	PACKADM authority
User analyst	Defines the data requirements for an application program, by examining the DB2 catalog.	• SELECT on the SYSTABLES, SYSCOLUMNS, and SYSVIEWS catalog tables • CREATETMTAB system privilege to create temporary tables
Program user	Executes an application program.	EXECUTE for the application plan

Table 19. Required privileges for common jobs and tasks (continued)

Job title	Tasks	Required privileges
Information center consultant	• Defines the data requirements for a query user. • Provides the data by creating tables and views, loading tables, and granting access.	• DBADM authority over some databases • SELECT on the SYSTABLES, SYSCOLUMNS, and SYSVIEWS catalog tables
Query user	• Issues SQL statements to retrieve, add, or change data. • Saves results as tables or in global temporary tables.	• EXPLAIN privilege on some tables and views • SELECT, INSERT, UPDATE, DELETE on some tables and views • CREATETAB, to create tables in other than the default database • CREATETAB, to create tables in the implicitly created database • CREATETMTAB system privilege to create temporary tables • SELECT on SYSTABLES, SYSCOLUMNS, or views thereof. QMF™ provides the views.

GUPI

Checking access authorization for data definition statements

DB2 checks for the necessary authorization privileges and authorities when you use data definition statements on certain DB2 objects.

At both bind and run time, DB2 determines whether the authorization ID that you are using has the necessary privileges to access the following objects:

- Alias
- Table
- Explicitly created auxiliary table
- Explicitly created table space
- Explicitly created index
- Storage group
- Database

At run time, DB2 determines whether the authorization ID that you are using has the necessary privileges to access the following objects:

- Buffer pool that is involved with an implicitly created table space
- Buffer pool and storage group that are involved with an implicitly created auxiliary index and LOB table space
- Buffer pool and storage group that are involved with implicitly created XML indexes and XML table space
- Trigger
- Function
- Procedure
- Sequence
- View
- Trusted context

- JAR
- Role
- Distinct type
- Table, buffer pool, and storage group for an implicitly created unique key index, primary key index, or ROWID index.

Privileges required for handling plans and packages

An ID, or a role that runs in a trusted context, needs specific privileges to perform actions on plans and packages.

GUPI The following table lists the IDs and describes the privileges that they need for performing each type of plan or package operation. A user-defined function, stored procedure, or trigger package does not need to be included in a package list. A trigger package cannot be deleted by FREE PACKAGE or DROP PACKAGE. The DROP TRIGGER statement must be used to delete the trigger package.

Table 20. Required privileges for basic operations on plans and packages

Operation	ID or role	Required privileges
Execute a plan	Primary ID, any secondary ID, or role	Any of the following privileges: • Ownership of the plan • EXECUTE privilege for the plan • DATAACCESS authority • SYSADM authority
Bind embedded SQL statements, for any bind operation	Package owner	Any of the following privileges: • Applicable privileges required by the statements • Authorities that include the privileges • Ownership that implicitly includes the privileges Object names include the value of QUALIFIER, where it applies.
BIND EXPLAIN without generating a package	Plan or package owner	Any of the following privileges: • Ownership of the plan or package • BIND • BINDAGENT • EXPLAIN privilege • PACKADM • SQLADM • System DBADM authority • SYSCTRL • SYSADM
Include package in PKLIST[1]	Plan owner	Any of the following privileges: • Ownership of the package • EXECUTE privilege for the package • PACKADM authority over the package collection • SYSADM authority
BIND a new plan using the default owner or primary authorization ID	Primary ID or role	Any of the following privileges: • BINDADD privilege • System DBADM authority • SYSCTRL authority • SYSADM authority

Table 20. Required privileges for basic operations on plans and packages (continued)

Operation	ID or role	Required privileges
BIND a new package using the default owner or primary authorization ID	Primary ID or role	If the value of the field BIND NEW PACKAGE on installation panel DSNTIPP is BIND, any of the following privileges: • BIND privilege and CREATE IN privilege for the collection • PACKADM authority for the collection • System DBADM authority • SYSADM or SYSCTRL authority If BIND NEW PACKAGE is BINDADD, any of the following privileges: • BINDADD privilege and either the CREATE IN or PACKADM privilege for the collection • System DBADM authority • SYSADM or SYSCTRL authority
BIND REPLACE or REBIND for a plan or package using the default owner or primary authorization ID	Primary ID, any secondary ID, or role	Any of the following privileges: • Ownership of the plan or package • BIND privilege for the plan or package • BINDAGENT from the plan or package owner • PACKADM authority for the collection (for a package only) • System DBADM authority • SYSADM or SYSCTRL authority.
BIND a new version of a package, with default owner	Primary ID or role	If BIND NEW PACKAGE is BIND, any of the following privileges: • BIND privilege on the package or collection • BINDADD privilege and CREATE IN privilege for the collection • PACKADM authority for the collection • System DBADM authority • SYSADM or SYSCTRL authority If BIND NEW PACKAGE is BINDADD, any of the following: • BINDADD privilege and either the CREATE IN or PACKADM privilege for the collection • System DBADM authority • SYSADM or SYSCTRL authority
FREE or DROP a package[2]	Primary ID, any secondary ID, or role	Any of the following privileges: • Ownership of the package • BINDAGENT from the package owner • PACKADM authority for the collection • System DBADM authority • SYSADM or SYSCTRL authority
COPY a package	Primary ID, any secondary ID, or role	Any of the following: • Ownership of the package • COPY privilege for the package • BINDAGENT from the package owner • PACKADM authority for the collection • System DBADM authority • SYSADM or SYSCTRL authority

Table 20. Required privileges for basic operations on plans and packages (continued)

Operation	ID or role	Required privileges
FREE a plan	Primary ID, any secondary ID, or role	Any of the following privileges: • Ownership of the plan • BIND privilege for the plan • BINDAGENT from the plan owner • System DBADM authority • SYSADM or SYSCTRL authority
Name a new OWNER other than the primary authorization ID for any bind operation	Primary ID, any secondary ID, or role	Any of the following privileges: • New owner is the primary or any secondary ID • BINDAGENT from the new owner • System DBADM authority (if SEPARATE_SECURITY is set to NO) • SYSADM or SYSCTRL authority (if SEPARATE_SECURITY is set to NO)

GUPI

Privileges required for using dynamic SQL statements

An ID needs specific privileges to issue dynamic SQL statements.

GUPI The following table lists the IDs and describes the privileges that they need for issuing each type of SQL statement:

Table 21. Required privileges for basic operations on dynamic SQL statements

Operation	ID or role	Required privileges
GRANT	Current SQL ID or role	Any of the following privileges: • The applicable privilege with the grant option • An authority that includes the privilege, with the grant option (not needed for SYSADM or SYSCTRL) • Ownership that implicitly includes the privilege
REVOKE	Current SQL ID or role	Must either have granted the privilege that is being revoked, or hold SYSCTRL or SYSADM authority.
CREATE, for unqualified object name	Current SQL ID or role	Applicable table, database, or schema privilege
Qualify name of object created	ID or role named as owner	Applicable table or database privilege. The qualifier can be any ID at all and does not need to have any privilege if the current SQL ID or the role (if in a trusted context with the ROLE AS OBJECT OWNER AND QUALIFIER clause specified) has the SYSADM. system DBADM, or SYSCTRL authority (wherever applicable) or the DBADM or DBCTRL authority for the database (wherever applicable).

Table 21. Required privileges for basic operations on dynamic SQL statements (continued)

Operation	ID or role	Required privileges
Other dynamic SQL if DYNAMICRULES uses run behavior	All primary IDs, role, secondary IDs, and the current SQL ID together	As required by the statement. Unqualified object names are qualified by the value of the special register CURRENT SQLID.
Other dynamic SQL if DYNAMICRULES uses bind behavior	Plan or package owner	As required by the statement. DYNAMICRULES behavior determines how unqualified object names are qualified.
Other dynamic SQL if DYNAMICRULES uses define behavior	Function or procedure owner	As required by the statement. DYNAMICRULES behavior determines how unqualified object names are qualified.
Other dynamic SQL if DYNAMICRULES uses invoke behavior	ID of the SQL statement that invoked the function or procedure or role	As required by the statement. DYNAMICRULES behavior determines how unqualified object names are qualified.

GUPI

Managing administrative authorities

DB2 provides a range of auditable administrative authorities that help you control access to sensitive business data. The granularity and flexibility in DB2 administrative authority help you achieve adequate separation of duties and responsibilities and prevent a single user from possessing unlimited privileges.

Depending on the setting of the SEPARATE_SECURITY system parameter, you can separate DB2 security administration from system administration. You can set the parameter by using the SEPARATE SECURITY field on panel DSNTIPP1 during installation or migration.

If you set SEPARATE_SECURITY to YES, the SYSADM authority can no longer manage security-related objects (i.e., roles, trusted contexts, row permissions, and column masks) or have the ability to grant or revoke privileges that are granted by others. The SYSCTRL authority can no longer manage roles or grant or revoke privileges that are granted by others, either. Instead, the SECADM authority will manage all security-related objects. The SECADM and ACCESSCTRL authorities control access to all databases even though they cannot access any user data in the databases.

In addition, the SYSADM authority can only set CURRENT SQLID to its primary or one of its secondary authorization IDs. The SYSADM, SYSCTRL, and system DBADM authorities can only set BIND OWNER to the primary or one of the secondary authorization IDs of the binder. Finally, the SYSADM authority will not have implicit insert, update, delete access to the SYSIBM.SYSAUDITPOLICIES table.

If you set SEPARATE_SECURITY to NO (which is the default), the SYSADM authority retains all the existing privileges and responsibilities and gets implicit privileges of the SECADM authority. In other words, the SYSADM authority

continues to be the security administrator and manage all security-related objects, perform grants, and revoke privileges that are granted by others. In addition, it gets implicit insert, update, delete access on the SYSIBM. SYSAUDITPOLICIES table and is able to set CURRENT SQLID and BIND OWNER to any value.

Setting SEPARATE_SECURITY to NO also allows the SYSCTRL authority to get most of the implicit privileges of the ACCESSCTRL authority. SYSCTRL can manage roles, perform certain grants, revoke privileges that are granted by others, and set BIND OWNER to any value.

The installation SYSADM authority is not affected by the setting of the SEPARATE_SECURITY parameter. Installation SYSADM can manage security-related objects, grant and revoke authorities or privileges, and set CURRENT SQLID and BIND OWNER to any value regardless of the setting of the SEPARATE_SECURITY parameter.

Separating the SYSADM authority

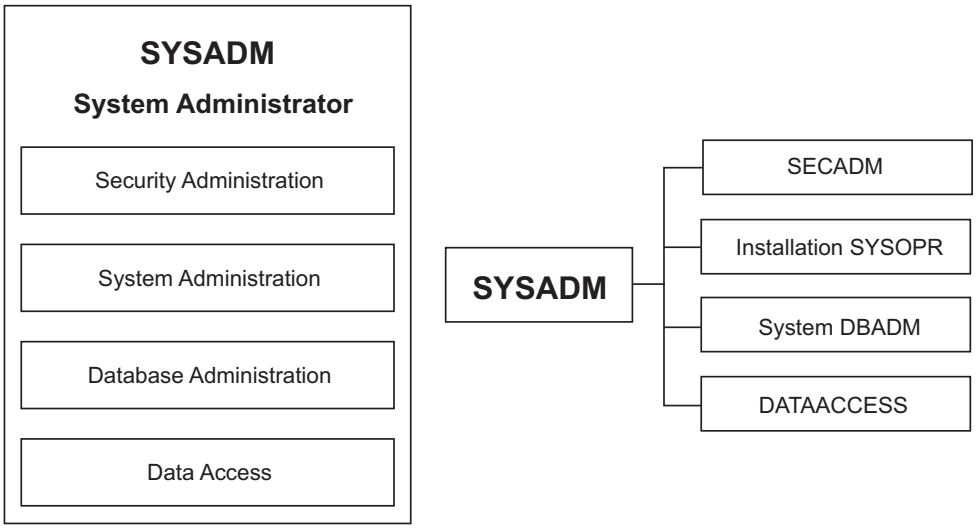
Granularity and flexibility in DB2 administrative authority allows you to separate security administration, database administration, and data access control from system administration. Separating the SYSADM authority (a combination of security and system administration) can help you simplify your system administration and strengthen the security administration of your business data.

Procedure

GUPI To separate the SYSADM authority, choose the system and security administration model that best meets the security needs of your business:

- Maintain the existing system administration model in which the SYSADM authority continues to be able to perform security administration

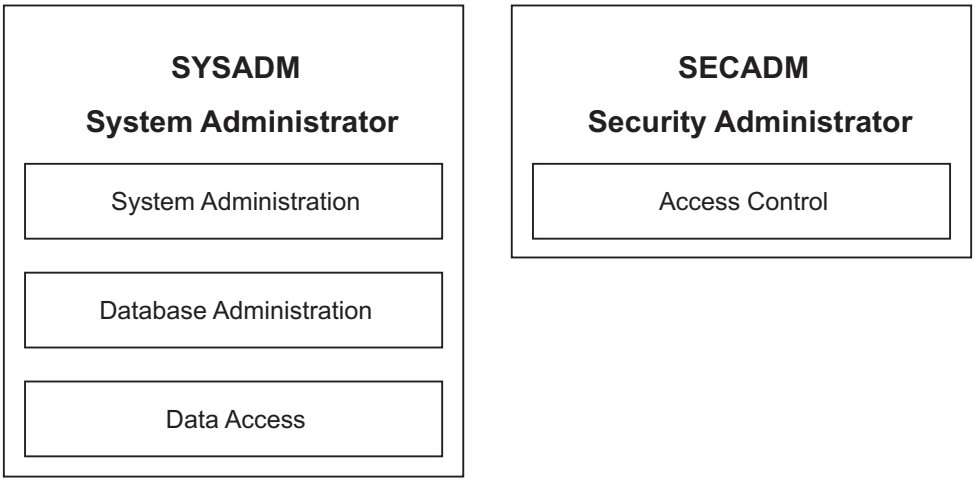
  You must first set the SEPARATE_SECURITY system parameter on panel DSNTIPP1 to NO (which is the default) during installation or migration. As shown below, this setting allows the system administrator to continue to be the security administrator and the SYSADM authority to get implicit privileges of the SECADM authority. A system administrator can therefore manage all security-related objects, perform grants, and revoke privileges that are granted by others.



Setting SEPARATE_SECURITY to NO also allows the SYSCTRL authority to get implicit privileges of the ACCESSCTRL authority. SYSCTRL can manage roles, perform grants, and revoke privileges that are granted by others.

- Separate security administration from system administration (SYSADM)

  You must first set the SEPARATE_SECURITY system parameter on panel DSNTIPP1 to YES during installation or migration. As shown below, this setting separates the security administration from the SYSADM authority. A system administrator can no longer manage access control, audit policies, or security-related objects, including roles and trusted contexts. The SYSCTRL authority can no longer manage roles. Neither the SYSADM authority nor the SYSCTRL authority can grant or revoke privileges that are granted by others.



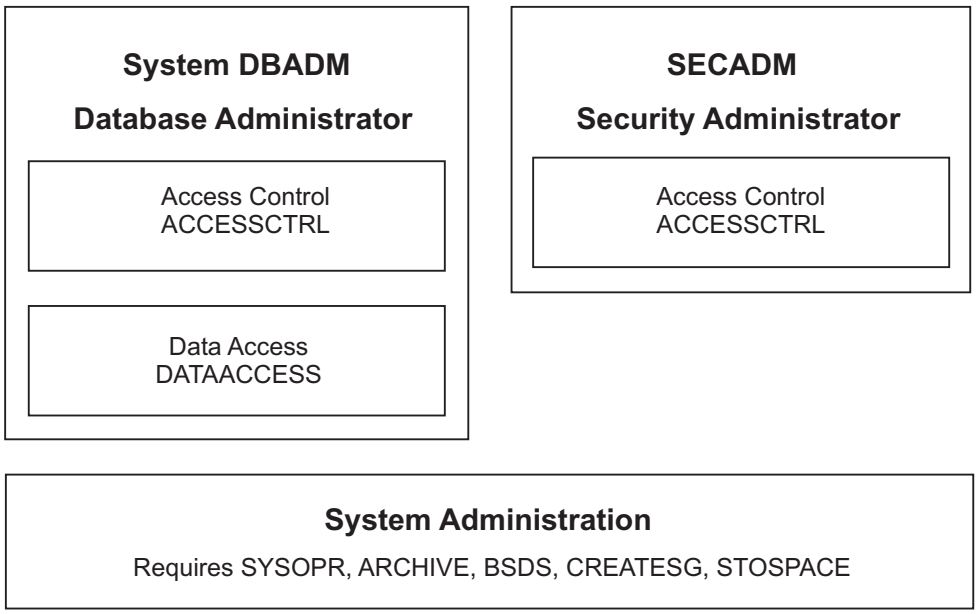
  In addition to setting the SEPARATE_SECURITY system parameter, you also need to set one of the system SECADM parameters to an authorization ID or a role during installation that will perform security administration. To ensure complete separation of system and security administration, do not set the SECADM system parameter to a SYSADM ID. Instead, set SECADM to a SECADM ID and installation SYSADM to an installation SYSADM ID.

- Separate system database administration with the data access authority and the access control authority from system and security administration.

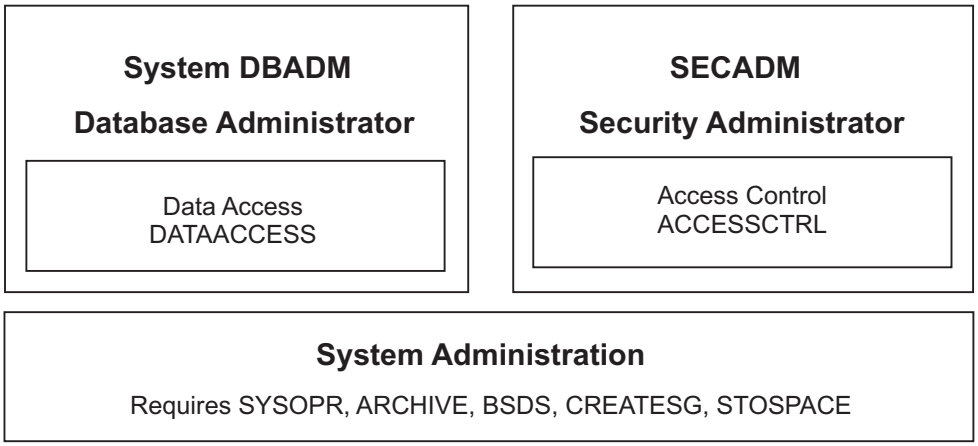
  DB2 provides both the system DBADM authority and the DBADM authority, with each having a different set of privileges. The system DBADM authority allows you to manage objects in all databases across a DB2 subsystem, but doesn't give you access to the data in the databases. In addition, with the system DBADM authority, you can perform administrative tasks and issue commands for a DB2 subsystem, but you don't have the authority to execute objects or the ability to grant or revoke privileges.

  Unlike the system DBADM authority, the DBADM authority allows you to manage objects in a specific database and gives you access to the data in that database. You also get the privileges of the DBCTRL and DBMAINT authorities over the same database.

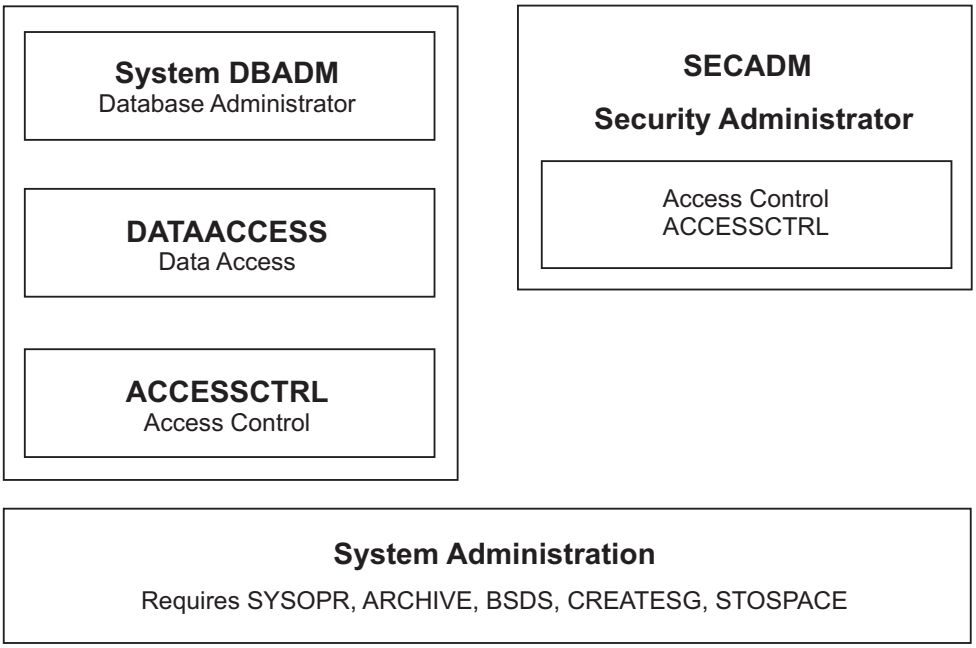
  If you want the system database administrators to have access to data and the ability to grant and revoke privileges, you can grant them the system DBADM, DATAACCESS, and ACCESSCTRL authorities, as shown below. By default, the DATAACCESS and ACCESSCTRL authorities are granted when the system DBADM authority is granted.



If you want the system database administrators to have access to data, but not the ability to grant or revoke privileges, you can grant them the system DBADM and DATAACCESS authorities, but not the ACCESSCTRL authority, as shown below. You can also grant system database administrators the SYSOPR authority and the privileges to perform ARCHIVE, BSDS, CREATESG, STOSPACE, or other system-related tasks.



- Separate system database administration from the data access authority, the access control authority, security administration, and system administration.



If you want the system database administrators to manage database objects, but have no access to data or the ability to grant and revoke privileges, you can grant them the system DBADM authority, but not the SYSADM, DATAACCESS, or ACCESSCTRL authority. GUPI

Related reference:

"System DBADM" on page 38

"SECADM" on page 39

"ACCESSCTRL" on page 39

"DATAACCESS" on page 40

"SQLADM" on page 40

Migrating the SYSADM authority

To take advantage of the granularity of DB2 administrative authority and simplify your system database administration, you can separate the privileges of the SYSADM authority and migrate them to other administrative authorities based on the security needs of your business. This will allow you to eliminate or minimize the need for granting the SYSADM authority.

About this task

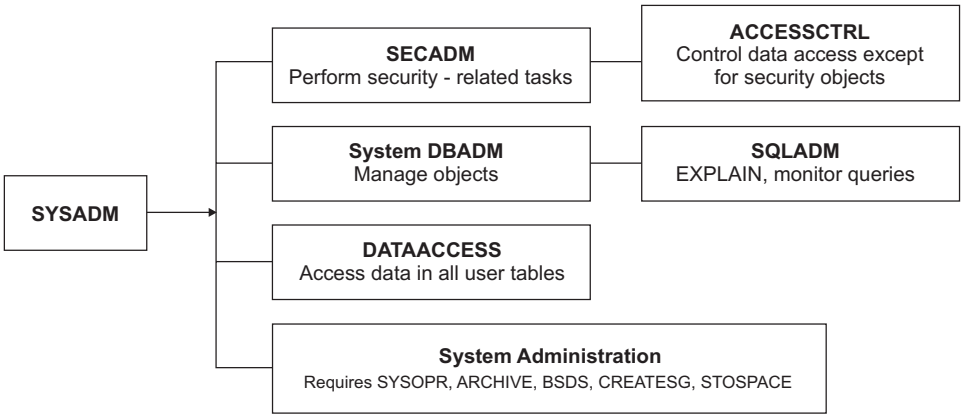
If you decide to separate the SYSADM authority into the SECADM and other administrative authorities, consider setting the SEPARATE_SECURITY system parameter on panel DSNTIPP1 to YES during installation or migration. This setting enables you to achieve complete separation of administrative duties.

Procedure

To migrate the SYSADM authority that is currently assigned to authorization IDs or roles:

1. In your security policies, identify the administration model that you will use for separating the SYSADM authority and define the criteria for assigning specific administrative authorities to specific authorization IDs or roles.

Suppose that you choose the following model to separate the current SYSADM authority into the system DBADM, SECADM, DATAACCESS, ACCESSCTRL, and SQLADM authorities:



You can define the following set of criteria for granting administrative authorities:

- The system DBADM authority can be granted to database administrators who need to manage objects
- The DATAACCESS authority can be granted to database administrators who need to access data
- The ACCESSCTRL authority can be granted to database administrators who need to control access to DB2 subsystems
- The SECADM authority can be assigned (during installation) to security administrators who perform security administration and manage access control
- The SQLADM authority can be assigned to performance analysts who are responsible for analyzing the performance of DB2 subsystems
- The EXPLAIN privilege can be granted to application architects who need to explain SQL statements or collect metadata information about the statements
- The SYSOPR authority and the ARCHIVE, BSDS, CREATESG, and STOSPACE privileges can be granted to system administrators for performing system administrative tasks.

2. Perform a query to list all the users and roles that are currently granted the SYSADM authority.

   The SYSADM authority can be granted to authorization IDs or roles. You can query the catalog and find out the users and roles who are currently granted the SYSADM authority.

   Suppose that your query returns a list of the following six users, user groups, or roles that are assigned the SYSADM authority:

   - John (Security administrator)
   - Sally (Application Architect)
   - Bob (Performance Analyst)
   - ApplProgrammer_role (Application Programmer role)
   - SysAdmin_Role (System administrator role)
   - DBAdmGrp (database administrator group).

3. Divide the responsibilities of the SYSADM authority and grant to different IDs or roles based on your security policies, as shown below:

- John is granted the SECADM authority to perform security-related administration tasks and control access to DB2.
- Sally is granted the DATAACCESS authority because she requires DML privileges on tables during application development, but she does not need access control or database administration.
- Bob is granted the SQLADM authority who analyzes the performance of DB2 subsystems, but does not need access to data.
- ApplProg_role is granted the EXPLAIN privilege because all application programmers need to explain SQL statements and collect metadata information in trusted context definitions.
- DBAdmGrp is granted the system DBADM authority for managing and maintaining objects. Since database administrators belong to the DBAdmGrp RACF group, they should not be able to access data or grant and revoke privileges.
- SysAdmin_role is granted the SYSOPR authority and the ARCHIVE, BSDS, CREATESG, and STOSPACE privileges to perform system administrative tasks.

4. Revoke the SYSADM authority from all current IDs or roles.

   Once the authorities are granted, you can revoke the SYSADM authority from John, Sally, Bob, ApplProgrammer_ role and DBAdmGrp. Revoking the SYSADM authority causes the revoking of dependent privileges, by default. If you want to leave the grants that they had made, you can issue the REVOKE statement with the NOT INCLUDING DEPENDENT PRIVILEGES clause, assuming the REVOKE_DEP_PRIVILEGES system parameter is set to SQLSTMT.
5. Once the SYSADM authority is revoked, set the SEPARATE_SECURITY system parameter to YES on panel DSNTIPP1. With the installation SYSADM authority, you can perform an online change of the SEPARATE_SECURITY system parameter and set it to YES. This further ensures that SYSADM is separated into SECADM and other authorities.

Related reference:

"System DBADM" on page 38

"SECADM" on page 39

"ACCESSCTRL" on page 39

"DATAACCESS" on page 40

"SQLADM" on page 40

Creating roles or trusted contexts with the SECADM authority

If you separate security administration from system and database administration, you need to have the SECADM authority to manage security-related objects in DB2 and control access to all database objects and resources in a subsystem.

Before you begin

To separate security administration from system administration, you must set the SEPARATE_SECURITY system parameter on panel DSNTIPP1 to YES during installation or migration.

To use trusted connections, you cannot set the ALL subsystem parameter to ALL and set the RESTART subsystem parameter to DEFER on installation panel DSNTIPS.

About this task

With the separation of security administration from system administration, the SYSADM authority can no longer define roles or trusted contexts or manage any other security-related objects; the SECADM authority is, instead, responsible for performing security administrative tasks, including creating roles and trusted contexts, activating row and column access control, and granting security-related authorities and privileges on objects.

Procedure

To create roles or trusted contexts with the SECADM authority:

- Issue the following CREATE ROLE statement to create CTXROLE by using an authorization ID or role that is given the SECADM authority.

  If SEPARATE_SECURITY is set to YES, the SECADM authority is required to create roles and trusted contexts. GUPI

  ```
  CREATE ROLE CTXROLE;
  ```

  GUPI

  DB2 checks to make sure that you have the required privilege to create roles and, upon successful verification, allows the creation of role CTXROLE.
- Issue the following CREATE TRUSTED CONTEXT statement to create CTX1 and associate CTXROLE with CTX1:

  GUPI

  ```
  CREATE TRUSTED CONTEXT CTX1
  BASED UPON CONNECTION USING SYSTEM AUTHID USER1
  DEFAULT ROLE CTXROLE
  ATTRIBUTES (ADDRESS '9.67.40.219')
  WITH USE FOR USER2, USER3
  ENABLE;
  ```

  GUPI

  DB2 checks to make sure that you have the required privilege to create trusted contexts and, upon successful verification, allows the creation of trusted context CTX1.

Related reference:

"SECADM" on page 39

Altering tables with the system DBADM authority

The system DBADM authority separates object management from data access and access control. It allows object management without requiring the ownership of the object in a DB2 subsystem.

About this task

Suppose that you are a database administrator DB2ADMIN1 and need to alter TABLE1, but do not have any table privileges on the table. You must first be granted the system DBADM authority before you can alter the table.

Procedure

To alter tables with the system DBADM authority:

1. Obtain the system DBADM authority from a security administrator

   An authorization ID or role with the SECADM authority can grant you the system DBADM authority by issuing the following statement: GUPI

   ```
   GRANT DBADM WITHOUT DATAACCESS WITHOUT ACCESSCTRL ON SYSTEM TO DB2ADMIN1;
   ```

   GUPI

   DB2 inserts a row in SYSIBM.SYSUSERAUTH with the column SDBADMAUTH set to 'Y', where column GRANTEE is set to DB2ADMIN1.
2. With the system DBADM authority, issue the ALTER TABLE statement to alter table TABLE1.

   DB2 checks to make sure that you have the required privilege set, including the ALTER TABLE privilege that is allowed by the system DBADM authority. The table is altered successfully.

Related reference:

"System DBADM" on page 38

Accessing data with the DATAACCESS authority

A database administrator must have the DATAACCESS authority to access data in all user tables, views, and materialized query tables in a DB2 subsystem.

About this task

Suppose that you are a database administrator DB2ADMIN1 and need access to data in TABLE1. You must first be granted the DATAACCESS authority.

Procedure

To access data with the DATAACCESS authority:

1. Obtain the DATAACCESS authority from a security administrator. The SECADM (an authorization ID or role) can grant you the DATAACCESS authority by issuing the following statement:

   GUPI

   ```
   GRANT DATAACCESS ON SYSTEM TO DB2ADMIN1;
   ```

   GUPI

   DB2 inserts a row in SYSIBM.SYSUSERAUTH with the new column DATAACCESSAUTH set to 'Y', where column GRANTEE is set DB2ADMIN1.
2. After obtaining the DATAACCESS authority, issue an SQL SELECT statement to select from table TABLE1. DB2 checks to make sure that you have the required privilege set, including the SELECT privilege that is granted by the DATAACCESS authority. The SELECT statement completes successfully.

Related reference:
"DATAACCESS" on page 40

Granting and revoking privileges with the ACCESSCTRL authority

If you separate database administration from system and security administration, a database administrator must have the ACCESSCTRL or SECADM authority to grant or revoke user privileges in a DB2 subsystem.

About this task

GUPI The ACCESSCTRL authority allows you to grant and revoke (BY clause) privileges on all resources in a DB2 subsystem. However, it cannot grant the CREATE_SECURE_OBJECT privilege or the system DBADM, DATAACCESS, and ACCESSCTRL authorities.

If you are a database administrator DB2ADMIN1 and need to grant application developer APPDEV1 load privileges on DBTEMP1, you must first have the ACCESSCTRL authority for yourself.

Procedure

To grant or revoke privileges with the ACCESSCTRL authority:

1. Obtain the ACCESSCTRL authority from a security administrator. The SECADM (an authorization ID or role) can grant you the ACCESSCTRL authority by issuing the following statement:

   ```
   GRANT ACCESSCTRL ON SYSTEM TO DB2ADMIN1;
   ```

   DB2 inserts a row in SYSIBM.SYSUSERAUTH with the new column ACCESSCTRLAUTH set to 'Y', where column GRANTEE is set to DB2ADMIN.1.

   You can specify WITH GRANT OPTION when you issue the GRANT statement, but the option is ignored when the authority is ACCESSCTRL, DBADM, or DATAACCESS.
2. After obtaining the ACCESSCTRL authority, grant APPDEV1 load privileges on DBTEMP1 by issuing the following GRANT statement:

   ```
   GRANT LOAD ON DATABASE DBTEMP1 TO APPDEV1;
   ```

   DB2 checks to make sure that you have the required privilege set, including the GRANT privilege that is allowed by the ACCESSCTRL authority. The GRANT statement completes successfully. GUPI

Related reference:
"ACCESSCTRL" on page 39

Managing explicit privileges

You can use the SQL GRANT and REVOKE statements to grant and remove privileges if you enable authorization checking during DB2 installation. You can grant to or revoke privileges from authorization IDs or roles if they run in a trusted context. You can revoke only privileges that are explicitly granted.

About this task

You can grant privileges in the following ways:

- Grant a specific privilege on one object in a single statement
- Grant a list of privileges
- Grant privileges on a list of objects
- Grant ALL, for all the privileges of accessing a single table, or for all privileges that are associated with a specific package

If you grant privileges on a procedure or a package, all versions of that procedure or package have those privileges. DB2 ignores duplicate grants and keeps only one record of a grant in the catalog. The suppression of duplicate records applies not only to explicit grants, but also to the implicit grants of privileges that are made when a package is created.

For example, suppose that Susan grants the SELECT privilege on the EMP table to Ray. Then suppose that Susan grants the same privilege to Ray again, without revoking the first grant. When Susan issues the second grant, DB2 ignores it and maintains the record of the first grant in the catalog.

Database privileges that are granted on DSNDB04 apply to all implicitly created databases. For example, if you have the DBADM authority on DSNDB04, you can select data from any table in any implicitly created database. If you have the STOPDB privilege on DSNDB04, you can stop any implicitly created database. However, you cannot grant the same authorities or privileges to others on any implicitly created database.

Related tasks:

"Managing implicit privileges" on page 77

Granting privileges to a role

You can grant privileges to a role by using the GRANT statement. You can associate primary authorization IDs with a role in the definition of the trusted context and then use the GRANT statement with the ROLE option to grant privileges to the role.

About this task

You can improve access control by granting privileges to roles. When you grant certain privileges to a role, you make those privileges available to all users that are associated with the role in the specific trusted context.

You can also simplify the administration of granting privileges by using roles rather than individual authorization IDs. To make a role a grantor, you need to specify the ROLE AS OBJECT OWNER clause when you define the trusted context. For a static GRANT statement, the grantor is the role that owns the plan or package. For a dynamic GRANT statement, the role for the primary authorization ID that executes the GRANT statement becomes the grantor.

Granting privileges to the PUBLIC ID

You can grant to the PUBLIC ID privileges or authorities other than CREATE_SECURE_OBJECT, system DBADM, DATAACCESS, or ACCESSCTRL.

About this task

When you grant privileges to PUBLIC, the privileges become available to all IDs at the local DB2® site, including the owner IDs of packages that are bound from a remote location. Public access is generally not a good practice when it comes to the protection of sensitive business data and critical system resources. Many compliance requirements prohibit public access to any system components. For example, the Payment Card Industry (PCI) Data Security Standard Requirements and Security Assessment Procedures restrict the use of PUBLIC.

When you grant any privilege to PUBLIC, DB2 catalog tables record the grantee of the privilege as PUBLIC. DB2 also grants the following implicit table privileges to PUBLIC for declared temporary tables:

- All table privileges on the tables and the authority to drop the tables
- The CREATETAB privilege to define temporary tables in the work file database
- The USE privilege to use the table spaces in the work file database

You do not need any additional privileges to access the work file database and the temporary tables that are in it. You cannot grant or revoke table privileges for temporary tables. The DB2 catalog does not record these implicit privileges for declared temporary tables.

Because PUBLIC is a special identifier that is used by DB2 internally, you should not use PUBLIC as a primary ID or secondary ID. When a privilege is revoked from PUBLIC, authorization IDs to which the privilege was specifically granted retain the privilege.

However, when an ID uses PUBLIC privileges to perform actions, the actions and the resulting objects depend on the privileges that are currently in effect for PUBLIC. If PUBLIC loses a privilege, objects that are created with that privilege can be dropped or invalidated. The following examples demonstrate how certain objects depend on PUBLIC not losing its privileges.

Example

Suppose that Juan has the ID USER1 and that Meg has the ID USER2. Juan creates a table TAB1 and grants ALL PRIVILEGES on it to PUBLIC. Juan does not explicitly grant any privileges on the table to Meg's ID, USER2. Using the PUBLIC privileges, Meg creates a view on TAB1. Because the ID USER2 requires the SELECT privilege on TAB1 to create the view, the view is dropped if PUBLIC loses the privilege.

Related tasks:

"Granting privileges to remote users"

Granting privileges to remote users

A query that arrives at your local DB2 subsystem through the distributed data facility (DDF) is accompanied by an authorization ID. After connection processing, the ID can be translated to another value and be associated with secondary authorization IDs.

About this task

DB2 also uses the ID to determine if the connection is associated with a trusted context. As the end result of these processes, the remote query is associated with a

set of IDs that is known to your local DB2 subsystem. You assign privileges to these IDs in the same way that you assign privileges to IDs that are associated with local queries.

GUPI GUPI

Related tasks:

"Granting privileges to the PUBLIC ID" on page 59

Granting privileges through views

You can grant most table privileges (except ALTER, REFERENCES, TRIGGER, and INDEX) on a view. By creating a view and granting privileges through it, you can give an ID access to only a specific combination of data.

About this task

The ability to grant privileges through views is sometimes called *field-level access control* or *field-level sensitivity*.

Suppose that you want the ID MATH110 to be able to extract the following column data from the sample employee table for statistical investigation: HIREDATE, JOB, EDLEVEL, SEX, SALARY, BONUS, and COMM for DSN8910.EMP. However, you want to impose the following restrictions:

- No access to employee names or identification numbers
- No access to data for employees hired before 1996
- No access to data for employees with an education level less than 13
- No access to data for employees whose job is MANAGER or PRES

You can create and name a view that shows exactly that combination of data.

Procedure

To grant privileges to the view that you create:

1. Issue the following CREATE statement to create the view that you want:

   GUPI

   ```
   CREATE VIEW SALARIES AS
      SELECT HIREDATE, JOB, EDLEVEL, SEX, SALARY, BONUS, COMM
         FROM DSN8B10.EMP
         WHERE HIREDATE > '1995-12-31' AND
               EDLEVEL >= 13 AND
               JOB <> 'MANAGER' AND
               JOB <> 'PRES';
   ```

   GUPI

2. Issue the following statement to grant the SELECT privilege on the SALARIES view to MATH110:

   GUPI

   ```
   GRANT SELECT ON SALARIES TO MATH110;
   ```

   GUPI

Results

After you grant the privilege, MATH110 can execute SELECT statements on the restricted set of data only. Alternatively, you can give an ID access to only a specific combination of data by using multilevel security with row-level granularity.

Related tasks:

"Granting privileges with the GRANT statement"

"Revoking privileges with the REVOKE statement" on page 68

Granting privileges with the GRANT statement

You can assign privileges to an ID or a role by issuing the GRANT statement.

About this task

Suppose that the Spiffy Computer Company wants to create a database to hold information that is usually posted on hallway bulletin boards. For example, the database might hold notices of upcoming holidays and bowling scores.

To create and maintain the tables and programs that are needed for this application, the Spiffy Computer Company develops the security plan shown in the following diagram.

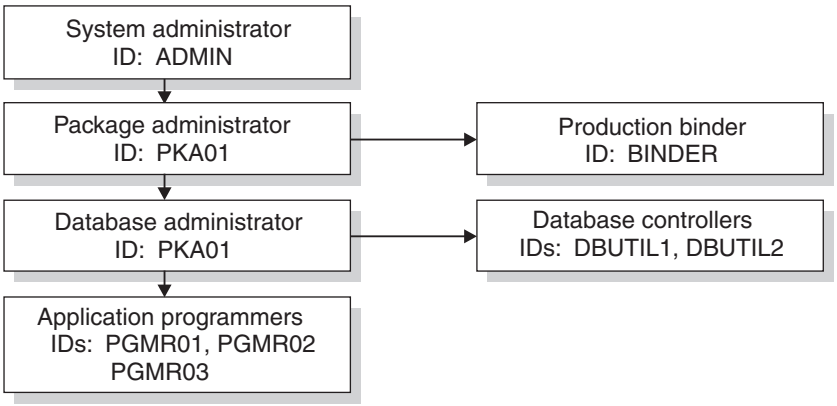
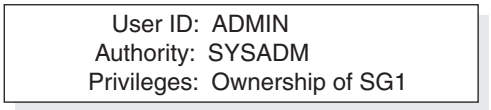


Figure 3. Security plan for the Spiffy Computer Company

The Spiffy Computer Company's system of privileges and authorities associates each role with an authorization ID. For example, the System Administrator role has the ADMIN authorization ID.



GUPI The system administrator uses the ADMIN authorization ID, which has the SYSADM authority, to create a storage group (SG1) and to issue the following statements:

```
1. GRANT PACKADM ON COLLECTION BOWLS TO PKA01 WITH GRANT OPTION;
```

This statement grants to PKA01 the CREATE IN privilege on the collection BOWLS and BIND, EXECUTE, and COPY privileges on all packages in the collection. Because ADMIN used the WITH GRANT OPTION clause, PKA01 can grant those privileges to others.

2. `GRANT CREATEDBA TO DBA01;`

   This statement grants to DBA01 the privilege to create a database and to have DBADM authority over that database.

3. `GRANT USE OF STOGROUP SG1 TO DBA01 WITH GRANT OPTION;`

   This statement allows DBA01 to use storage group SG1 and to grant that privilege to others.

4. `GRANT USE OF BUFFERPOOL BP0, BP1 TO DBA01 WITH GRANT OPTION;`

   This statement allows DBA01 to use buffer pools BP0 and BP1 and to grant that privilege to others.

5. `GRANT CREATE IN COLLECTION DSN8CC91 TO ROLE ROLE1;`

   This statement grants to ROLE1 the privilege to create new packages in collections DSN8CC91. GUPI

User ID:	PKA01
Authority:	PACKADM over the collection BOWLS

The package administrator, PKA01, controls the binding of packages into collections. PKA01 can use the CREATE IN privilege on the collection BOWLS and the BIND, EXECUTE, and COPY privileges on all packages in the collection. PKA01 also has the authority to grant these privileges to others.

User ID:	DBA01
Authority:	DBADM over DB1
Privileges:	CREATEDBA Use of SG1 with GRANT Use of BP0 and BP1 with GRANT Ownership of DB1

The database administrator, DBA01, using the CREATEDBA privilege, creates the database DB1. When DBA01 creates DB1, DBA01 automatically has DBADM authority over the database.

User ID:	DBUTIL1, DBUTIL2
Authority:	DBCTRL over DB1

The database administrator at Spiffy Computer Company wants help with running the COPY and RECOVER utilities. Therefore DBA01 grants DBCTRL authority over database DB1 to DBUTIL1 and DBUTIL2.

GUPI To grant DBCTRL authority, the database administrator issues the following statement:

```
GRANT DBCTRL ON DATABASE DB1 TO DBUTIL1, DBUTIL2;
```

GUPI

Related tasks:

"Granting privileges through views" on page 61

Granting privileges to secondary IDs

The Spiffy Computer Company uses RACF to manage external access to DB2. Therefore, Spiffy can use secondary authorization IDs to define user groups and associate primary authorization IDs with those user groups.

About this task

The primary authorization IDs are the RACF user IDs. The secondary authorization IDs are the names of the groups with which the primary IDs are associated.

Spiffy can grant DB2 privileges to primary IDs indirectly, by granting privileges to secondary IDs that are associated with the primary IDs. This approach associates privileges with a *functional ID* rather than an *individual ID*. Functional IDs, also called group IDs, are granted privileges based on the function that certain job roles serve in the system. Multiple primary IDs can be associated with a functional ID and receive the privileges that are granted to that functional ID. In contrast, individual IDs are connected to specific people. Their privileges need to be updated as people join the company, leave the company, or serve different roles within the company. Functional IDs have the following advantages:

- Functional IDs reduce system maintenance because they are more permanent than individual IDs. Individual IDs require frequent updates, but each functional ID can remain in place until Spiffy redesigns its procedures.

  Example: Suppose that Joe retires from the Spiffy Computer Company. Joe is replaced by Mary. If Joe's privileges are associated with functional ID DEPT4, those privileges are maintained in the system even after Joe's individual ID is removed from the system. When Mary enters the system, she will have all of Joe's privileges after her ID is associated with the functional ID DEPT4.
- Functional IDs reduce the number of grants that are needed because functional IDs often represent groups of individuals.
- Functional IDs reduce the need to revoke privileges and re-create objects when they change ownership.

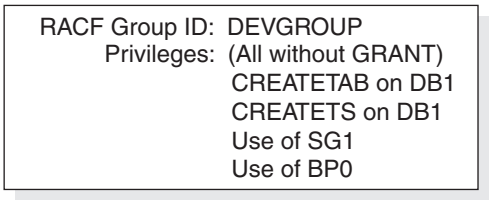
  Example: Suppose that Bob changes jobs within the Spiffy Computer Company. Bob's individual ID has privileges on many objects in the system and owns three databases. When Bob's job changes, he no longer needs privileges over these objects or ownership of these databases. Because Bob's privileges are associated with his individual ID, a system administrator needs to revoke all of Bob's privileges on objects and drop and re-create Bob's databases with a new owner. If Bob received privileges by association with a functional ID, the system administrator would only need to remove Bob's association with the functional ID.

Granting privileges to user groups

You can simplify the assignment and management of privileges by creating user groups and by granting privileges to the groups. In this way, you can efficiently assign the same set of privileges to all the users of a given group at the same time.

About this task

Suppose that the database administrator at Spiffy wants several employees in the Software Support department to create tables in the DB1 database. The database administrator creates DEVGROUP as a RACF group ID for this purpose. To simplify the process, the database administrator decides that each CREATE TABLE statement should implicitly create a unique table space for the table. Hence, DEVGROUP needs the CREATETAB privilege, the CREATETS privilege, the privilege to use the SG1 storage group and, the privilege to use one of the buffer pools, BP0, for the implicitly created table spaces. The following diagram shows this group and their privileges:



GUPI The database administrator, DBA01, owns database DB1 and has the privileges to use storage group SG1 and buffer pool BP0. The database administrator holds both of these privileges with the GRANT option. The database administrator issues the following statements:

1. `GRANT CREATETAB, CREATETS ON DATABASE DB1 TO DEVGROUP;`
2. `GRANT USE OF STOGROUP SG1 TO DEVGROUP;`
3. `GRANT USE OF BUFFERPOOL BP0 TO DEVGROUP;` GUPI

Because the system and database administrators at Spiffy still need to control the use of those resources, the preceding statements are issued without the GRANT option.

Three programmers in the Software Support department write and test a new program, PROGRAM1. Their IDs are PGMR01, PGMR02, and PGMR03. Each programmer needs to create test tables, use the SG1 storage group, and use one of the buffer pools. All of those resources are controlled by DEVGROUP, which is a RACF group ID.

Therefore, granting privileges over those resources specifically to PGMR01, PGMR02, and PGMR03 is unnecessary. Each ID should be associated with the RACF group DEVGROUP and receive the privileges that are associated with that functional ID. The following diagram shows the DEVGROUP and its members:

The security administrator connects as many members as required to the group DEVGROUP. Each member can exercise all the privileges that are granted to the group ID.

Granting privileges for binding plans

Binding requires additional privileges. You must have the required privileges to bind a plan.

About this task

GUPI Suppose that three programmers can share the tasks that are done by the DEVGROUP ID. Someone creates a test table, DEVGROUP.T1, in database DB1 and loads it with test data. Someone writes a program, PROGRAM1, to display bowling scores that are contained in T1. Someone must bind the plan and packages that accompany the program.

Binding requires an additional privilege. ADMIN, who has the SYSADM authority, grants the required privilege by issuing the following statement:

```
GRANT BINDADD TO DEVGROUP;
```

GUPI

With that privilege, any member of the RACF group DEVGROUP can bind plans and packages that are to be owned by DEVGROUP. Any member of the group can rebind a plan or package that is owned by DEVGROUP. The following diagram shows the BINDADD privilege granted to the group:

The Software Support department proceeds to create and test the program.

Granting privileges for rebinding plans and packages

You can use the GRANT statement to grant privileges for rebuilding plans and packages.

About this task

Spiffy has a different set of tables, which contain actual data that is owned by the ROLE PRODCTN. PROGRAM1 is written with unqualified table names. For example, table T1 was referred to as simply T1, not DEVGROUP.T1. The new packages and plan must refer to table PRODCTN.T1. To move the completed program into production, someone must perform the following steps:

- Rebind the application plan with the owner PRODCTN.
- Rebind the packages into the collection BOWLS, again with the owner PRODCTN.

Spiffy gives that job to a production binder with the ID BINDER. BINDER needs privileges to bind a plan or package that DEVGROUP owns, to bind a plan or package with OWNER (PRODCTN), and to add a package to the collection BOWLS. BINDER acquires these abilities through its RACF DEVGROUP group and ROLE PRODCTN. ROLE PRODCTN needs to have all the necessary privileges.

Suppose that ID BINDER has ROLE PRODCTN when binding in a trusted context and that ROLE PRODCTN has the following privileges:

DB2 Role:	PRODCTN
Privileges:	BINDADD
	CREATE IN collection BOWLS
	Privileges on SQL objects referenced in application

BINDER can bind plans and packages for owner ROLE PRODCTN because it performs binds in a trusted context with ROLE PRODCTN.

PACKADM, the package administrator for BOWLS, can grant the CREATE privilege with the following statement:

GUPI

```
GRANT CREATE ON COLLECTION BOWLS TO ROLE PRODCTN;
```

GUPI

With the plan in place, the database administrator at Spiffy wants to make the PROGRAM1 plan available to all employees by issuing the following statement:

GUPI

```
GRANT EXECUTE ON PLAN PROGRAM1 TO PUBLIC;
```

GUPI

More than one ID has the authority or privileges that are necessary to issue this statement. For example, ADMIN has SYSADM authority and can grant the EXECUTE privilege. Also, any ID in a trusted context with ROLE PRODCTN that owns PROGRAM1 can issue the statement. When EXECUTE is granted to PUBLIC, other IDs do not need any explicit authority on T1.

Finally, the plan to display bowling scores at Spiffy Computer Company is complete. The production plan, PROGRAM1, is created, and all IDs have the authority to execute the plan.

Granting privileges for accessing distributed data

Some time after the system and database administrators at Spiffy Computer Company implement their security plan, the company president tells them that other applications on other systems must connect to the local DB2 subsystem. She wants people at every location to be able to access bowling scores through PROGRAM1 on the local subsystem.

Procedure

GUPI The administrators perform the following steps to enable access from all Spiffy locations:

1. Add a CONNECT statement to the program, naming the location at which table PRODCTN.T1 resides. In this case, the table and the package reside at only the central location.
2. Issue the following statement so that PKA01, who has PACKADM authority, can grant the required privileges to DEVGROUP:

   ```
   GRANT CREATE IN COLLECTION BOWLS TO DEVGROUP;
   ```

3. Bind the SQL statements in PROGRAM1 as a package.
4. Bind the SQL statements in PROGRAM1 as a package by the package owner:
   ```
   GRANT EXECUTE ON PACKAGE PROGRAM1 TO PUBLIC;
   ```

Results

Any system that is connected to the original DB2 location can run PROGRAM1 and execute the package by using DRDA® access. However, if the remote system is another DB2, a plan must be bound there that includes the package in its package list. GUPI

Revoking privileges with the REVOKE statement

You can use the REVOKE statement to remove the privileges that you explicitly grant to an ID or a role.

About this task

GUPI You can revoke the privilege that you grant to an ID by issuing the following statement:

```
REVOKE authorization-specification FROM auth-id
```

Generally, you can revoke only the privileges that you grant. If you revoke privileges on a procedure or package, the privileges are revoked from all versions of that procedure or package.

However, an ID with the SECADM or ACCESSCTRL authority can revoke a privilege that has been granted by another ID with the following statement:

```
REVOKE authorization-specification FROM auth-id BY auth-id
```

If the SEPARATE SECURITY system parameter on panel DSNTIPP1 is set to NO (the default) during installation, an ID with the SYSADM or SYSCTRL authority can revoke a privilege that has been granted by another ID. In this case, the SYSADM authority implicitly has the privileges of the SECADM authority, and the SYSCTRL authority implicitly has the privileges of the ACCESSCTRL authority.

The BY clause specifies the authorization ID that originally granted the privilege. If two or more grantors grant the same privilege to an ID, executing a single REVOKE statement does not remove the privilege. To remove it, each grant of the privilege must be revoked.

The WITH GRANT OPTION clause of the GRANT statement allows an ID to pass the granted privilege to others. If the privilege is removed from the ID, its revocation can cascade to others depending on the setting of the REVOKE DEP PRIV system parameter. For example, when a privilege is removed from authorization ID X, it is also removed from any ID to which X granted it, unless that ID also has the privilege from some other source.

Example: Suppose that DBA01 grants DBCTRL authority with the GRANT option on database DB1 to DBUTIL1. Then DBUTIL1 grants the CREATETAB privilege on DB1 to PGMR01. If DBA01 revokes DBCTRL from DBUTIL1, PGMR01 loses the

1. DB2 does not cascade a revoke of the SYSADM authority from the installation SYSADM authorization IDs.

CREATETAB privilege. If PGMR01 also granted the CREATETAB privilege to OPER1 and OPER2, they also lose the privilege.

Example: Suppose that PGMR01 from the preceding example created table T1 while holding the CREATETAB privilege. If PGMR01 loses the CREATETAB privilege, table T1 is not dropped, and the privileges that PGMR01 has as owner of the table are not deleted. Furthermore, the privileges that PGMR01 grants on T1 are not deleted. For example, PGMR01 can grant SELECT on T1 to OPER1 as long as PGMR01 owns of the table. Even when the privilege to create the table is revoked, the table remains, the privilege remains, and OPER1 can still access T1.

Example: Consider the following REVOKE scenario:

1. Grant #1: SYSADM, SA01, grants SELECT on TABLE1 to USER01 with the GRANT option.
2. Grant #2: USER01 grants SELECT on TABLE1 to USER02 with the GRANT option.
3. Grant #3: USER02 grants SELECT on TABLE1 back to SA01.
4. USER02 then revokes SELECT on TABLE1 from SA01.

The cascade REVOKE process of Grant #3 determines if SA01 granted SELECT to anyone else. It locates Grant #1. Because SA01 did not have SELECT from any other source, this grant is revoked. The cascade REVOKE process then locates Grant #2 and revokes it for the same reason. In this scenario, the single REVOKE action by USER02 triggers and results in the cascade removal of all the grants even though SA01 has the SYSADM authority. The SYSADM authority is not considered. GUPI

Related tasks:

"Granting privileges with the GRANT statement" on page 62

"Revoking dependent privileges"

Revoking dependent privileges

Revoking a privilege or authority, such as the SYSADM authority, from one user (an authorization ID or role) can result in the automatic removal of that privilege from other users and the privileges that it has granted. To prevent this, you can assign the REVOKE DEP PRIV parameter different values to control whether or not dependent privileges or authorities should be removed.

Procedure

To specify the REVOKE DEP PRIV parameter, use one of the following approaches:

- Set REVOKE DEP PRIV to SQLSTMT (the default) if you want to use the dependent privileges clause on the REVOKE statement to control the revocation of dependent privileges.
  - Specify the NOT INCLUDING DEPENDENT PRIVILEGES clause on the REVOKE statement when you need to revoke a privilege or authority from a user but retain all the grants that are already made by that user. However, if the same privilege is later granted to that user again and subsequently revoked with the INCLUDING DEPENDENT PRIVILEGES clause specified, all dependent privileges including the grants made by the user earlier are removed.
  - Specify the INCLUDING DEPENDENT PRIVILEGES clause (the default) when you need to revoke a privilege or authority (other than ACCESSCTRL,

DATAACCESS, and system DBADM) from a user and remove all the privileges or authorities that are already granted by that privilege or authority.

- Set REVOKE DEP PRIV to YES if you want to remove all dependent privileges or authorities whenever you revoke a privilege or authority other than ACCESSCTRL, DATAACCESS, and system DBADM.

  You will receive an error if you specify the NOT INCLUDING DEPENDENT PRIVILEGES clause on the REVOKE statement when you revoke a privilege or authority other than ACCESSCTRL, DATAACCESS, and system DBADM.
- Set REVOKE DEP PRIV to NO if you want to retain all dependent privileges or authorities whenever you revoke a privilege or authority.

  You will receive an error if you specify the INCLUDING DEPENDENT PRIVILEGES clause on the REVOKE statement.

Results

If REVOKE DEP PRIV is set to NO or SQLSTMT or if the NOT INCLUDING DEPENDENT PRIVILEGES clause is specified on the REVOKE statement, dependent privileges or authorities are not revoked when a privilege or authority is revoked from a user. However, any packages, views, or MQTs that are owned by that user are invalidated, inoperative, or dropped.

Revoking dependent privileges does not occur in any of the following conditions:

- If the ACCESSCTRL authority is revoked from a user, grants made by the user are not revoked. However, if the user has already revoked its own grants prior to the removal of the ACCESSCTRL authority, that revocation of dependent privileges continues to take effect unless otherwise instructed through the REVOKE_DEP_PRIV parameter or the REVOKE statement.
- If the SECADM authority is removed from a user, grants made by the user are not revoked. However, if the user has already revoked its own grants prior to the removal of the SECADM authority, that revocation of dependent privileges continues to take effect unless otherwise instructed through the REVOKE_DEP_PRIV parameter or the REVOKE statement.

Revoking privileges granted by multiple IDs

A user can be granted the same privilege by multiple IDs at different times, but that privilege and any dependent privileges can be simultaneously revoked.

About this task

GUPI Suppose that DBUTIL1 grants the CREATETAB privilege to PGMR01 and that DBUTIL2 also grants the CREATETAB privilege to PGMR01. The second grant is recorded in the catalog, with its date and time, but it has no other effect until the grant from DBUTIL1 to PGMR01 is revoked. After the first grant is revoked, DB2 must determine the authority that PGMR01 used to grant CREATETAB to OPER1. The following diagram illustrates the situation; the arrows represent the granting of the CREATETAB privilege.

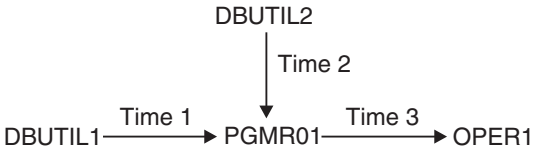


Figure 4. Authorization granted by two or more IDs

Suppose that DBUTIL1 issues the GRANT statement at Time 1 and that DBUTIL2 issues the GRANT statement at Time 2. DBUTIL1 and DBUTIL2 both use the following statement to issue the grant:

```
GRANT CREATETAB ON DATABASE DB1 TO PGMR01 WITH GRANT OPTION;
```

At Time 3, PGMR01 grants the privilege to OPER1 by using the following statement:

```
GRANT CREATETAB ON DATABASE DB1 TO OPER1;
```

After Time 3, DBUTIL1's authority is revoked, along with all of the privileges and authorities that DBUTIL1 granted. However, PGMR01 also has the CREATETAB privilege from DBUTIL2, so PGMR01 does not lose the privilege. The following criteria determine whether OPER1 loses the CREATETAB privilege when DBUTIL1's authority is revoked:

- If Time 3 *comes after* Time 2, OPER1 does not lose the privilege. The recorded dates and times show that, at Time 3, PGMR01 could have granted the privilege entirely on the basis of the privilege that was granted by DBUTIL2. That privilege was not revoked.
- If Time 3 *precedes* Time 2, OPER1 does lose the privilege. The recorded dates and times show that, at Time 3, PGMR01 could have granted the privilege only on the basis of the privilege that was granted by DBUTIL1. That privilege was revoked, so the privileges that are dependent on it are also revoked. GUPI

Revoking privileges granted by other IDs

An ID with the SYSADM or SYSCTRL authority can revoke privileges that are granted by other IDs.

Procedure

GUPI To revoke privileges granted by other IDs, choose one of the following approaches:

- Issue a REVOKE statement and include BY ALL in that statement. This statement will revoke privileges granted by all other IDs. The following example revokes the CREATETAB privileges that are granted to PGMR01 on database DB1 by all IDs:

  ```
  REVOKE CREATETAB ON DATABASE DB1 FROM PGMR01 BY ALL;
  ```

- Issue a REVOKE statement and include the specific ID in that statement. This statement will revoke privileges that were granted by a specific ID and leave intact the same privileges if they were granted by any other ID. The following example revokes privileges that are granted by DBUTIL1 and leaves intact the same privileges if they were granted by any other ID:

  ```
  REVOKE CREATETAB, CREATETS ON DATABASE DB1 FROM PGMR01 BY DBUTIL1;
  ```

GUPI

Related reference:

REVOKE (DB2 SQL)

Revoking privileges granted by a role

You can use the REVOKE statement to revoke privileges that are granted by a role in a trusted context.

About this task

To revoke privileges that are granted by a role, you can issue the REVOKE statement in the trusted context that was defined with the ROLE AS OBJECT OWNER clause. Also, make sure the role that revokes a privilege matches the one that grants the privilege. For a static REVOKE statement, the revoker is the role that owns the plan or package. For a dynamic REVOKE statement, the role for the primary authorization ID that executes the REVOKE statement becomes the revoker.

An authorization ID or role that has the SYSADM or SYSCTRL authority can use the BY (ROLE *role-name*) clause of the REVOKE statement to revoke privileges that are granted by a role.

Revoking all privileges from a role

You can revoke all privileges that are assigned to a role by dropping the role itself or by using the REVOKE statement.

About this task

GUPI When you attempt to drop a role, make sure that the role does not own any objects. If the role owns objects, the DROP statement is terminated. If the role does not own any objects, the role is dropped. As a result, all privileges that are held by this role are revoked, and the revocation is cascaded. GUPI

Revoking privileges for views

If a table privilege is revoked from the owner of a view on the table, the corresponding privilege on the view is revoked. The same privilege is also revoked from other IDs if it was granted by the view owner.

About this task

GUPI If the SELECT privilege on the base table is revoked from the owner of the view, the view is dropped. However, if another grantor granted the SELECT privilege to the view owner before the view was created, the view is not dropped.

Example: Suppose that OPER2 has the SELECT and INSERT privileges on table T1 and creates a view of the table. If the INSERT privilege on T1 is revoked from OPER2, all insert privileges on the view are revoked. If the SELECT privilege on T1 is revoked from OPER2, and if OPER2 did not have the SELECT privilege from another grantor before the view was created, the view is dropped.

If a view uses a user-defined function, the view owner must have the EXECUTE privilege on the function. If the EXECUTE privilege is revoked, the revoke fails because the view is using the privilege and the RESTRICT clause prevents the revoke.

An authorization ID with the SYSADM authority can create a view for another authorization ID. In this case, the view could have both a creator and an owner. The owner is automatically given the SELECT privilege on the view. However, the privilege on the base table determines whether the view is dropped.

Example: Suppose that IDADM, with SYSADM authority, creates a view on TABLX with OPER as the owner of the view. OPER now has the SELECT privilege on the view, but not necessarily any privileges on the base table. If SYSADM is revoked from IDADM, the SELECT privilege on TABLX is gone and the view is dropped.

If one ID creates a view for another ID, the catalog table SYSIBM.SYSTABAUTH needs either one or two rows to record the associated privileges. The number of rows that DB2 uses to record the privilege is determined by the following criteria:

- If IDADM creates a view for OPER when OPER has enough privileges to create the view by itself, only one row is inserted in SYSTABAUTH. The row shows only that OPER granted the required privileges.
- If IDADM creates a view for OPER when OPER does not have enough privileges to create the view by itself, two rows are inserted in SYSTABAUTH. One row shows IDADM as GRANTOR and OPER as GRANTEE of the SELECT privilege. The other row shows any other privileges that OPER might have on the view because of privileges that are held on the base table. GUPI

Revoking privileges for materialized query tables

If the SELECT privilege on a source table is revoked from the owner of a materialized query table, the corresponding privilege on the materialized query table is revoked. The same privilege is also revoked from other IDs if it was granted by the table owner.

About this task

GUPI If the SELECT privilege on the source table is revoked from the owner of a materialized query table, the materialized query table is dropped. However, if another grantor granted the SELECT privilege to the materialized query table owner before the materialized query table was created, the materialized query table is not dropped.

Example: Suppose that OPER7 has the SELECT privilege on table T1 and creates a materialized query table T2 by selecting from T1. If the SELECT privilege on T1 is revoked from OPER7, and if OPER7 did not have the SELECT privilege from another grantor before T2 was created, T2 is dropped.

If a materialized query table uses a user-defined function, the owner of the materialized query table must have the EXECUTE privilege on the function. If the EXECUTE privilege is revoked, the revoke fails because the materialized query table is using the privilege and the RESTRICT clause prevents the revoke. GUPI

Revoking privileges for plans or packages

If the owner of an application plan or package loses a required privilege and does not have that privilege from another source, DB2 invalidates the package.

About this task

GUPI Suppose that OPER2 has the SELECT and INSERT privileges on table T1 and creates a package that uses SELECT, but not INSERT. When privileges are revoked from OPER2, the plan is affected in the following ways:

- If the INSERT privilege is revoked, the plan is unaffected.
- If the revoked privilege was EXECUTE on a user-defined function, DB2 marks the package **inoperative** instead of invalid.

If authorization data is cached for a package and an ID loses EXECUTE authority on the package, that ID is removed from the cache. Similarly, if authorization data is cached for routines, a revoke or cascaded revoke of EXECUTE authority on a routine, or on all routines in a schema (schema.*), from any ID causes the ID to be removed from the cache.

If authorization data is cached for plans, a revoke of EXECUTE authority on the plan from any ID causes the authorization cache to be invalidated.

If an application is caching dynamic SQL statements, and a privilege is revoked that was needed when the statement was originally prepared and cached, that statement is removed from the cache. Subsequent PREPARE requests for that statement do not find it in the cache and therefore execute a full PREPARE. If the plan or package is bound with KEEPDYNAMIC(YES), which means that the application does not need to explicitly re-prepare the statement after a commit operation, you might get an error on an OPEN, DESCRIBE, or EXECUTE of that statement following the next commit operation. The error can occur because a prepare operation is performed implicitly by DB2. If you no longer have sufficient authority for the prepare, the OPEN, DESCRIBE, or EXECUTE request fails. GUPI

Revoking the SYSADM authority from users

You can revoke the SYSADM authority from users (IDs or roles) without revoking dependent privileges.

About this task

Revoking the SYSADM authority causes the revoking of dependent privileges, by default. If you want to leave the grants that they had made, you can issue the REVOKE statement with the NOT INCLUDING DEPENDENT PRIVILEGES clause, assuming the REVOKE_DEP_PRIVILEGES system parameter is set to SQLSTMT.

Restrictions on privilege revocation

You can specify the RESTRICT clause of the REVOKE statement to impose limitations on privilege revocation.

About this task

GUPI Whether specified or not, the RESTRICT clause of the REVOKE statement always applies to the following objects:

- User-defined functions
- JARs (Java classes for a routine)
- Stored procedures
- Distinct types
- Sequences

When an attempt is made to revoke a privilege on one of these objects, DB2 determines whether the revokee owns an object that is dependent on the privilege. If such a dependency exists, the REVOKE statement proceeds only if the revokee also holds this privilege from another grantor or holds this privilege indirectly (such as if PUBLIC has this privilege, or if the revokee has SYSADM authority).

Example

Consider the following scenario:

1. UserA creates a user-defined function named UserA.UDFA.
2. UserA grants EXECUTE on UserA.UDFA to UserB.
3. User B then creates a user-defined function UserB.UDFB that is sourced on UserA.UDFA.

At this point, UserA attempts to revoke the EXECUTE privilege on UserA.UDFA from UserB. The revoke succeeds or fails based on the following criteria:

- If UserB has the EXECUTE privilege on UserA.UDFA only from UserA, the revoke fails with an accompanying message that indicates that a dependency on this privilege.
- If UserB has the EXECUTE privilege on UserA.UDFA from another source, directly or indirectly, the EXECUTE privilege that was granted by UserA is revoked successfully.

For distinct types, the following objects that are owned by the revokee can have dependencies:

- A table that has a column that is defined as a distinct type
- A user-defined function that has a parameter that is defined as a distinct type
- A stored procedure that has a parameter that is defined as a distinct type
- A sequence that has a parameter that is defined as a distinct type

For user-defined functions, the following objects that are owned by the revokee can have dependencies:

- Another user-defined function that is sourced on the user-defined function
- A view that uses the user-defined function
- A table that uses the user-defined function in a check constraint or user-defined default clause
- A trigger package that uses the user-defined function

For JARs (Java classes for a routine), the following objects that are owned by the revokee can have dependencies:

- A Java user-defined function that uses a JAR
- A Java stored procedure that uses a JAR

For stored procedures, a trigger package that refers to the stored procedure in a CALL statement can have dependencies.

For sequences, the following objects that are owned by the revokee can have dependencies:

- Triggers that contain NEXT VALUE or PREVIOUS VALUE expressions that specify a sequence
- Inline SQL routines that contain NEXT VALUE or PREVIOUS VALUE expressions that specify a sequence

One way to ensure that the REVOKE statement succeeds is to drop the object that has a dependency on the privilege. To determine which objects are dependent on which privileges before attempting the revoke, use the following SELECT statements.

For a distinct type:

- List all tables that are owned by the revokee USRT002 that contain columns that use the distinct type USRT001.UDT1:

```
SELECT * FROM SYSIBM.SYSCOLUMNS WHERE
  TBCREATOR = 'USRT002'      AND
  TYPESCHEMA = 'USRT001'     AND
  TYPENAME = 'UDT1'          AND
  COLTYPE = 'DISTINCT';
```

- List the user-defined functions that are owned by the revokee USRT002 that contain a parameter that is defined as distinct type USRT001.UDT1:

```
SELECT * FROM SYSIBM.SYSPARMS WHERE
  OWNER = 'USRT002'          AND
  TYPESCHEMA = 'USRT001'     AND
  TYPENAME = 'UDT1'          AND
  ROUTINETYPE = 'F';
```

- List the stored procedures that are owned by the revokee USRT002 that contain a parameter that is defined as distinct type USRT001.UDT1:

```
SELECT * FROM SYSIBM.SYSPARMS WHERE
  OWNER = 'USRT002'          AND
  TYPESCHEMA = 'USRT001'     AND
  TYPENAME = 'UDT1'          AND
  ROUTINETYPE = 'P';
```

- List the sequences that are owned by the revokee USRT002 that contain a parameter that is defined as distinct type USRT001.UDT1:

```
SELECT SYSIBM.SYSSEQUENCES.SCHEMA, SYSIBM.SYSSEQUENCES.NAME
  FROM SYSIBM.SYSSEQUENCES, SYSIBM.SYSDATATYPES WHERE
    SYSIBM.SYSSEQUENCES.DATATYPEID = SYSIBM.SYSDATATYPES.DATATYPEID AND
    SYSIBM.SYSDATATYPES.SCHEMA ='USRT001' AND
    SYSIBM.SYSDATATYPES.NAME   ='UDT1';
```

For a user-defined function:

- List the user-defined functions that are owned by the revokee USRT002 that are sourced on user-defined function USRT001.SPECUDF1:

```
SELECT * FROM SYSIBM.SYSROUTINES WHERE
  OWNER = 'USRTOO2'            AND
  SOURCESCHEMA = 'USRTOO1'     AND
  SOURCESPECIFIC = 'SPECUDF1'  AND
  ROUTINETYPE = 'F';
```

- List the views that are owned by the revokee USRT002 that use user-defined function USRT001.SPECUDF1:

```
SELECT * FROM SYSIBM.SYSVIEWDEP WHERE
  DCREATOR = 'USRTOO2'       AND
  BSCHEMA = 'USRT001'        AND
  BNAME = 'SPECUDF1'         AND
  BTYPE = 'F';
```

- List the tables that are owned by the revokee USRT002 that use user-defined function USRT001.A_INTEGER in a check constraint or user-defined default clause:

```
SELECT * FROM SYSIBM.SYSCONSTDEP WHERE
  DTBCREATOR = 'USRT002'      AND
  BSCHEMA = 'USRT001'         AND
  BNAME = 'A_INTEGER'         AND
  BTYPE = 'F';
```

- List the trigger packages that are owned by the revokee USRT002 that use user-defined function USRT001.UDF4:

```
SELECT * FROM SYSIBM.SYSPACKDEP WHERE
  DOWNER = 'USRT002'         AND
  BQUALIFIER = 'USRT001'     AND
  BNAME = 'UDF4'             AND
  BTYPE = 'F';
```

For a JAR (Java class for a routine), list the routines that are owned by the revokee USRT002 and that use a JAR named USRT001.SPJAR:

```
SELECT * FROM SYSIBM.SYSROUTINES WHERE
  OWNER = 'USRT002'          AND
  JARCHEMA = 'USRT001'       AND
  JAR_ID = 'SPJAR';
```

For a stored procedure that is used in a trigger package, list the trigger packages that refer to the stored procedure USRT001.WLMLOCN2 that is owned by the revokee USRT002:

```
SELECT * FROM SYSIBM.SYSPACKDEP WHERE
  DOWNER = 'USRT002'         AND
  BQUALIFIER = 'USRT001'     AND
  BNAME = 'WLMLOCN2'         AND
  BTYPE = 'O';
```

For a sequence:

- List the sequences that are owned by the revokee USRT002 and that use a trigger named USRT001.SEQ1:

```
SELECT * FROM SYSIBM.SYSPACKDEP WHERE
  BNAME = 'SEQ1'
  BQUALIFIER = 'USRT001'
  BTYPE = 'Q'
  DOWNER = 'USRT002'
  DTYPE = 'T';
```

- List the sequences that are owned by the revokee USRT002 and that use a inline SQL routine named USRT001.SEQ1:

```
SELECT * FROM SYSIBM.SYSSEQUENCESDEP WHERE
  DCREATOR = 'USRT002'
  DTYPE = 'F'
  BNAME = 'SEQ1'
  BSCHEMA = 'USRT001';
```

GUPI

Managing implicit privileges

You acquire privileges implicitly through ownership of objects, including ownership of plans and packages. You can control access to data by managing those privileges through object ownership and stored procedures, which are also known as routines.

Related tasks:

"Managing explicit privileges" on page 58

Managing implicit privileges through object ownership

Ownership of an object carries with it a set of related privileges on the object. DB2 provides separate controls for creation and ownership of objects.

In general, when you create an object, the owner of the object can be your primary authorization ID, one of your secondary authorization IDs, or the role that you are associated with in a trusted context.

Ownership of objects with unqualified names

If an object name is unqualified, the object type and the way it is created determine its ownership.

GUPI If the name of a table, view, index, alias, or synonym is unqualified, you can establish the object's ownership in the following ways:

- If you issue the CREATE statement dynamically, perhaps using SPUFI, QMF, or some similar program, the owner of the created object is your current SQL ID. That ID must have the privileges that are needed to create the object.
- If you issue the CREATE statement statically, by running a plan or package that contains it, the ownership of the created object depends on the option that is used for the bind operation. You can bind the plan or package with either the QUALIFIER option, the OWNER option, or both.
  - If the plan or package is bound with the QUALIFIER option only, the authorization ID in the QUALIFIER option is the owner of the object. The QUALIFIER option allows the binder to name a qualifier to use for all unqualified names of tables, views, indexes, aliases, or synonyms that appear in the plan or package.
  - If the plan or package is bound with the OWNER option only, the authorization ID in the OWNER option is the owner of the object.
  - If the plan or package is bound with both the QUALIFIER option and the OWNER option, the authorization ID in the QUALIFIER option is the owner of the object.
  - If neither option is specified, the authorization ID of the binder of the plan or package is implicitly the object owner.

If the name of a user-defined function, stored procedure, distinct type, sequence, or trigger is unqualified, you can establish the ownership of one of these objects in these ways:

- If you issue the CREATE statement dynamically, the owner of the created object is your current SQL ID. That ID must have the privileges that are needed to create the object.
- If you issue the CREATE statement statically, by running a plan or package that contains it, the owner of the object is the plan or package owner. You can use the OWNER bind option to explicitly name the object owner. If you do not use the OWNER bind option, the binder of the package or plan is implicitly the object owner.

If the name of a user-defined function, stored procedure, distinct type, sequence, or trigger is unqualified, the implicit qualifier is determined based on the schema name in dynamic statements and the PATH bind option in static statements. The owner of a JAR (Java class for a routine) that is used by a stored procedure or a user-defined function is the current SQL ID of the process that performs the INSTALL_JAR function. GUPI

Ownership of objects with qualified names

If an object name is qualified, the type of object indicates its ownership.

GUPI If you create a table, view, index, or alias with a qualified name, the owner of the object is the *schema name*. The schema name identifies the schema to which the object belongs. You can consider all of the objects that are qualified by the same schema name as a group of related objects.

If you create a distinct type, user-defined function, stored procedure, sequence, or trigger with a qualified name, the owner of the object is the authorization ID of the process. The owner of a JAR (Java class for a routine) that is used by a stored procedure or a user-defined function is the current SQL ID of the process that performs the INSTALL_JAR function. GUPI

Ownership of objects within a trusted context

You can simplify the administration of authorization by having roles as object owners. In addition, object ownership carries with it a set of related privileges on the object; you can prevent users from obtaining implicit privileges from object ownership by making roles object owners.

GUPI If the owner of an object is an authorization ID and you need to transfer the ownership to another ID, you need to drop the object first and re-create it with the new authorization ID as the owner. You don't need to take these steps if the owner is a role because all users that are associated with that role have the owner privilege.

The definition of a trusted context determines the ownership of objects that are created in the trusted context. Assume that you issue the CREATE statement dynamically and that the trusted context is defined with the ROLE AS OBJECT OWNER clause. In this case, the associated role is the owner of the objects, regardless of whether the objects are explicitly qualified.

In contrast, assume that you issue the CREATE statement statically and that the plan or package is bound in the trusted context with the ROLE AS OBJECT OWNER clause. In this case, the role that owns the plan or package also owns the objects that are created, regardless of whether the objects are explicitly qualified. GUPI

Related concepts:

"Trusted contexts" on page 219

Related reference:

"Establishing plan and package ownership in a trusted context" on page 81

Changing object ownership

You can make a DB2 role, a primary authorization ID, or a secondary authorization ID the owner of an object.

About this task

Object ownership carries with it a set of related privileges on the object. The privileges that are implicit in ownership cannot be revoked; you cannot replace or change the owner of an object while the object exists.

If you a DB2 role the owner of an object, you don't need to change or replace the ownership. All users that are associated with that role have the same owner

privileges. To make a role the owner of an object, you need to create the object in a trusted context that is defined with the ROLE AS OBJECT OWNER AND QUALIFIER clause.

You can change the owner of an object from an authorization ID to a role by using the CATMAINT UPDATE utility with the OWNER option. To do so, you must also have the installation SYSADM authority, define a trusted context with the ROLE AS OBJECT OWNER AND QUALIFIER clause, and run the process in the new function mode.

Alternately, you can make the object owning ID a secondary ID with which several primary IDs are associated. You can change the list of primary IDs that are associated with the secondary ID without dropping and re-creating the object.

If the owner of the object is a primary authorization ID and if you need to transfer the ownership to another ID, you must drop the object and then re-create it with a new authorization ID as the owner.

Granting implicit privileges of object ownership

Certain implicit privileges of ownership correspond to the privileges that can be granted by a GRANT statement. For the privileges that do correspond, the owner of the object can grant them to other users.

About this task

GUPI The owner of a table can grant the SELECT privilege on the table to any other user.

Example

To grant the SELECT privilege on TABLE3 to USER4, the owner of the table can issue the following statement:

```
GRANT SELECT ON TABLE3 TO USER4
```

GUPI

Managing implicit privileges through plan or package ownership

If you are the owner of a plan or package, you must hold privileges to perform actions on the plan or package. You can grant privileges to execute the plan or package to any ID.

GUPI When the EXECUTE privilege on a plan or package is granted to an ID, the ID can execute a plan or package without holding the privileges for every action that the plan or package performs. However, the ID is restricted by the SQL statements in the original program.

Example: The program might contain the following statement:

```
EXEC SQL
  SELECT * INTO :EMPREC FROM DSN8B10.EMP
    WHERE EMPNO='000010';
```

The statement puts the data for employee number 000010 into the host structure EMPREC. The data comes from table DSN8B10.EMP, but the ID does not have

unlimited access to DSN8910.EMP. Instead, the ID that has EXECUTE privilege for this plan can access rows in the DSN8B10.EMP table only when EMPNO = '000010'.

If any of the privileges that are required by the package are revoked from the owner, the package is invalidated. The package must be rebound, and the new owner must have the required privileges. GUPI

Establishing or changing plan or package ownership

You can use the BIND and REBIND subcommands to create or change an application plan or a package.

About this task

On either subcommand, you can use the OWNER option to name the owner of the resulting plan or package. Consider the following factors when naming an owner:

- Any user can name the primary ID or any secondary ID.
- An ID with the BINDAGENT privilege can name the grantor of that privilege.
- An ID with SYSCTRL or SYSADM authority can name any authorization ID on a BIND command, but not on a REBIND command.

If you omit the OWNER option, your primary ID becomes the owner on BIND, and the previous owner retains ownership on REBIND.

Some systems that can bind a package at a DB2 system do not support the OWNER option. When the OWNER option is not supported, the primary authorization ID is always the owner of the package because a secondary ID cannot be named as the owner.

Related reference:

"Establishing plan and package ownership in a trusted context"

Establishing plan and package ownership in a trusted context

You can issue the BIND and REBIND commands in a trusted context with the ROLE AS OBJECT OWNER clause to specify the ownership of a plan or package. In this trusted context, you can specify only a role, not an authorization ID, as the OWNER of a plan or package.

GUPI If you specify the OWNER option, the specified role becomes the owner of the plan or package. If you don't specify the OWNER option, the role that is associated with the binder becomes the owner. If the ROLE AS OBJECT OWNER clause is omitted for the trusted context, the current rules for plan and package ownership apply.

Considerations: If you want a role to own the package at the remote DB2, you need to define the role ownership in the trusted context at the remote server. Make sure to establish the connection to the remote DB2 as trusted when binding or re-binding the package at the remote server.

If you specify the OWNER option in a trusted connection during the remote BIND processing, the outbound authorization ID translation is not performed for the OWNER.

If the plan owner is a role and the application uses a package bound at a remote DB2 for z/OS server, the privilege of the plan owner to execute the package is not

considered at the remote DB2 server. The privilege set of the authorization ID (either the package owner or the process runner determined by the DYNAMICRULES behavior) at the DB2 for z/OS server must have the EXECUTE privilege on the package at the DB2 server. GUPI

Related concepts:

"Trusted contexts" on page 219

Related tasks:

"Establishing or changing plan or package ownership" on page 81

Related reference:

"Ownership of objects within a trusted context" on page 79

How DB2 resolves unqualified names

A plan or package can contain SQL statements that use unqualified table and view names.

GUPI For static SQL, the default qualifier for those names is the owner of the plan or package. However, you can use the QUALIFIER option of the BIND command to specify a different qualifier. For static statements, the PATH bind option determines the path that DB2 searches to resolve unqualified distinct types, user-defined functions, stored procedures, sequences, and trigger names.

When you perform bind operations on packages or plans that contain static SQL, you should use group and ROLE authority rather than individual ID authority whenever possible. The combinations of OWNER, QUALIFIER, SCHEMA, and ROLE ownership provide you more flexibility.

For plans or packages that contain dynamic SQL, DYNAMICRULES behavior determines how DB2 qualifies unqualified object names. For unqualified distinct types, user-defined functions, stored procedures, sequences, and trigger names in dynamic SQL statements, DB2 uses the schema name as the qualifier. DB2 finds the schema name in the CURRENT PATH special register. For unqualified tables, views, aliases, and indexes, DB2 uses the CURRENT SCHEMA special register as the qualifier.

Exception: ALTER, CREATE, DROP, COMMENT ON, GRANT, and REVOKE statements follow different conventions for assigning qualifiers. For static SQL, you must specify the qualifier for these statements in the QUALIFIER bind option. For dynamic SQL, the qualifier for these statements is the value in the CURRENT SCHEMA special register. GUPI

Validating authorization for executing plans or packages

You can use the VALIDATE option to control how DB2 handles existence and authorization errors.

About this task

GUPI The owner of a plan or package must have authorization to execute all static SQL statements that are embedded in the plan or package. A bind operation always checks whether a local object exists and whether the owner has the required privileges on it. However, you do not need to have the authorization when the plan or package is bound. The objects to which the plan or package refers do not even need to exist at bind time. If the initial checking fails, an error

message is returned. You can choose whether the failure prevents the bind operation from completion by using the VALIDATE option on the BIND PLAN and BIND PACKAGE commands.

The following values for the VALIDATE option determine how DB2 is to handle existence and authorization errors:

RUN If you choose RUN for the VALIDATE option, the bind succeeds even when existence or authorization errors exist. DB2 checks existence and authorization at run time.

BIND If you choose BIND for the VALIDATE option, which is recommended, the bind fails when existence or authorization errors exist. **Exception:** If you use the SQLERROR(CONTINUE) option on the BIND PACKAGE command, the bind succeeds, but the package's SQL statements that have errors cannot execute.

The corresponding existence and authorization checks for remote objects are always made at run time. Authorization to execute dynamic SQL statements is also checked at run time. Applications that use the Resource Recovery Services attachment facility (RRSAF) to connect to DB2 do not require a plan. GUPI

Checking authorization at a DB2 database server:

A remote requester, either a DB2 for z/OS server or other requesting system, runs a package at the DB2 intermediate server. DB2 checks for the privileges that are required for service requests.

About this task

GUPI As shown in the following diagram, a statement in the package uses an alias or a three-part name to request services from a DB2 database server.

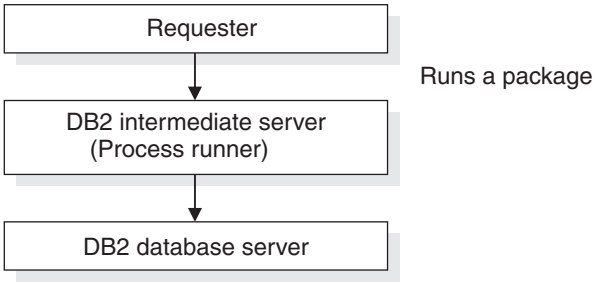


Figure 5. Execution at a second DB2 server

The ID that is checked for the required privileges to run at the DB2 database server can be:

- The owner of the plan, if not a role, that is running at the requester site (if the requester is DB2 for z/OS)

  If the owner of the plan is a role and the application uses a package bound at a remote DB2 for z/OS server, the authorization ID at the DB2 for z/OS server must have the EXECUTE privilege on the package at the DB2 server. The authorization ID can be the package owner or the process runner that is determined by the DYNAMICRULES behavior.
- The owner of the package that is running at the DB2 server

In addition, if a remote alias is used in the SQL statement, the alias must be defined at the requester site. The ID that is used depends on the following factors:

- Whether the requester is a DB2 for z/OS server or a different system
- The value of the DYNAMICRULES bind option
- Whether the SQL statement that is executed at the DB2 database server is static or dynamic

Checking authorization for executing an RRSAF application without a plan:

RRSAF provides the capability for an application to connect to DB2 and run without a DB2 plan.

About this task

If an RRSAF application does not have a plan, the following authorization rules are true:

- For the following types of packages, the primary or secondary authorization ID and role of the process are used for checking authorization to execute the package:
  - A local package
  - A remote package that is on a DB2 for z/OS system and is accessed using DRDA
- At a DB2 for z/OS system, the authorization to execute the DESCRIBE TABLE statement includes checking the primary and secondary authorization IDs.
- For a double hop situation, the authorization ID that must hold the required privileges to execute SQL statements at the second server is determined as if the requester is not a DB2 for z/OS system.

Caching authorization IDs for better performance

You can specify that DB2 is to cache authorization IDs for plans, packages, or routines (user-defined functions and stored procedures). Caching IDs can help improve performance, especially when IDs are frequently reused.

One cache exists for each plan, one global cache exists for packages, and a global cache exists for routines. The global cache for packages and routines are allocated at the DB2 startup. For a data sharing group, each member does its own authorization caching.

Caching authorization IDs for plans:

Authorization checking is fastest when the plan is reused by an ID or role that already appears in the cache and when the EXECUTE privilege is granted to PUBLIC.

About this task

You can set the size of the plan authorization cache by using the BIND PLAN subcommand. The default cache size is specified by an installation option, with an initial default setting of 3072 bytes.

Caching authorization IDs for packages:

DB2 authorization can cache roles or primary authorization IDs for handling packages. DB2 checks and caches a role if it is in effect and authorized. If a role is not in effect or authorized, DB2 checks and caches the primary authorization ID.

About this task

Caching roles or authorization IDs for packages can provide benefits for handling the following objects at run time:

- Stored procedures
- Remotely bound packages
- Local packages in a package list in which the plan owner does not have execute authority on the package at bind time, but does at run time
- Local packages that are not explicitly listed in a package list, but are implicitly listed by *collection-id.**, *.*, or **.package-id*

You can set the size of the package authorization cache by using the PACKAGE AUTH CACHE field on the DSNTIPP installation panel. The default value, 5 MB, is enough storage to support about 690 *collection-id.package-id* entries or *collection-id.** entries.

You can cache more package authorization information by using any of the following strategies:

- Granting package execute authority to *collection.**
- Increasing the size of the cache
- Granting package authority to a secondary ID or role when running in a trusted context
- Granting package execute authority to PUBLIC for some packages or collections

PSPI The QTPACAUT field in the package accounting trace indicates how often DB2 succeeds at reading package authorization information from the cache. PSPI

Related reference:

"Caching of EXECUTE on plans, packages, and routines" on page 267

Caching authorization IDs for routines:

DB2 authorization can cache roles or primary authorization IDs for handling routines. DB2 checks and caches a role if it is in effect and authorized. If a role is not in effect or authorized, DB2 checks and caches the primary authorization ID.

About this task

The routine authorization cache stores roles or authorization IDs with the EXECUTE privilege on a specific routine. A routine is identified as *schema.routine-name.type*, where the routine name is one of the following names:

- The specific function name for user-defined functions
- The procedure name for stored procedures
- '*' for all routines in the schema

You can set the size of the routine authorization cache by using the ROUTINE AUTH CACHE field on the DSNTIPP installation panel. The initial default size of 5 MB is enough storage to support about 690*schema.routine.type* or *schema.*.type*entries.

You can cache more authorization information about routines by using the following strategies:

- Granting EXECUTE on *schema.**
- Increasing the size of the cache
- Granting package authority to a secondary ID or role when running in a trusted context
- Granting routine execute authority to PUBLIC for some or all routines in the schema.

Related reference:

"Caching of EXECUTE on plans, packages, and routines" on page 267

Authorizing plan or package access through applications

Because an ID executes a package or plan by running an application program, implementing control measures in an application program can be useful.

About this task

Example: Consider the following SQL statement:

GUPI

```
EXEC SQL
  SELECT * INTO :EMPREC FROM DSN8B10.EMP
    WHERE EMPNO='000010';
```

GUPI

The statement permits access to the row of the employee table WHERE EMPNO='000010'. If you replace the value 000010 with a host variable, the program could supply the value of the variable and permit access to various employee numbers. Routines in the program could limit that access to certain IDs, certain times of the day, certain days of the week, or other special circumstances.

Stored procedures provide an alternative to controls in the application. By encapsulating several SQL statements into a single message to the DB2 server, a stored procedure can protect sensitive portions of the application program. Also, stored procedures can include access to non-DB2 resources, as well as DB2.

Recommendation: Do not use programs to extend security. Whenever possible, use other techniques, such as stored procedures or views, as a security mechanism. Using programs to extend security has the following drawbacks:

- Program controls are separate from other access controls, can be difficult to implement properly, are difficult to audit, and are relatively simple to bypass.
- Almost any debugging facility can be used to bypass security checks in a program.
- Other programs might use the plan without doing the needed checking.
- Errors in the program checks might allow unauthorized access.
- Because the routines that check security might be quite separate from the SQL statement, the security check could be entirely disabled without requiring a bind operation for a new plan.
- A BIND REPLACE operation for an existing plan does not necessarily revoke the existing EXECUTE privileges on the plan. (Revoking those privileges is the

default, but the plan owner has the option to retain them. For packages, the EXECUTE privileges are always retained.)

For those reasons, if the program accesses any sensitive data, the EXECUTE privileges on the plan and on packages are also sensitive. They should be granted only to a carefully planned list of IDs.

Restricting access of plans or packages to particular systems:

If you use controls in an application program, you can limit the access of a plan or package to the particular systems for which the application program is designed.

About this task

GUPI DB2 does not ensure that only specific programs are used with a plan, but program-to-plan control can be enforced in IMS and CICS. DB2 provides a consistency check to avoid accidental mismatches between program and plan, but the consistency check is not a security check.

You can use the the ENABLE and DISABLE options on the BIND and REBIND subcommands to restrict access of plans and packages to a particular system.

Example: The ENABLE IMS option allows the plan or package to run from any IMS connection. Unless other systems are also named, ENABLE IMS does not allow the plan or package to run from any other type of connection.

Example: DISABLE BATCH prevents a plan or package from running through a batch job, but it allows the plan or package to run from all other types of connection.

You can exercise even finer control with the ENABLE and DISABLE options. You can enable or disable particular IMS connection names, CICS application IDs, requesting locations, and so forth. GUPI

Authorization checking for executing packages:

If PKLIST is specified in the BIND and REBIND options and the *location.collection* is an asterisk (*), DB2 defers the package authorization check until run time. Make sure that you use a specific location name or omit this part of the identifier if you do not want the package authorization check deferred until run time.

GUPI If you execute the packages remotely, make sure that the privileges required for a remote bind (BIND PACKAGE *location.collection*) are granted at the server location. The ID that owns the package must have all of the privileges that are required to run the package at the server, and BINDADD[2] and CREATE IN privileges at the server.

Exceptions:

- For a BIND COPY operation, the owner must have the COPY privilege at the local DB2 site or subsystem, where the package that is being copied resides.

2. Or BIND, depending on the installation option BIND NEW PACKAGE.

- If the creator of the package is not the owner, the creator must have SYSCTRL authority or higher, or must have been granted the BINDAGENT privilege by the owner. That authority or privilege is granted at the local DB2.

Binding a plan with a package list (BIND PLAN PKLIST) is done at the local DB2, and bind privileges must be held there. Authorization to execute a package at a remote location is checked at execution time, as follows:

- If the server is a DB2 for z/OS subsystem:
  - If the subsystem parameter PRIVATE_PROTOCOL is set to NO, the authorization ID of the process (primary ID or any secondary ID) must have the EXECUTE privilege for the package at the DB2 server.
  - If subsystem parameter PRIVATE_PROTOCOL is set to AUTH, the owner of the plan at the DB2 requester must have the EXECUTE privilege on the package at the DB2 server.
- If the server is not DB2 for z/OS, the primary authorization ID must have whatever privileges are needed. Check that product's documentation. GUPI

Managing implicit privileges through routines

You can control authorization checking by using a DB2-supplied exit routine or an exit routine that you write. You can use the access control authorization routine to control authorization checking.

Privileges required for executing routines

A number of steps are involved in implementing, defining, and invoking user-defined functions and stored procedures, which are also called *routines*.

GUPI The following table summarizes the common tasks and the privileges that are required for executing routines.

Table 22. Common tasks and required privileges for routines

Role	Tasks	Required privileges
Implementer	If SQL is in the routine: codes, precompiles, compiles, and link-edits the program to use as the routine. Binds the program as the routine package. If no SQL is in the routine: codes, compiles, and link-edits the program.	If binding a package, BINDADD system privilege and CREATE IN on the collection.
Definer	Issues a CREATE FUNCTION statement to define a user-defined function or CREATE PROCEDURE statement to define a stored procedure.	CREATEIN privilege on the schema. EXECUTE authority on the routine package when invoked.
Invoker	Invokes a routine from an SQL application.	EXECUTE authority on the routine.

The routine *implementer* typically codes the routine in a program and precompiles the program. If the program contains SQL statements, the implementer binds the DBRM. In general, the authorization ID that binds the DBRM into a package is the package owner. The implementer is the routine package owner. As package owner, the implementer implicitly has EXECUTE authority on the package and has the authority to grant EXECUTE privileges to other users to execute the code within the package.

The implementer grants EXECUTE authority on the routine package to the definer. EXECUTE authority is necessary only if the package contains SQL. For

user-defined functions, the definer requires EXECUTE authority on the package. For stored procedures, the EXECUTE privilege on the package is checked for the definer and other IDs.

The routine *definer* owns the routine. The definer issues a CREATE FUNCTION statement to define a user-defined function or a CREATE PROCEDURE statement to define a stored procedure. The definer of a routine is determined as follows:

- If the SQL statement is embedded in an application program, the definer is the authorization ID of the owner of the plan or package.
- If the SQL statement is dynamically prepared, the definer is the SQL authorization ID that is contained in the CURRENT SQLID special register. If the SQL statement is executed in a trusted context that is specified with the ROLE AS OBJECT OWNER clause, the definer is the role in effect.

The definer grants EXECUTE authority on the routine to the invoker, that is, any user that needs to invoke the routine.

The routine *invoker* invokes the routine from an SQL statement in the invoking plan or package. The invoker for a routine is determined as follows:

- For a static statement, the invoker is the plan or package owner.
- For a dynamic statement, the invoker depends on DYNAMICRULES behavior.

GUPI

Granting privileges through routines

You can grant users the required privileges for implementing, defining, and using a user-defined function through exit routines.

Implementing a user-defined function:

You can code an application program to implement a user-defined function.

Procedure

GUPI To implement a user-defined function:

1. The implementer codes a program that implements the user-defined function. Assume that the implementer codes the following external user-defined function in C and names the function C_SALARY:

```
/*********************************************************************
* This routine accepts an employee serial number and a percent raise. *
* If the employee is a manager, the raise is not applied.  Otherwise, *
* the new salary is computed, truncated if it exceeds the employee's  *
* manager's salary, and then applied to the database.                 *
*********************************************************************/
 void C_SALARY                          /* main routine               */
 ( char       *employeeSerial           /* in: employee serial no.    */
   decimal    *percentRaise             /* in: percentage raise       */
   decimal    *newSalary,               /* out: employee's new salary */
   short int  *niEmployeeSerial         /* in: indic var, empl ser    */
   short int  *niPercentRaise           /* in: indic var, % raise     */
   short int  *niNewSalary,             /* out: indic var, new salary */
   char       *sqlstate,                /* out: SQLSTATE              */
   char       *fnName,                  /* in: family name of function*/
   char       *specificName,            /* in: specific name of func  */
   char       *message                  /* out: diagnostic message    */
 )
 {
   EXEC SQL BEGIN DECLARE SECTION;
```

```
char        hvEMPNO-7-;             /* host var for empl serial   */
decimal     hvSALARY;               /* host var for empl salary   */
char        hvWORKDEPT-3-;          /* host var for empl dept no. */
decimal     hvManagerSalary;        /* host var,emp's mgr's salary*/
EXEC SQL END DECLARE SECTION;

sqlstate = 0;
memset( message,0,70 );
/*****************************************************************
* Copy the employee's serial into a host variable                *
*****************************************************************/
strcpy( hvEMPNO,employeeSerial );
/*****************************************************************
* Get the employee's work department and current salary          *
*****************************************************************/
EXEC SQL SELECT  WORKDEPT, SALARY
           INTO :hvWORKDEPT, :hvSALARY
           FROM  EMP
          WHERE  EMPNO = :hvEMPNO;
/*****************************************************************
* See if the employee is a manager                               *
*****************************************************************/
EXEC SQL SELECT  DEPTNO
           INTO :hvWORKDEPT
           FROM  DEPT
          WHERE  MGRNO = :hvEMPNO;
/*****************************************************************
* If the employee is a manager, do not apply the raise           *
*****************************************************************/
if( SQLCODE == 0 )
  {
    newSalary = hvSALARY;
  }
/*****************************************************************
* Otherwise, compute and apply the raise such that it does not   *
* exceed the employee's manager's salary                         *
*****************************************************************/
else
  {
    /*************************************************************
    * Get the employee's manager's salary                        *
    *************************************************************/
    EXEC SQL SELECT  SALARY
               INTO :hvManagerSalary
               FROM  EMP
              WHERE  EMPNO = (SELECT MGRNO
                                FROM DSN8610.DEPT
                               WHERE DEPTNO = :hvWORKDEPT);
    /*************************************************************
    * Compute proposed raise for the employee                    *
    *************************************************************/
    newSalary = hvSALARY * (1 + percentRaise/100);
    /*************************************************************
    * Don't let the proposed raise exceed the manager's salary   *
    *************************************************************/
    if( newSalary > hvManagerSalary
      newSalary = hvManagerSalary;
    /*************************************************************
    * Apply the raise                                            *
    *************************************************************/
    hvSALARY = newSalary;
    EXEC SQL UPDATE  EMP
                SET  SALARY = :hvSALARY
              WHERE  EMPNO  = :hvEMPNO;
```

```
    }

  return;
} /* end C_SALARY */
```

The implementer requires the UPDATE privilege on table EMP. Users with the EXECUTE privilege on function C_SALARY do not need the UPDATE privilege on the table.

2. Because this program contains SQL, the implementer performs the following steps:
   a. Precompile the program that implements the user-defined function.
   b. Link-edit the user-defined function with DSNRLI (RRS attachment facility), and name the program's load module C_SALARY.
   c. Bind the DBRM into package MYCOLLID.C_SALARY.

   After performing these steps, the implementer is the *function package owner.*
3. The implementer then grants EXECUTE privilege on the user-defined function package to the definer.

```
GRANT EXECUTE ON PACKAGE MYCOLLID.C_SALARY
 TO definer
```

   As package owner, the implementer can grant execute privileges to other users, which allows those users to execute code within the package. For example:

```
GRANT EXECUTE ON PACKAGE MYCOLLID.C_SALARY
      TO other_user
```

GUPI

Defining a user-defined function:

You can define a user-defined function to perform specific operations by issuing the CREATE FUNCTION statement.

Procedure

GUPI To define a user-defined function:

1. Issue the CREATE FUNCTION statement. For example, the following CREATE FUNCTION statement defines the user-defined function SALARY_CHANGE to DB2:

```
CREATE FUNCTION
  SALARY_CHANGE(
    VARCHAR( 6 )
    DECIMAL( 5,2 ) )
  RETURNS
    DECIMAL( 9,2 )
  SPECIFIC schema.SALCHANGE
  LANGUAGE C
  DETERMINISTIC
  MODIFIES SQL DATA
  EXTERNAL NAME C_SALARY
  PARAMETER STYLE DB2SQL
  RETURNS NULL ON NULL CALL
  NO EXTERNAL ACTION
  NO SCRATCHPAD
  NO FINAL CALL
  ALLOW PARALLEL
  NO COLLID
  ASUTIME LIMIT 1
  STAY RESIDENT NO
```

```
PROGRAM TYPE SUB
WLM ENVIRONMENT WLMENV
SECURITY DB2
NO DBINFO;
```

After issuing the CREATE FUNCTION statement, the person who defined the function owns the user-defined function. This person (the definer) can execute the user-defined function package. In this case, the owner of the user-defined function package (the implementer) granted to the definer the EXECUTE privilege on the package that contains the user-defined function.

2. The definer grants the EXECUTE privilege on SALARY_CHANGE to all function invokers.

```
GRANT EXECUTE ON FUNCTION SALARY_CHANGE
   TO invoker1, invoker2, invoker3, invoker4
```

GUPI

Using a user-defined function:

The invoker of a user-defined function need to perform a sequence of tasks to use the user-defined function.

About this task

1. GUPI The invoker codes an application program, named SALARY_ADJ. The application program contains a static SQL statement that invokes the user-defined function SALARY_CHANGE. SALARY_CHANGE gives an employee a 10% raise if the employee is not a manager. The static SQL statement follows:

```
EXEC SQL SELECT  FIRSTNME,
                 LASTNAME
                 SALARY_CHANGE( :hvEMPNO, 10.0 )
           INTO :hvFIRSTNME,
                :hvLASTNAME,
                :hvSALARY
           FROM  EMP
          WHERE  EMPNO = :hvEMPNO;
```

2. The invoker then precompiles, compiles, link-edits, and binds the invoking application's DBRM into the *invoking package*. An invoking package or invoking plan is the package or plan that contains the SQL that invokes the user-defined function. After performing these steps, the invoker is the owner of the invoking plan or package.

   Restriction: The invoker must hold the SELECT privilege on the table EMP and the EXECUTE privilege on the function SALARY_CHANGE.

GUPI

Authorization ID validation:

DB2 uses the rules for static SQL to determine the authorization ID (invoker) that executes the user-defined function package. For a static statement, the invoker is the authorization ID of the plan or package owner.

GUPI The invoking package SALARY_ADJ contains a static SQL SELECT statement that invokes the user-defined function SALARY_CHANGE.

- While execution occurs in invoking package SALARY_ADJ, DB2 uses the authorization ID of the invoker (the package owner).

  The invoker requires the EXECUTE privilege on the user-defined function SALARY_CHANGE, which the package SALARY_ADJ invokes. Because the user-defined function definer has the EXECUTE privilege on the user-defined function package C_SALARY, the invoker does not require the explicit EXECUTE privilege.
- When execution changes to the user-defined function package C_SALARY, DB2 uses the authorization ID of the implementer (the package owner). The package owner is the authorization ID with authority to execute all static SQL in the user-defined function package C_SALARY. GUPI

Authorization behaviors for dynamic SQL statements

The two key factors that influence authorization behaviors are the DYNAMICRULES value and the run time environment of a package. The combination of the DYNAMICRULES value and the run time environment determine the values for the dynamic SQL attributes. Those attribute values are called the *authorization behaviors*.

GUPI The DYNAMICRULES option on the BIND or REBIND command determines the values that apply at run time for the following dynamic SQL attributes:

- The authorization ID or role that is used to check authorization
- The qualifier that is used for unqualified objects
- The source for application programming options that DB2 uses to parse and semantically verify dynamic SQL statements

The DYNAMICRULES option also determines whether dynamic SQL statements can include GRANT, REVOKE, ALTER, CREATE, DROP, and RENAME statements.

In addition to the DYNAMICRULES value, the run time environment of a package controls how dynamic SQL statements behave at run time. The two possible run time environments are:

- The package runs as part of a stand-alone program.
- The package runs as a stored procedure or user-defined function package, or runs under a stored procedure or user-defined function.

  A package that runs under a stored procedure or user-defined function is a package whose associated program meets one of the following conditions:
  - The program is called by a stored procedure or user-defined function.
  - The program is in a series of nested calls that start with a stored procedure or user-defined function. GUPI

Run behavior:

DB2 processes dynamic SQL statements by using their standard attribute. These attributes are collectively called the *run behavior*.

The run behavior consists of the following attributes:

- GUPI DB2 uses the authorization IDs (primary, secondary and the current SQL ID) of the application process to check for authorization of dynamic SQL statements. It also checks the role in effect if running in a trusted context.

- Dynamic SQL statements use the values of application programming options that were specified during installation. The installation option USE FOR DYNAMICRULES has no effect.
- The GRANT, REVOKE, CREATE, ALTER, DROP, and RENAME statements can be executed dynamically. GUPI

Related concepts:

"Bind behavior"

"Define behavior"

"Invoke behavior" on page 95

Related reference:

"Common attribute values for bind, define, and invoke behaviors" on page 95

Bind behavior:

DB2 uses the bind behavior to process dynamic SQL statements.

GUPI The bind behavior consists of the following attributes:

- DB2 uses the authorization ID or role of the plan or package for authorization checking of dynamic SQL statements.
- Unqualified table, view, index, and alias names in dynamic SQL statements are implicitly qualified by the default schema, which is the value of the bind option QUALIFIER. If you do not specify the QUALIFIER bind option, DB2 uses the plan or package owner as the qualifier.

  The values of the authorization ID or role and the qualifier for unqualified objects are the same as those that are used for embedded or static SQL statements.
- The bind behavior consists of the common attribute values for bind, define, and invoke behaviors. GUPI

Related concepts:

"Run behavior" on page 93

"Define behavior"

"Invoke behavior" on page 95

Related reference:

"Common attribute values for bind, define, and invoke behaviors" on page 95

Define behavior:

When the package is run as or under a stored procedure or a user-defined function package, DB2 processes dynamic SQL statements by using the define behavior.

GUPI The define behavior consists of the following attribute values:

- DB2 uses the authorization ID or role of the user-defined function or the stored procedure owner for authorization checking of dynamic SQL statements in the application package.
- The default qualifier for unqualified objects is the user-defined function or the stored procedure owner.
- Define behavior consists of the common attribute values for bind, define, and invoke behaviors.

When the package is run as a stand-alone program, DB2 processes dynamic SQL statements using bind behavior or run behavior, depending on the DYNAMICRULES value specified. GUPI

Related concepts:

"Run behavior" on page 93

"Bind behavior" on page 94

"Invoke behavior"

Related reference:

"Common attribute values for bind, define, and invoke behaviors"

Invoke behavior:

When the package is run as, or runs under, a stored procedure or a user-defined function package, DB2 processes dynamic SQL statements by using the invoke behavior.

GUPI The invoke behavior consists of the following attribute values:

- DB2 uses the authorization ID of the user-defined function or the stored procedure invoker to check the authorization for dynamic SQL statements in the application package. It uses the following rules:
  - The current SQL ID of the invoker is checked for the required authorization.
  - Secondary authorization IDs and roles that are associated with the primary authorization ID are also checked if they are needed for the required authorization.
- The default qualifier for unqualified objects is the user-defined function or the stored procedure invoker.
- Invoke behavior consists of the common attribute values for bind, define, and invoke behaviors.

When the package is run as a stand-alone program, DB2 processes dynamic SQL statements using bind behavior or run behavior, depending on the DYNAMICRULES specified value. GUPI

Related concepts:

"Run behavior" on page 93

"Bind behavior" on page 94

"Define behavior" on page 94

Related reference:

"Common attribute values for bind, define, and invoke behaviors"

Common attribute values for bind, define, and invoke behaviors:

Certain attribute values apply to dynamic SQL statements in plans or packages that specify the bind, define, or invoke behavior.

The following attribute values apply:

- GUPI You can execute the statement SET CURRENT SQLID in a package or plan that is bound with any DYNAMICRULES value. However, DB2 does not use the current SQL ID as the authorization ID for dynamic SQL statements.

DB2 always uses the current SQL ID as the qualifier for the EXPLAIN output PLAN_TABLE.

- If the value of installation option USE FOR DYNAMICRULES is YES, DB2 uses the application programming default values that were specified during installation to parse and semantically verify dynamic SQL statements. If the value of USE for DYNAMICRULES is NO, DB2 uses the precompiler options to parse and semantically verify dynamic SQL statements.
- The GRANT, REVOKE, CREATE, ALTER, DROP, and RENAME statements cannot be executed dynamically.

The following table shows the DYNAMICRULES values and run time environments, and the dynamic SQL behaviors that they yield.

Table 23. How DYNAMICRULES and the run time environment determine dynamic SQL statement behavior

DYNAMICRULES value	Dynamic SQL statements in a stand-alone program environment	Dynamic SQL statements in a user-defined function or stored procedure environment
BIND	Bind behavior	Bind behavior
RUN	Run behavior	Run behavior
DEFINEBIND	Bind behavior	Define behavior
DEFINERUN	Run behavior	Define behavior
INVOKEBIND	Bind behavior	Invoke behavior
INVOKERUN	Run behavior	Invoke behavior

The following table shows the dynamic SQL attribute values for each type of dynamic SQL behavior.

Table 24. Definitions of dynamic SQL statement behaviors

Dynamic SQL attribute	Bind behavior	Run behavior	Define behavior	Invoke behavior
Authorization ID	Plan or package owner	Authorization IDs of the process and role, if applicable	User-defined function or stored procedure owner	Authorization ID of invoker [1]
Default qualifier for unqualified objects	Bind OWNER or QUALIFIER value	Current Schema register determines the qualifier	User-defined function or stored procedure owner	Authorization ID of invoker or role
CURRENT SQLID [2]	Not applicable	Applies	Not applicable	Not applicable
Source for application programming options	Determined by *dsnhdecp*[3] parameter DYNRULS [4]	Install panel DSNTIPF	Determined by *dsnhdecp*[3] parameter DYNRULS [4]	Determined by *dsnhdecp*[3] parameter DYNRULS [4]
Can execute GRANT, REVOKE, CREATE, ALTER, DROP, RENAME?	No	Yes	No	No

1. If the invoker is the primary authorization ID of the process or the current SQL ID, the following rules apply:
   - The ID or role of the invoker is checked for the required authorization.
   - Secondary authorization IDs are also checked if they are needed for the required authorization.
2. DB2 uses the current SQL ID as the authorization ID for dynamic SQL statements only for plans and packages that have DYNAMICRULES run

behavior. For the other dynamic SQL behaviors, DB2 uses the authorization ID that is associated with each dynamic SQL behavior, as shown in this table.

The initial current SQL ID is independent of the dynamic SQL behavior. For stand-alone programs, the current SQL ID is initialized to the primary authorization ID.You can execute the SET CURRENT SQLID statement to change the current SQL ID for packages with any dynamic SQL behavior, but DB2 uses the current SQL ID only for plans and packages with run behavior.

3. *dsnhdecp* is the application default load module. The default name is DSNHDECP.
4. The value of *dsnhdecp* parameter DYNRULS, which you specify in field USE FOR DYNAMICRULES in installation panel DSNTIPF, determines whether DB2 uses the precompiler options or the application programming defaults for dynamic SQL statements. GUPI

Related concepts:

"Run behavior" on page 93

"Bind behavior" on page 94

"Define behavior" on page 94

"Invoke behavior" on page 95

Determining authorization IDs for dynamic SQL statements in routines:

You can determine the authorization IDs under which dynamic SQL statements in routines run based on various factors. These factors include the ownership of the stored procedure or the stored procedure package.

GUPI Suppose that A is a stored procedure and C is a program that is neither a user-defined function nor a stored procedure. Also suppose that subroutine B is called by both stored procedure A and program C. Subroutine B, which is invoked by a language call, is neither a user-defined function nor a stored procedure. AP is the package that is associated with stored procedure A, and BP is the package that is associated with subroutine B. A, B, and C execute as shown in the following diagram.

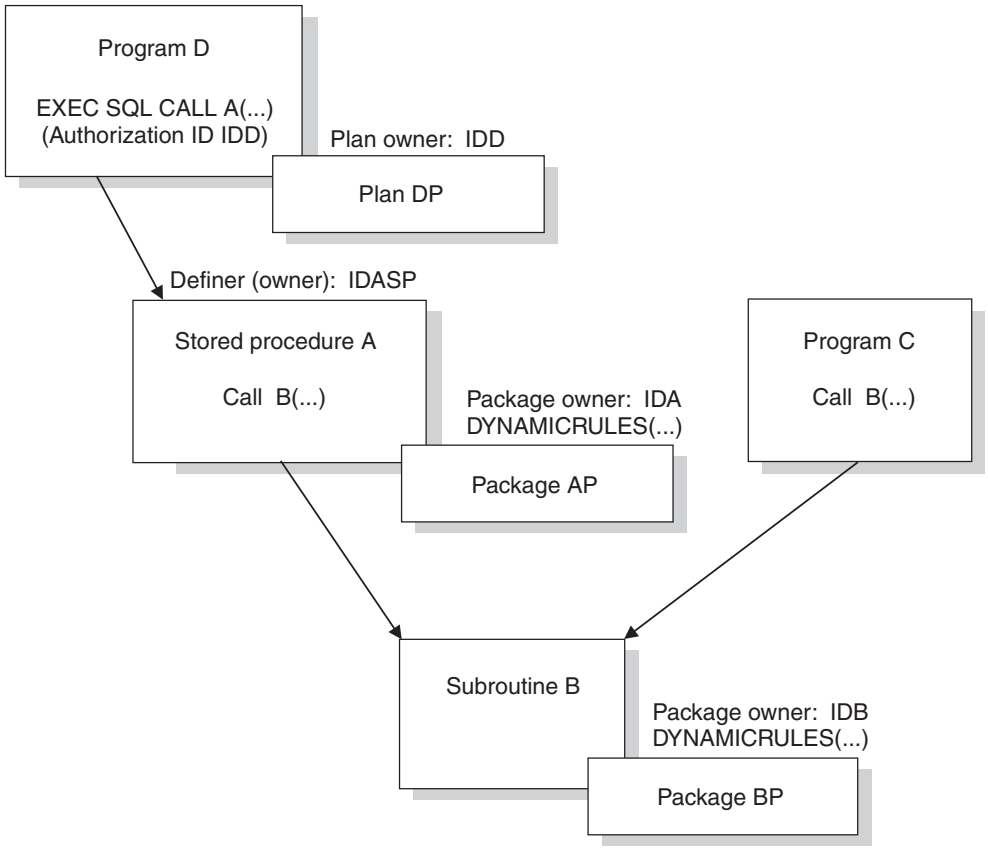


Figure 6. Authorization for dynamic SQL statements in programs and routines

Stored procedure A was defined by IDASP and is therefore owned by IDASP. The stored procedure package AP was bound by IDA and is therefore owned by IDA. Package BP was bound by IDB and is therefore owned by IDB. The authorization ID under which EXEC SQL CALL A runs is IDD, the owner of plan DP.

The authorization ID under which dynamic SQL statements in package AP run is determined in the following way:

- If package AP uses DYNAMICRULES bind behavior, the authorization ID for dynamic SQL statements in package AP is IDA, the owner of package AP.
- If package AP uses DYNAMICRULES run behavior, the authorization ID for dynamic SQL statements in package AP is the value of CURRENT SQLID when the statements execute.
- If package AP uses DYNAMICRULES define behavior, the authorization ID for dynamic SQL statements in package AP is IDASP, the definer (owner) of stored procedure A.
- If package AP uses DYNAMICRULES invoke behavior, the authorization ID for dynamic SQL statements in package AP is IDD, the invoker of stored procedure A.

The authorization ID under which dynamic SQL statements in package BP run is determined in the following way:

- If package BP uses DYNAMICRULES bind behavior, the authorization ID for dynamic SQL statements in package BP is IDB, the owner of package BP.

- If package BP uses DYNAMICRULES run behavior, the authorization ID for dynamic SQL statements in package BP is the value of CURRENT SQLID when the statements execute.
- If package BP uses DYNAMICRULES define behavior:
  - When subroutine B is called by stored procedure A, the authorization ID for dynamic SQL statements in package BP is IDASP, the definer of stored procedure A.
  - When subroutine B is called by program C:
    - If package BP uses the DYNAMICRULES option DEFINERUN, DB2 executes package BP using DYNAMICRULES run behavior, which means that the authorization ID for dynamic SQL statements in package BP is the value of CURRENT SQLID when the statements execute.
    - If package BP uses the DYNAMICRULES option DEFINEBIND, DB2 executes package BP using DYNAMICRULES bind behavior, which means that the authorization ID for dynamic SQL statements in package BP is IDB, the owner of package BP.
- If package BP uses DYNAMICRULES invoke behavior:
  - When subroutine B is called by stored procedure A, the authorization ID for dynamic SQL statements in package BP is IDD, the authorization ID under which EXEC SQL CALL A executed.
  - When subroutine B is called by program C:
    - If package BP uses the DYNAMICRULES option INVOKERUN, DB2 executes package BP using DYNAMICRULES run behavior, which means that the authorization ID for dynamic SQL statements in package BP is the value of CURRENT SQLID when the statements execute.
    - If package BP uses the DYNAMICRULES option INVOKEBIND, DB2 executes package BP using DYNAMICRULES bind behavior, which means that the authorization ID for dynamic SQL statements in package BP is IDB, the owner of package BP.

Now suppose that B is a user-defined function, as shown in the following diagram.

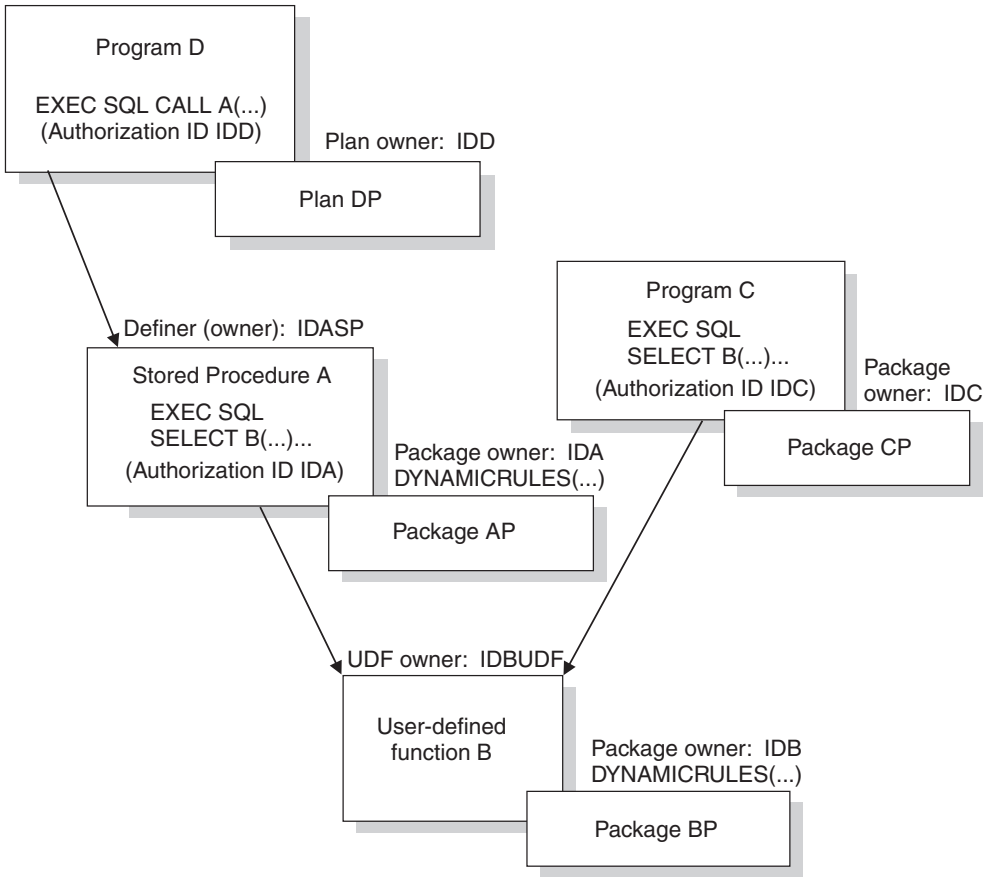


Figure 7. Authorization for dynamic SQL statements in programs and nested routines

User-defined function B was defined by IDBUDF and is therefore owned by ID IDBUDF. Stored procedure A invokes user-defined function B under authorization ID IDA. Program C invokes user-defined function B under authorization ID IDC. In both cases, the invoking SQL statement (EXEC SQL SELECT B) is static.

The authorization ID under which dynamic SQL statements in package BP run is determined in the following way:

- If package BP uses DYNAMICRULES bind behavior, the authorization ID for dynamic SQL statements in package BP is IDB, the owner of package BP.
- If package BP uses DYNAMICRULES run behavior, the authorization ID for dynamic SQL statements in package BP is the value of CURRENT SQLID when the statements execute.
- If package BP uses DYNAMICRULES define behavior, the authorization ID for dynamic SQL statements in package BP is IDBUDF, the definer of user-defined function B.
- If package BP uses DYNAMICRULES invoke behavior:
  - When user-defined function B is invoked by stored procedure A, the authorization ID for dynamic SQL statements in package BP is IDA, the authorization ID under which B is invoked in stored procedure A.
  - When user-defined function B is invoked by program C, the authorization ID for dynamic SQL statements in package BP is IDC, the owner of package CP, and is the authorization ID under which B is invoked in program C. GUPI

Related tasks:

"Simplifying access authorization for routines"

"Using composite privileges"

"Performing multiple actions in one statement" on page 102

Simplifying access authorization for routines:

You can simplify authorization for routines in several ways without violating any of the authorization standards at your installation.

About this task

GUPI Consider the following strategies to simplify authorization:

- Have the implementer bind the user-defined function package using DYNAMICRULES define behavior. With this behavior in effect, DB2 only needs to check the definer's ID to execute dynamic SQL statements in the routine. Otherwise, DB2 needs to check the many different IDs that invoke the user-defined function.
- If you have many different routines, group those routines into schemas. Then grant EXECUTE on the routines in the schema to the appropriate users. Users have execute authority on any functions that you add to that schema.

  Example: To grant the EXECUTE privilege on a schema to PUBLIC, issue the following statement:

  ```
  GRANT EXECUTE ON FUNCTION schemaname.* TO PUBLIC;
  ```

GUPI

Related reference:

"Determining authorization IDs for dynamic SQL statements in routines" on page 97

Using composite privileges:

SQL statements that name more than one object require privileges on all of the tables included in the statement.

About this task

GUPI An SQL statement can name more than one object. A SELECT operation, for example, can join two or more tables, or an INSERT statement can use a subquery. These operations require privileges on all of the tables that are included in the statement. However, you might be able to issue such a statement dynamically even though one of your IDs alone does not have all the required privileges.

If the DYNAMICRULES run behavior is in effect when the dynamic statement is prepared and your primary ID, any associated role, or any of your secondary IDs has all the needed privileges, the statement is validated. However, if you embed the same statement in a host program and try to bind it into a plan or package, the validation fails. The validation also fails for the dynamic statement if DYNAMICRULES bind, define, or invoke behavior is in effect when you issue the dynamic statement. In each case, all the required privileges must be held by the

single authorization ID, determined by DYNAMICRULES behavior. GUPI

Related reference:

"Determining authorization IDs for dynamic SQL statements in routines" on page 97

Performing multiple actions in one statement:

A REBIND or FREE subcommand can name more than one plan or package. If no owner is named, the set of privileges that is associated with the primary ID, the associated role, and the secondary IDs must include the BIND privilege for each object.

Example

GUPI Suppose that a user with a secondary ID of HQFINANCE has the BIND privilege on plan P1 and that another user with a secondary ID of HQHR has the BIND privilege on plan P2. Assume that someone with HQFINANCE and HQHR as secondary authorization IDs issues the following command:

```
REBIND PLAN(P1,P2)
```

P1 and P2 are successfully rebound, even though neither the HQFINANCE nor HQHR has the BIND privilege for both plans. GUPI

Related reference:

"Determining authorization IDs for dynamic SQL statements in routines" on page 97

Retrieving privilege records in the DB2 catalog

You can query the DB2 catalog tables by using the SQL SELECT statement. Executing the SQL statement requires appropriate privileges and authorities. You can control access to the catalog by granting and revoking these privileges and authorities.

Catalog tables with privilege records

An authorization ID can hold different privileges. DB2 records information about the privileges of an ID in catalog tables.

GUPI The following catalog tables contain information about the privileges that IDs can hold:

Table 25. Privileges information in DB2 catalog tables

Table name	Records privileges held for or authorization related to
SYSIBM.SYSCOLAUTH	Updating columns
SYSIBM.SYSDBAUTH	Databases
SYSIBM.SYSPLANAUTH	Plans
SYSIBM.SYSPACKAUTH	Packages
SYSIBM.SYSRESAUTH	Buffer pools, storage groups, collections, table spaces, JARs, and distinct types
SYSIBM.SYSROUTINEAUTH	User-defined functions and stored procedures
SYSIBM.SYSSCHEMAAUTH	Schemas

Table 25. Privileges information in DB2 catalog tables (continued)

Table name	Records privileges held for or authorization related to
SYSIBM.SYSTABAUTH	Tables and views
SYSIBM.SYSUSERAUTH	System authorities
SYSIBM.SYSSEQUENCEAUTH	Sequences
SYSIBM.SYSCONTEXT	Associating a role with a trusted context
SYSIBM.SYSCTXTTRUSTATTRS	Associating trust attributes with a trusted context
SYSIBM.SYSCONTEXTAUTHIDS	Associating users with a trusted context

GUPI

Retrieving all authorization IDs or roles with granted privileges

Catalog tables that contain authorization information include GRANTEE and GRANTEETYPE columns. Depending on the settings of these columns, you can modify the WHERE clause of the SELECT statement to retrieve all IDs or roles with the same privileges.

About this task

GUPI No single catalog table contains information about all privileges. If GRANTEETYPE is blank, the value of GRANTEE is the primary or secondary authorization ID that has been granted a privilege. If GRANTEETYPE is "L", the value of GRANTEE is a role.

To retrieve all IDs or roles with privileges, you can issue the SQL code as shown in the following example:

```
SELECT GRANTEE, 'PACKAGE ' FROM SYSIBM.SYSPACKAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'TABLE   ' FROM SYSIBM.SYSTABAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'COLUMN  ' FROM SYSIBM.SYSCOLAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'ROUTINE ' FROM SYSIBM.SYSROUTINEAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'PLAN    ' FROM SYSIBM.SYSPLANAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'SYSTEM  ' FROM SYSIBM.SYSUSERAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'DATABASE' FROM SYSIBM.SYSDBAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'SCHEMA  ' FROM SYSIBM.SYSSCHEMAAUTH
       WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'USER    ' FROM SYSIBM.SYSRESAUTH
```

```
      WHERE GRANTEETYPE IN (' ','L')
  UNION
SELECT GRANTEE, 'SEQUENCE ' FROM SYSIBM.SYSSEQUENCEAUTH
      WHERE GRANTEETYPE IN (' ','L');
```

Periodically, you should compare the list of IDs or roles that is retrieved by this SQL code with the following lists:

- Lists of users from subsystems that connect to DB2 (such as IMS, CICS, and TSO)
- Lists of RACF users and groups
- Lists of users from other DBMSs that access your DB2 subsystem
- Lists of remote connections.

If DB2 lists IDs or roles that do not exist elsewhere, you should revoke their privileges. GUPI

Retrieving multiple grants of the same privilege

You can query the catalog to find information about duplicate grants of the same privilege on objects. If multiple grant records clutter your catalog, consider revoking unnecessary grants, which removes duplicate grant data from the catalog.

Procedure

To retrieve duplicate grants on plans:

Issue the following SQL statement:

GUPI

```
SELECT GRANTEE, NAME, COUNT(*)
  FROM SYSIBM.SYSPLANAUTH
  GROUP BY GRANTEE, NAME
  HAVING COUNT(*) > 2
  ORDER BY 3 DESC;
```

GUPI

This statement orders the duplicate grants by frequency, so that you can easily identify the most duplicated grants. Similar statements for other catalog tables can retrieve information about multiple grants on other types of objects.
If several grantors grant the same privilege to the same grantee, the DB2 catalog can become cluttered with similar data. This similar data is often unnecessary, and it might cause poor performance.

Example

Example 1: Suppose that Judy, Kate, and Patti all grant the SELECT privilege on TABLE1 to Chris. If you care that Chris's ID has the privilege but not who granted the privilege, you might consider two of the SELECT grants to be redundant and unnecessary performance liabilities.

However, you might want to maintain information about authorities that are granted from several different IDs, especially when privileges are revoked.

Example 2: Suppose that the SELECT privilege from the previous example is revoked from Judy. If Chris has the SELECT privilege from only Judy, Chris loses the SELECT privilege. However, Chris retains the SELECT privilege because Kate

and Patti also granted the SELECT privilege to Chris. In this case, the similar grants prove not to be redundant.

Retrieving all authorization IDs or roles with the DBADM and system DBADM authorities

You can retrieve all authorization IDs or roles that have the DBADM and system DBADM authorities.

About this task

Issue the following statement to retrieve all authorization IDs or roles that have the DBADM authority:

GUPI

```
SELECT DISTINCT GRANTEE
  FROM SYSIBM.SYSDBAUTH
  WHERE DBADMAUTH <>' ' AND GRANTEETYPE IN (' ','L');
```

Issue the following statement to retrieve all authorization IDs or roles that have the system DBADM authority on specific databases in the DB2 system:

```
SELECT DISTINCT GRANTEE
  FROM SYSIBM.SYSUSERAUTH
  WHERE SDBADMAUTH <>' ' AND GRANTEETYPE IN (' ','L');
```

GUPI

Retrieving all IDs or roles with access to the same table

You can retrieve all IDs or roles (GRANTEETYPE="L") that are explicitly authorized to access the same object.

About this task

GUPI To retrieve all IDs or roles (GRANTEETYPE="L") that are explicitly authorized to access the sample employee table (DSN8B10.EMP in database DSN8D11A), issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSTABAUTH
  WHERE TTNAME='EMP' AND TCREATOR='DSN8910' AND
        GRANTEETYPE IN (' ','L');
```

To retrieve all IDs or roles (GRANTEETYPE="L") that can change the sample employee table (IDs with administrative authorities and IDs to which authority is explicitly granted), issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSTABAUTH
  WHERE TTNAME='EMP' AND
        TCREATOR='DSN8910' AND
        GRANTEETYPE IN (' ','L') AND
        (ALTERAUTH  <> ' ' OR
         DELETEAUTH <> ' ' OR
         INSERTAUTH <> ' ' OR
         UPDATEAUTH <> ' ')
UNION
SELECT GRANTEE FROM SYSIBM.SYSUSERAUTH
  WHERE SYSADMAUTH <> ' '
UNION
SELECT GRANTEE FROM SYSIBM.SYSDBAUTH
  WHERE DBADMAUTH <> ' ' AND NAME='DSN8D91A';
```

To retrieve the columns of DSN8B10.EMP for which update privileges have been granted on a specific set of columns, issue the following statement:

```
SELECT DISTINCT COLNAME, GRANTEE, GRANTEETYPE FROM SYSIBM.SYSCOLAUTH
  WHERE CREATOR='DSN8B10' AND TNAME='EMP'
  ORDER BY COLNAME;
```

The character in the GRANTEETYPE column shows whether the privileges have been granted to a primary or secondary authorization ID (blank), a role (L), or are used by an application plan or package (P).

To retrieve the IDs that have been granted the privilege of updating one or more columns of DSN8B10.EMP, issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSTABAUTH
  WHERE TTNAME='EMP' AND
        TCREATOR='DSN8910' AND
        GRANTEETYPE IN (' ','L') AND
        UPDATEAUTH <> ' ';
```

The query returns only the IDs or roles (GRANTEETYPE="L") to which update privileges have been specifically granted. It does not return IDs or roles that have the privilege because of SYSADM or DBADM authority. You could include them by forming a union with additional queries, as shown in the following example:

```
SELECT DISTINCT GRANTEE GRANTEETYPE FROM SYSIBM.SYSTABAUTH
  WHERE TTNAME='EMP' AND
        TCREATOR='DSN8910' AND
        GRANTEETYPE IN (' ','L') AND
        UPDATEAUTH <> ' '
UNION
SELECT GRANTEE FROM SYSIBM.SYSUSERAUTH
  WHERE SYSADMAUTH <> ' '
UNION
SELECT GRANTEE FROM SYSIBM.SYSDBAUTH
  WHERE DBADMAUTH <> ' ' AND NAME='DSN8D91A';
```

GUPI

Retrieving all IDs or roles with access to the same routine

You can retrieve the IDs or roles (GRANTEETYPE="L") that are authorized to access the same routines.

Example

GUPI To retrieve the IDs or roles (GRANTEETYPE="L") that are authorized to access stored procedure PROCA in schema SCHEMA1, issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSROUTINEAUTH
  WHERE SPECIFICNAME='PROCA' AND
        SCHEMA='SCHEMA1' AND
        GRANTEETYPE IN (' ','L') AND
        ROUTINETYPE='P';
```

You can write a similar statement to retrieve the IDs or roles (GRANTEETYPE="L") that are authorized to access a user-defined function. To retrieve the IDs or roles that are authorized to access user-defined function UDFA in schema SCHEMA1, issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSROUTINEAUTH
  WHERE SPECIFICNAME='UDFA' AND
        SCHEMA='SCHEMA1' AND
        GRANTEETYPE IN (' ','L') AND
        ROUTINETYPE='F';
```

GUPI

Retrieving plans or packages with access to the same table

You can retrieve all the plans or packages that are granted access to the same table.

About this task

GUPI For example, to retrieve the names of application plans and packages that refer to table DSN8B10.EMP directly, issue the following statement:

```
SELECT DISTINCT GRANTEE FROM SYSIBM.SYSTABAUTH
  WHERE GRANTEETYPE = 'P' AND
        TCREATOR = 'DSN8B10'  AND
        TTNAME = 'EMP';
```

The preceding query does not distinguish between plans and packages. To identify a package, use the COLLID column of table SYSTABAUTH, which names the collection in which a package resides and is blank for a plan.

A plan or package can refer to the table indirectly, through a view.

To find all views that refer to the table:

1. Issue the following query:

   ```
   SELECT DISTINCT DNAME FROM SYSIBM.SYSVIEWDEP
     WHERE BTYPE = 'T' AND
           BCREATOR = 'DSN8B10'  AND
           BNAME = 'EMP';
   ```

2. Write down the names of the views that satisfy the query. These values are instances of *DNAME_list*.
3. Find all plans and packages that refer to those views by issuing a series of SQL statements. For each instance of *DNAME_list*, issue the following statement:

   ```
   SELECT DISTINCT GRANTEE FROM SYSIBM.SYSTABAUTH
     WHERE GRANTEETYPE = 'P' AND
           TCREATOR = 'DSN8B10'  AND
           TTNAME = DNAME_list;
   ```

   GUPI

Retrieving privilege information through views

An ID with the SQLADM, system DBADM, DATAACCESS, ACCESSCTRL, SECADM, SYSADM, or SYSCTRL authority automatically has the privilege of retrieving data from catalog tables. If you do not want to grant the SELECT privilege on all catalog tables to PUBLIC, consider using views to let each ID retrieve information about its own privileges.

About this task

GUPI The following view includes the owner and the name of every table on which a user's primary authorization ID has the SELECT privilege:

```
CREATE VIEW MYSELECTS AS
  SELECT TCREATOR, TTNAME FROM SYSIBM.SYSTABAUTH
    WHERE SELECTAUTH <> ' ' AND
          GRANTEETYPE = ' ' AND
          GRANTEE IN (USER, 'PUBLIC', CURRENT SQLID);
```

The keyword USER in that statement is equal to the value of the primary authorization ID. To include tables that can be read by a secondary ID, set the current SQLID to that secondary ID before querying the view.

To make the view available to every ID, issue the following GRANT statement:

```
GRANT SELECT ON MYSELECTS TO PUBLIC;
```

Similar views can show other privileges. This view shows privileges over columns:

```
CREATE VIEW MYCOLS (OWNER, TNAME, CNAME, REMARKS, LABEL)
  AS SELECT DISTINCT TBCREATOR, TBNAME, NAME, REMARKS, LABEL
  FROM SYSIBM.SYSCOLUMNS, SYSIBM.SYSTABAUTH
    WHERE TCREATOR = TBCREATOR AND
          TTNAME = TBNAME AND
          GRANTEETYPE = '  ' AND
          GRANTEE IN (USER,'PUBLIC',CURRENT SQLID);
```

GUPI

Implementing multilevel security with DB2

Multilevel security allows you to classify objects and users with security labels that are based on hierarchical security levels and non-hierarchical security categories. Multilevel security prevents unauthorized users from accessing information at a higher classification than their authorization. It also prevents users from declassifying information.

Using multilevel security with row-level granularity, you can define security for DB2 objects and perform security checks, including row-level security checks. Row-level security checks allow you to control which users have authorization to view, modify, or perform other actions on specific rows of data.

You can implement multilevel security with the following combinations:

DB2 authorization with multilevel security with row-level granularity
In this combination, DB2 grants are used for authorization at the DB2 object level (database, table, and so forth). Multilevel security is implemented only at the row level within DB2.

External access control and multilevel security with row-level granularity
In this combination, external access control (such as the RACF access control module) is used for authorization at the DB2 object level. External access control also uses security labels to perform mandatory access checking on DB2 objects as part of multilevel security. Multilevel security is also implemented on the row level within DB2.

Important: The following information about multilevel security is specific to DB2. It does not describe all aspects of multilevel security. However, this specific information assumes that you have general knowledge of multilevel security.

Related concepts:

"Multilevel security"

"Access control through multilevel security" on page 4

Multilevel security

Multilevel security is a security policy that allows you to classify objects and users based on a system of hierarchical security levels and a system of non-hierarchical security categories.

Multilevel security provides the capability to prevent unauthorized users from accessing information at a higher classification than their authorization, and prevents users from declassifying information.

Multilevel security offers the following advantages:

- Multilevel security enforcement is mandatory and automatic.
- Multilevel security can use methods that are difficult to express through traditional SQL views or queries.
- Multilevel security does not rely on special views or database variables to provide row-level security control.
- Multilevel security controls are consistent and integrated across the system, so that you can avoid defining users and authorizations more than once.
- Multilevel security does not allow users to declassify information.

Using multilevel security, you can define security for DB2 objects and perform other checks, including row-level security checks. Row-level security checks allow you to control which users have authorization to view, modify, or perform other actions on specific rows of data.

Multilevel security and row access control are mutually exclusive. While you can activate column access control on a table that has a security label column and enforce it on a security label column, you cannot do the same with row access control. If a table has a security label column, you cannot enable it with row access control. Vice versa is true; if a table is activated with row access control, you cannot alter it to include a security label column.

Related reference:

"Implementing multilevel security with DB2" on page 108

Security labels

Multilevel security restricts access to an object or a row based on the security label of the object or row and the security label of the user.

For local connections, the security label of the user is the security label that the user specified during sign-on. This security label is associated with the DB2 primary authorization ID and accessed from the RACF ACEE control block. If no security label is specified during sign-on, the security label is the user's default security label.

For normal TCP/IP connections, the security label of the user can be defined by the security zone. IP addresses are grouped into security zones on the DB2 server. For trusted TCP/IP connections, the security label of the user is the security label established under the trusted context.

For SNA connections, the default security label for the user is used instead of the security label that the user signed on with.

Security labels can be assigned to a user by establishing a trusted connection within a trusted context. The trusted context definition specifies the security label that is associated with a user on the trusted connection. You can define trusted contexts if you have the SYSADM authority.

Security labels are based on security levels and security categories. You can use the Common Criteria (COMCRIT) environment's subsystem parameter to require that all tables in the subsystem are defined with security labels.

When defining security labels, do not include national characters, such as @, #, and $. Use of these characters in security labels may cause CCSID conversion errors.

Related concepts:

"Security levels"

"Security categories"

Determining the security label of a user

DB2 provides several built-in session variables that contain information about the server and application process. You can obtain the value of a built-in session variable by invoking the GETVARIABLE command with the name of the built-in session variable.

One of the built-in session variables is the user's security label. You can issue the GETVARIABLE('SYSIBM.SECLABEL') command to obtain the security label of a user.

Security levels

Along with security categories, hierarchical security levels are used as a basis for mandatory access-checking decisions.

When you define the security level of an object, you define the degree of sensitivity of that object. Security levels ensure that an object of a certain security level is protected from access by a user of a lower security level.

Related concepts:

"Security labels" on page 109

"Security categories"

Security categories

Security categories are the non-hierarchical basis for mandatory access-checking decisions.

When making security decisions, mandatory access control checks whether one set of security categories includes the security categories that are defined in a second set of security categories.

Related concepts:

"Security labels" on page 109

"Security levels" on page 110

Users and objects in multilevel security

In multilevel security, a *user* is any entity that requires access to system resources; the entity can be a human user, a stored procedure, or a batch job. An *object* is any system resource to which access must be controlled; the resource can be a data set, a table, a table row, or a command.

Related concepts:

"Global temporary tables with multilevel security"

"Materialized query tables with multilevel security"

"Constraints in a multilevel-secure environment" on page 112

"Field, edit, and validation procedures in a multilevel-secure environment" on page 112

"Triggers in a multilevel-secure environment" on page 113

Global temporary tables with multilevel security

For a declared temporary table with a column definition, no syntax exists to specify a security label on a DECLARE GLOBAL TEMPORARY TABLE statement. An attempt to specify a security label results in an error.

If a DECLARE GLOBAL TEMPORARY TABLE statement uses a fullselect or a LIKE predicate or a CREATE GLOBAL TEMPORARY TABLE statement uses a LIKE predicate, the resulting temporary table can inherit the security label column from the referenced table or view. However, the temporary table does not inherit any security attributes on that column. That means that the inherited column in the temporary table is not defined AS SECURITY LABEL. The column in the temporary table is defined as NOT NULL, with no default. Therefore, any statements that insert data in the temporary table must provide a value for the inherited column.

Related concepts:

"Users and objects in multilevel security"

"Materialized query tables with multilevel security"

"Constraints in a multilevel-secure environment" on page 112

"Field, edit, and validation procedures in a multilevel-secure environment" on page 112

"Triggers in a multilevel-secure environment" on page 113

Materialized query tables with multilevel security

Materialized query tables are tables that contain information that is derived and summarized from other tables.

If one or more of the source tables for a materialized query table has multilevel security with row-level granularity enabled, some additional rules apply to working with the materialized query table and the source tables.

Related concepts:

"Users and objects in multilevel security" on page 111

"Global temporary tables with multilevel security" on page 111

"Constraints in a multilevel-secure environment"

"Field, edit, and validation procedures in a multilevel-secure environment"

"Triggers in a multilevel-secure environment" on page 113

Constraints in a multilevel-secure environment

Although a referential constraint is not allowed for the security label column, DB2 enforces referential constraints for other columns in the table that are not defined with a security label.

Constraints operate in an multilevel-secure environment in the following ways:

- A unique constraint is allowed on a security label column.
- A referential constraint is not allowed on a security label column.
- A check constraint is not allowed on a security label column.

Multilevel security with row-level checking is not enforced when DB2 checks a referential constraint.

Related concepts:

"Users and objects in multilevel security" on page 111

"Global temporary tables with multilevel security" on page 111

"Materialized query tables with multilevel security" on page 111

"Field, edit, and validation procedures in a multilevel-secure environment"

"Triggers in a multilevel-secure environment" on page 113

Field, edit, and validation procedures in a multilevel-secure environment

In a multilevel-secure environment, field procedures, edit procedures, and validation procedures operate in certain ways.

- Field procedures are not allowed on a security label column. Edit procedures that are defined as WITH ROW ATTRIBUTES are not allowed on a table with a security label column.
- Validation procedures are allowed on a table that is defined with a security label column. When an authorized user with write-down privilege makes an INSERT or UPDATE request for a row, the validation procedure passes the new row with the security label of the user. If the authorized user does not have write-down privilege, the security label of the row remains the same.

Related concepts:

"Users and objects in multilevel security" on page 111

"Global temporary tables with multilevel security" on page 111

"Materialized query tables with multilevel security" on page 111

"Constraints in a multilevel-secure environment" on page 112

"Triggers in a multilevel-secure environment"

Triggers in a multilevel-secure environment

When a transition table is generated as the result of a trigger, the security label of the table or row from the original table is not inherited by the transition table. Therefore, multilevel security with row-level checking is not enforced for transition tables and transition values.

If an ALTER TABLE statement is used to add a security label column to a table with a trigger on it, the same rules apply to the new security label column that would apply to any column that is added to the table with the trigger on it.

When a BEFORE trigger is activated, the value of the NEW transition variable that corresponds to the security label column is set to the security label of the user if either of the following criteria are met:

- Write-down control is in effect and the user does not have the write-down privilege
- The value of the security label column is not specified

Related concepts:

"Users and objects in multilevel security" on page 111

"Global temporary tables with multilevel security" on page 111

"Materialized query tables with multilevel security" on page 111

"Constraints in a multilevel-secure environment" on page 112

"Field, edit, and validation procedures in a multilevel-secure environment" on page 112

Mandatory access checking

Mandatory access checking evaluates dominance relationships between user security labels and object security labels and determines whether to allow certain actions based on certain rules.

- If the security label of the user dominates the security label of the object, the user can read from the object.
- If the security label of a user and the security label of the object are equivalent, the user can read from and write to the object.
- If the security label of the user dominates the security label of the object, the user cannot write to the object unless the user has the write-down RACF privilege.
- If the security label of the user is disjoint with the security label of the object, the user cannot read or write to that object.

Exception: IDs with the installation SYSADM authority bypass mandatory access checking at the DB2 object level because actions by installation SYSADM do not invoke the external access control exit routine (DSNX@XAC). However, multilevel security with row-level granularity is enforced for IDs with installation SYSADM authority.

After the user passes the mandatory access check, a discretionary check follows. The discretionary access check restricts access to objects based on the identity of a user, the user's role (if one exists), and the groups to which the user belongs. The discretionary access check ensures that the user is identified as having a “need to know” for the requested resource. The check is discretionary because a user with a certain access permission is capable of passing that permission to any other user.

Dominance relationships between security labels

Mandatory access checking is based on the dominance relationships between user security labels and object security labels. One security label dominates another security label in certain conditions.

- The security level that defines the first security label is greater than or equal to the security level that defines the second security label.
- The set of security categories that defines one security label includes the set of security categories that defines the other security label.

Comparisons between user security labels and object security labels can result in four types of relationships:

Dominant
: One security label dominates another security label when both of the following conditions are true:
  - The security level that defines the first security label is greater than or equal to the security level that defines the second security label.
  - The set of security categories that defines the first security label includes the set of security categories that defines the other security label.

  Reading data requires that the user security label dominates the data security label.

Reverse dominant
: One security label reverse dominates another security label when both of the following conditions are true:
  - The security level that defines the first security label is less than or equal to the security level that defines the second security label.
  - The set of security categories that defines the first security label is a subset of the security categories that defines the other security label.

Equivalent
: One security label is equivalent to another security label when they are the same or have the same level and set of categories. If both dominance and reverse dominance are true for two security labels, they are equivalent. The user security label must be equivalent to the data security label to be able to read and write data without being able to write down.

Disjoint
: A security label is disjoint or incompatible with another security label if incompatible security categories cause neither security label to dominate the other security label. Two security labels are disjoint when each of them has at least one category that the other does not have. Disjoint access is not allowed, even when a user is allowed to write down. If a user security label that is disjoint to the data security label issues an INSERT, UPDATE, or LOAD command, DB2 issues an error.

Example: Suppose that the security level "secret" for the security label HIGH is greater than the security level "sensitive" for the security label MEDIUM. Also, suppose that the security label HIGH includes the security categories Project_A,

Project_B, and Project_C, and that the security label MEDIUM includes the security categories Project_A and Project_B. The security label HIGH dominates the security label MEDIUM because both conditions for dominance are true.

Example: Suppose that the security label HIGH includes the security categories Project_A, Project_B, and Project_C, and that the security label MEDIUM includes the security categories Project_A and Project_Z. In this case, the security label HIGH does not dominate the security label MEDIUM because the set of security categories that define the security label HIGH does not contain the security category Project_Z.

Write-down control

Mandatory access checking prevents a user from declassifying information. It prevents a user from writing to an object unless the security label of the user is equivalent to or dominated by that of the object.

DB2 requires either the equivalence of the security labels or the *write-down privilege* of the user to write to DB2 objects.

Example: Suppose that user1 has a security label of HIGH and that row_x has a security label of MEDIUM. Because the security label of the user and the security label of the row are not equivalent, user1 cannot write to row_x. Therefore, write-down control prevents user1 from declassifying the information that is in row_x.

Example: Suppose that user2 has a security label of MEDIUM and that row_x has a security label of MEDIUM. Because the security label of the user and the security label of the row are equivalent, user2 can read from and write to row_x. However, user2 cannot change the security label for row_x unless user2 has write-down privilege. Therefore write-down control prevents user2 from declassifying the information that is in row_x.

Granting write-down privileges

To grant the write-down privilege, you need to define a profile and then allow users to access the profile.

Procedure

To grant write-down privilege to users:

1. Issue the following RACF command to define an IRR.WRITEDOWN.BYUSER profile.

   ```
   RDEFINE FACILITY IRR.WRITEDOWN.BYUSER UACC(NONE)
   ```

2. Issue the following RACF command to allow users to access the IRR.WRITEDOWN.BYUSER profile that you just created.

   ```
   PERMIT IRR.WRITEDOWN.BYUSER ID(USRT051 USRT052 USRT054 USRT056 -
      USRT058 USRT060 USRT062 USRT064 USRT066 USRT068 USRT041) -
      ACCESS(UPDATE) CLASS(FACILITY)
   ```

Implementing multilevel security at the object level

You can implement multilevel security with DB2 at the object level.

Procedure

To implement multilevel security with DB2 at the object level:

1. Define security labels in RACF for all DB2 objects that require mandatory access checking by using the RDEFINE command.

   Define security labels for the following RACF resource classes:
   - DSNADM (administrative authorities)
   - DSNR (access to DB2 subsystems)
   - MDSNBP and GSNBP (buffer pools)
   - MDSNCL and GDSNCL (collections)
   - MDSNJR and MDSNJR (JAR)
   - MDSNPN and GDSNPN (plans)
   - MDSNSC and GDSNSC (schema)
   - MDSNSG and GDSNSG (storage groups)
   - MDSNSM and GDSNSM (system privileges)
   - MDSNSP and GDSNSP (stored procedures)
   - MDSNSQ and GDSNSQ (sequences)
   - MDSNTB and GDSNTB (tables, views, indexes)
   - MDSNTS and GDSNTS (table spaces)
   - MDSNUF and GDSNUF (user-defined functions)

   Recommendation: Define the security label SYSMULTI for DB2 subsystems that are accessed by users with different security labels and tables that require row-level granularity.
2. Specify a proper hierarchy of security labels.

   In general, the security label of an object that is higher in the object hierarchy should dominate the security labels of objects that are lower in the hierarchy. RACF and DB2 do not enforce the hierarchy; they merely enforce the dominance rules that you establish.

   You can use RACF to define security labels for the DB2 objects in the following object hierarchy:
   - Subsystem or data sharing group
     - Database
       - Table space
         - Table
           - Column
           - Row
     - View
     - Storage group
     - Buffer pool
     - Plan
     - Collection
       - Package
     - Schema
       - Stored procedure or user-defined function
       - Java Archive (JAR)
       - Distinct type
       - Sequence

   The following examples suggest dominance relationships among objects in the DB2 object hierarchy.

   Example: A collection should dominate a package.

   Example: A subsystem should dominate a database. That database should dominate a table space. That table space should dominate a table. That table should dominate a column.

   Example: If a view is based on a single table, the table should dominate the view. However, if a view is based on multiple tables, the view should dominate the tables.

3. Define security labels and associate users with the security labels in RACF. If you are using a TCP/IP connection, you need to define security labels in RACF for the security zones into which IP addresses are grouped. These IP addressed represent remote users. Give users with SYSADM, SYSCTRL, and SYSOPR authority the security label of SYSHIGH.
4. Activate the SECLABEL class in RACF. If you want to enforce write-down control, turn on write-down control in RACF.
5. Install the external security access control authorization exit routine (DSNX@XAC), such as the RACF access control module.

Related tasks:

"Implementing multilevel security with row-level granularity"

"Restricting access to the security label column" on page 119

Implementing multilevel security with row-level granularity

Many applications need row-level security within the relational database so that access can be restricted to a specific set of rows. This security control often needs to be mandatory so that users are unable to bypass the row-level security mechanism. Using mandatory controls with z/OS and RACF provides consistency across the system.

About this task

Requirement: You must have z/OS Version 1 Release 5 or later to use DB2 authorization with multilevel security with row-level granularity.

You can implement multilevel security with row-level granularity with or without implementing multilevel security on the object level. If you implement multilevel security on the object level, you must define security labels in RACF for all DB2 objects and install the external security access control authorization exit routine. If you do not use the access control authorization exit routine or RACF access control, you can use DB2 native authorization control.

You can implement multilevel security with row-level granularity with or without implementing multilevel security on the object level.

Recommendation: Use multilevel security at the object level with multilevel security with row-level granularity. Using RACF with multilevel security provides an independent check at run time and always checks the authorization of a user to the data.

DB2 performs multilevel security with row-level granularity by comparing the security label of the user to the security label of the row that is accessed. Because security labels can be equivalent without being identical, DB2 uses the RACROUTE REQUEST=DIRAUTH macro to make this comparison when the two security labels are not the same. For read operations, such as SELECT, DB2 uses ACCESS=READ. For update operations, DB2 uses ACCESS=READWRITE.

The write-down privilege for multilevel security with row-level granularity has the following properties:

- A user with the write-down privilege can update the security label of a row to any valid value. The user can make this update independent of the user's dominance relationship with the row.
- DB2 requires that a user have the write-down privilege to perform certain utilities.

- If write-down control is not enabled, all users with valid security labels are equivalent to users with the write-down privilege.

Related tasks:

"Implementing multilevel security at the object level" on page 115

"Restricting access to the security label column" on page 119

Creating tables with multilevel security

You can use multilevel security with row-level checking to control table access. You can do so by creating or altering a table that has a column with the AS SECURITY LABEL attribute.

About this task

GUPI Tables with multilevel security in effect can be dropped by using the DROP TABLE statement. Users must have a valid security label to execute CREATE TABLE, ALTER TABLE, and DROP TABLE statements on tables with multilevel security enabled.

The performance of tables that you create and alter can suffer if the security label is not included in indexes. The security label column is used whenever a table with multilevel security enabled is accessed. Therefore, the security label column should be included in indexes on the table. If you do not index the security label column, you cannot maintain index-only access.

When a user with a valid security label creates a table, the user can implement row-level security by including a security label column. The security label column can have any name, but it must be defined as CHAR(8) and NOT NULL WITH DEFAULT. It also must be defined with the AS SECURITY LABEL clause.

After the user specifies the AS SECURITY LABEL clause on a column, users can indicate the security label for each row by entering values in that column. When a user creates a table and includes a security label column, SYSIBM.SYSTABLES indicates that the table has row-level security enabled. Once a user creates a table with a security label column, the security on the table cannot be disabled. The table must be dropped and re-created to remove this protection. GUPI

Example

To create a table that is named TABLEMLS1 and that has row-level security enabled, issue the following statement:

```
CREATE TABLE TABLEMLS1
  (EMPNO      CHAR(6)       NOT NULL,
   EMPNAME           VARCHAR(20)   NOT NULL,
   DEPTNO     VARCHAR(5)
   SECURITY   CHAR(8)       NOT NULL WITH DEFAULT AS SECURITY LABEL,
   PRIMARY KEY (EMPNO)             )
IN DSN8D71A.DSN8S71D;
```

Adding multilevel security to existing tables

If you have a valid security label, you can implement row-level security on an existing table by adding a security label column to the table.

About this task

The security label column can have any name, but it must be defined as CHAR(8) and NOT NULL WITH DEFAULT. It also must be defined with the AS SECURITY LABEL clause.

Example: Suppose that the table EMP does not have row-level security enabled. To alter EMP so that it has row-level security enabled, issue the following statement:

GUPI

```
ALTER TABLE EMP
  ADD SECURITY   CHAR(8)       NOT NULL WITH DEFAULT AS SECURITY LABEL;
```

GUPI

After a user specifies the AS SECURITY LABEL clause on a column, row-level security is enabled on the table and cannot be disabled. The security label for existing rows in the table at the time of the alter is the same as the security label of the user that issued the ALTER TABLE statement.

Important: Packages and dynamic statements are invalidated when a table is altered to add a security label column.

Removing tables with multilevel security

With valid privileges, you can drop a table that has row-level security in effect.

About this task

It is the required privilege that you have on the table, not the row-level security of the table, that determines whether or not a DROP statement succeeds. When you drop a table that has row-level security, DB2 generates an audit record.

Caching security labels

DB2 caches security labels to improve performance when multilevel security with row-level granularity is used.

About this task

DB2 caches all security labels that are checked (successfully and unsuccessfully) during processing. At commit or rollback, the security labels are removed from the cache. If a security policy that employs multilevel security with row-level granularity requires an immediate change and long-running applications have not committed or rolled back, you might need to cancel the application.

Restricting access to the security label column

If you do not want users to see a security label column, you can create views that do not include the column.

Procedure

GUPI To restrict access to the security label column, choose one of the following options:

- Create a view that only includes those columns that are not security columns. For example, suppose that the ORDER table has the following columns:

ORDERNO, PRODNO, CUSTNO, SECURITY. Suppose that SECURITY is the security label column, and that you do not want users to see the SECURITY column. Use the following statement to create a view that hides the security label column from users:

```
CREATE VIEW V1 AS
  SELECT ORDERNO, PRODNO, CUSTNO FROM ORDER;
```

- Retrieve the value of the SYSIBM.SECLABEL session variable, and create a view that includes only the rows that match the session variable value. This will create a view that gives each user access only to the rows that include that user's security label column. For example, you would use the following statement to create a view that allows access only to the rows that match the user's security label:

```
CREATE VIEW V2 AS SELECT * FROM ORDER
    WHERE SECURITY=GETVARIABLE('SYSIBM.SECLABEL');
```

GUPI

Related tasks:

"Implementing multilevel security at the object level" on page 115

"Implementing multilevel security with row-level granularity" on page 117

Managing data in a multilevel-secure environment

Multilevel security with row-level checking affects the results of the SELECT, INSERT, UPDATE, MERGE, DELETE, and TRUNCATE statements.

For example, row-level checking ensures that DB2 does not return rows that have a HIGH security label to a user that has a LOW security label. Users must have a valid security label to execute the SELECT, INSERT, UPDATE, MERGE, DELETE, and TRUNCATE statements.

This effect also applies to the results of the LOAD, UNLOAD, and REORG TABLESPACE utilities on tables that are enabled with multilevel security.

Using the SELECT statement with multilevel security

When a user with a valid security label selects data from one or more tables with row-level security enabled, DB2 compares the security label of the user to the security label of each row.

About this task

GUPI The results from the comparison of the security label of the user to the security label of each row are returned according to the following rules:

- If the security label of the user dominates the security label of the row, DB2 returns the row.
- If the security label of the user does not dominate the security label of the row, DB2 does not return the data from that row, and DB2 does not generate an error report.

Example

Suppose that Alan has a security label of HIGH, Beth has a security label of MEDIUM, and Carlos has a security label of LOW. Suppose that DSN8910.EMP contains the data that is shown in the following table and that the SECURITY column has been declared with the AS SECURITY LABEL clause.

Table 26. Sample data from DSN8910.EMP

EMPNO	LASTNAME	WORKDEPT	SECURITY
000010	HAAS	A00	LOW
000190	BROWN	D11	HIGH
000200	JONES	D11	MEDIUM
000210	LUTZ	D11	LOW
000330	LEE	E21	MEDIUM

Now, suppose that Alan, Beth, and Carlos each submit the following SELECT statement:

```
SELECT LASTNAME
  FROM EMP
  ORDER BY LASTNAME;
```

Because Alan has the security label HIGH, he receives the following result:

```
BROWN
HAAS
JONES
LEE
LUTZ
```

Because Beth has the security label MEDIUM, she receives the following result:

```
HAAS
JONES
LEE
LUTZ
```

Beth does not see BROWN in her result set because the row with that information has a security label of HIGH.

Because Carlos has the security label LOW, he receives the following result:

```
HAAS
LUTZ
```

Carlos does not see BROWN, JONES, or LEE in his result set because the rows with that information have security labels that dominate Carlos's security label. Although Beth and Carlos do not receive the full result set for the query, DB2 does not return an error code to Beth or Carlos. GUPI

Using the INSERT statement with multilevel security

When a user with a valid security label inserts data into a table with row-level security, the security label of the row is determined according to a specific set of rules.

About this task

- GUPI If the user has write-down privilege or write-down control is not enabled, the user can set the security label for the row to any valid security label. If the user does not specify a value for the security label, the security label of the row becomes the same as the security label of the user.
- If the user does not have write-down privilege and write-down control is enabled, the security label of the row becomes the same as the security label of the user.

Considerations for INSERT from a fullselect: For statements that insert the result of a fullselect, DB2 does not return an error code if the fullselect contains a table with a security label column. DB2 allows it if the target table does not contain a security label column while the source table contains one.

Considerations for SELECT...FROM...INSERT statements: If the user has write-down privilege or write-down control is not in effect, the security label of the user might not dominate the security label of the row. For statements that insert rows and select the inserted rows, the INSERT statement succeeds. However, the inserted row is not returned.

Considerations for INSERT with subselect: If you insert data into a table that does not have a security label column, but a subselect in the INSERT statement does include a table with a security label column, row-level checking is performed for the subselect. However, the inserted rows will not be stored with a security label column. GUPI

Example

Suppose that Alan has a security label of HIGH, that Beth has a security label of MEDIUM and write-down privilege defined in RACF, and that Carlos has a security label of LOW. Write-down control is enabled.

Now, suppose that Alan, Beth, and Carlos each submit the following INSERT statement:

```
INSERT INTO DSN8910.EMP(EMPNO, LASTNAME, WORKDEPT, SECURITY)
    VALUES('099990', 'SMITH', 'C01', 'MEDIUM');
```

Because Alan does not have write-down privilege, Alan cannot choose the security label of the row that he inserts. Therefore DB2 ignores the security label of MEDIUM that is specified in the statement. The security label of the row becomes HIGH because Alan's security label is HIGH.

Because Beth has write-down privilege on the table, she can specify the security label of the new row. In this case, the security label of the new row is MEDIUM. If Beth submits a similar INSERT statement that specifies a value of LOW for the security column, the security label for the row becomes LOW.

Because Carlos does not have write-down privilege, Carlos cannot choose the security label of the row that he inserts. Therefore DB2 ignores the security label of MEDIUM that is specified in the statement. The security label of the row becomes LOW because Carlos' security label is LOW.

Using the UPDATE statement with multilevel security

When a user with a valid security label updates a table with row-level security enabled, DB2 compares the security label of the user to the security label of the row.

About this task

GUPI The update to the table proceeds according to the following rules:

- If the security label of the user and the security label of the row are equivalent, the row is updated and the value of the security label is determined by whether the user has write-down privilege:

  - If the user has write-down privilege or write-down control is not enabled, the user can set the security label of the row to any valid security label.
  - If the user does not have write-down privilege and write-down control is enabled, the security label of the row is set to the value of the security label of the user.
- If the security label of the user dominates the security label of the row, the result of the UPDATE statement is determined by whether the user has write-down privilege:
  - If the user has write-down privilege or write-down control is not enabled, the row is updated and the user can set the security label of the row to any valid security label.
  - If the user does not have write-down privilege and write-down control is enabled, the row is not updated.
- If the security label of the row dominates the security label of the user, the row is not updated.

Recommendation: To avoid failed updates, qualify the rows that you want to update with the following predicate, for the security label column SECLABEL:

```
WHERE SECLABEL=GETVARIABLE('SYSIBM.SECLABEL')
```

Using this predicate avoids failed updates because it ensures that the user's security label is equivalent to the security label of the rows that DB2 attempts to update.

Considerations for SELECT...FROM...UPDATE statements: If the user has write-down privilege or if the write-down control is not in effect, the security label of the user might not dominate the security label of the row. For statements that update rows and select the updated rows, the UPDATE statement succeeds. However, the updated row is not returned.

Example

Suppose that Alan has a security label of HIGH, that Beth has a security label of MEDIUM and write-down privilege defined in RACF, and that Carlos has a security label of LOW. Write-down control is enabled.

Suppose that DSN8910.EMP contains the data that is shown in the following table and that the SECURITY column has been declared with the AS SECURITY LABEL clause.

Table 27. Sample data from DSN8910.EMP

EMPNO	LASTNAME	WORKDEPT	SECURITY
000190	BROWN	D11	HIGH
000200	JONES	D11	MEDIUM
000210	LUTZ	D11	LOW

Now, suppose that Alan, Beth, and Carlos each submit the following UPDATE statement:

```
UPDATE DSN8910.EMP
  SET DEPTNO='X55', SECURITY='MEDIUM'
  WHERE DEPTNO='D11';
```

Because Alan has a security label that dominates the rows with security labels of MEDIUM and LOW, his write-down privilege determines whether these rows are updated. Alan does not have write-down privilege, so the update fails for these rows. Because Alan has a security label that is equivalent to the security label of the row with HIGH security, the update on that row succeeds. However, the security label for that row remains HIGH because Alan does not have the write-down privilege that is required to set the security label to any value. The results of Alan's update are shown in the following table:

Table 28. Sample data from DSN8910.EMP after Alan's update

EMPNO	EMPNAME	DEPTNO	SECURITY
000190	BROWN	X55	HIGH
000200	JONES	D11	MEDIUM
000210	LUTZ	D11	LOW

Because Beth has a security label that dominates the row with a security label of LOW, her write-down privilege determines whether this row is updated. Beth has write-down privilege, so the update succeeds for this row and the security label for the row becomes MEDIUM. Because Beth has a security label that is equivalent to the security label of the row with MEDIUM security, the update succeeds for that row. Because the row with the security label of HIGH dominates Beth's security label, the update fails for that row. The results of Beth's update are shown in the following table:

Table 29. Sample data from DSN8910.EMP after Beth's update

EMPNO	EMPNAME	DEPTNO	SECURITY
000190	BROWN	D11	HIGH
000200	JONES	X55	MEDIUM
000210	LUTZ	X55	MEDIUM

Because Carlos's security label is LOW, the update fails for the rows with security labels of MEDIUM and HIGH. Because Carlos has a security label that is equivalent to the security label of the row with LOW security, the update on that row succeeds. However, the security label for that row remains LOW because Carlos does not have the write-down privilege, which is required to set the security label to any value. The results of Carlos's update are shown in the following table:

Table 30. Sample data from DSN8910.EMP after Carlos's update

EMPNO	EMPNAME	DEPTNO	SECURITY
000190	BROWN	D11	HIGH
000200	JONES	D11	MEDIUM
000210	LUTZ	X55	LOW

GUPI

Using the MERGE statement with multilevel security

MERGE is an SQL statement that combines the conditional INSERT and UPDATE operations on a target table. Data that is not already present in the target table is

inserted with the INSERT part of the MERGE statement. Data that is already present in the target table is updated with the UPDATE part of the MERGE statement.

About this task

GUPI Because the MERGE statement consists of the INSERT and UPDATE operations, the multilevel security rules for the INSERT operation apply to the INSERT part of the MERGE statement and the multilevel security rules for the UPDATE operation apply to the UPDATE part of the MERGE statement.

For the INSERT part of the MERGE statement, when a user with a valid security label inserts data into a table with row-level security enabled, the security label of the row is determined according to the following rules:

- If the user has write-down privilege or if the write-down control is not enabled, the user can set the security label for the row to any valid security label. If the user does not specify a value for the security label, the security label of the row becomes the same as the security label of the user.
- If the user does not have write-down privilege and if the write-down control is enabled, the security label of the row becomes the same as the security label of the user.

For the UPDATE part of the MERGE statement, when a user with a valid security label updates a table with row-level security enabled, DB2 compares the security label of the user to the security label of the row. The update proceeds according to the following rules:

- If the security label of the user and the security label of the row are equivalent, the row is updated and the value of the security label is determined by whether the user has write-down privilege:
  - If the user has write-down privilege or if the write-down control is not enabled, the user can set the security label of the row to any valid security label.
  - If the user does not have write-down privilege and if the write-down control is enabled, the security label of the row is set to the value of the security label of the user.
- If the security label of the user dominates the security label of the row, the result of the UPDATE operation is determined by whether the user has write-down privilege:
  - If the user has write-down privilege or if the write-down control is not enabled, the row is updated and the user can set the security label of the row to any valid security label.
  - If the user does not have write-down privilege and if the write-down control is enabled, the row is not updated.
- If the security label of the row dominates the security label of the user, the row is not updated.

Considerations for SELECT...FROM...MERGE statements: If the user has write-down privilege or if the write-down control is not in effect, the security label of the user might not dominate the security label of the row. For statements that merge rows and select the merged rows, the MERGE statement succeeds. However, the merged row is not returned. GUPI

Using the DELETE statement with multilevel security

When a user with a valid security label deletes data from a table with row-level security, DB2 compares the security label of the user to that of the row.

About this task

GUPI The delete proceeds according to the following rules:

- If the security label of the user and the security label of the row are equivalent, the row is deleted.
- If the security label of the user dominates the security label of the row, the user's write-down privilege determines the result of the DELETE statement:
  - If the user has write-down privilege or write-down control is not enabled, the row is deleted.
  - If the user does not have write-down privilege and write-down control is enabled, the row is not deleted.
- If the security label of the row dominates the security label of the user, the row is not deleted.

Example: Suppose that Alan has a security label of HIGH, that Beth has a security label of MEDIUM and write-down privilege defined in RACF, and that Carlos has a security label of LOW. Write-down control is enabled.

Suppose that DSN8910.EMP contains the data that is shown in the following table and that the SECURITY column has been declared with the AS SECURITY LABEL clause.

Table 31. Sample data from DSN8910.EMP

EMPNO	LASTNAME	WORKDEPT	SECURITY
000190	BROWN	D11	HIGH
000200	JONES	D11	MEDIUM
000210	LUTZ	D11	LOW

Now, suppose that Alan, Beth, and Carlos each submit the following DELETE statement:

```
DELETE FROM DSN8910.EMP
   WHERE DEPTNO='D11';
```

Because Alan has a security label that dominates the rows with security labels of MEDIUM and LOW, his write-down privilege determines whether these rows are deleted. Alan does not have write-down privilege, so the delete fails for these rows. Because Alan has a security label that is equivalent to the security label of the row with HIGH security, the delete on that row succeeds. The results of Alan's delete are shown in the following table:

Table 32. Sample data from DSN8910.EMP after Alan's delete

EMPNO	EMPNAME	DEPTNO	SECURITY
000200	JONES	D11	MEDIUM
000210	LUTZ	D11	LOW

Because Beth has a security label that dominates the row with a security label of LOW, her write-down privilege determines whether this row is deleted. Beth has

write-down privilege, so the delete succeeds for this row. Because Beth has a security label that is equivalent to the security label of the row with MEDIUM security, the delete succeeds for that row. Because the row with the security label of HIGH dominates Beth's security label, the delete fails for that row. The results of Beth's delete are shown in the following table:

Table 33. Sample data from DSN8910.EMP after Beth's delete

EMPNO	EMPNAME	DEPTNO	SECURITY
000190	BROWN	D11	HIGH

Because Carlos's security label is LOW, the delete fails for the rows with security labels of MEDIUM and HIGH. Because Carlos has a security label that is equivalent to the security label of the row with LOW security, the delete on that row succeeds. The results of Carlos's delete are shown in the following table:

Table 34. Sample data from DSN8910.EMP after Carlos's delete

EMPNO	EMPNAME	DEPTNO	SECURITY
000190	BROWN	D11	HIGH
000200	JONES	D11	MEDIUM

Important: Do not omit the WHERE clause from DELETE statements. If you omit the WHERE clause from the DELETE statement, checking occurs for rows that have security labels. This checking behavior might have a negative impact on performance.

Considerations for SELECT...FROM...DELETE statements: If the user has write-down privilege or write-down control is not in effect, the security label of the user might not dominate the security label of the row. For statements that delete rows and select the deleted rows, the DELETE statement succeeds. However, the deleted row is not returned. GUPI

Using the TRUNCATE statement with multilevel security

When a user with a valid security label uses a TRUNCATE statement to delete all data from a table with row-level security enabled, DB2 compares the security label of the user to the security label of each row.

About this task

GUPI The delete proceeds according to the following rules:

- If the security label of the user and the security label of the row are equivalent, the row is deleted.
- If the security label of the user dominates the security label of the row, the user's write-down privilege determines the result of the DELETE statement:
  - If the user has write-down privilege or write-down control is not enabled, the row is deleted.
  - If the user does not have write-down privilege and write-down control is enabled, the row is not deleted.
- If the security label of the row dominates the security label of the user, the row is not deleted.

- If the row cannot be deleted as a result of the security label verification, the TRUNCATE statement fails. GUPI

Using utilities with multilevel security

You need a valid security label and additional authorizations to run certain LOAD, UNLOAD, and REORG TABLESPACE jobs on tables that have multilevel security enabled. All other utilities check only for authorization to operate on the table space; they do not check for row-level authorization.

About this task

There are valid security label and additional authorizations required to run certain LOAD, UNLOAD, and REORG TABLESPACE jobs on tables that have multilevel security enabled:

LOAD
You must have the write-down privilege to run LOAD REPLACE on a table space that contains a table with multilevel security enabled. In this case, you can specify the values for the security label column.

UNLOAD
Additional restrictions apply to UNLOAD jobs on tables that have multilevel security enabled. Each row is unloaded only if the security label of the user dominates the security label of the row. If security label of the user does not dominate the security label of the row, the row is not unloaded and DB2 does not issue an error message.

REORG TABLESPACE
REORG TABLESPACE jobs on tables that have multilevel security enabled have the following restrictions:

- For jobs with the UNLOAD EXTERNAL option, each row is unloaded only if the security label of the user dominates the security label of the row. If the security label of the user does not dominate the security label of the row, the row is not unloaded and DB2 does not issue an error message.
- For jobs with the DISCARD option, a qualifying row is discarded only if the user has the write-down privilege and the security label of the user dominates the security label of the row.

Implementing multilevel security in a distributed environment

SQL statements that originate from remote requesters can participate in a multilevel secure environment if all information on the requester has the same security label and all users of the requester are permitted to that security label.

Management of multilevel security in a distributed environment requires physical control of the participating systems and careful management of the network. Managed systems must be prevented from communicating with other systems that do not have equivalent security labels.

Configuring TCP/IP with multilevel security

A communications server IP stack that runs in a multilevel secure environment can be configured as either a restricted stack or an unrestricted stack.

About this task

Recommendations: Use an unrestricted stack for DB2. An unrestricted stack is configured with an ID that is defined with a security label of SYSMULTI. A single z/OS system can concurrently run a mix of restricted and unrestricted stacks. Unrestricted stacks allow DB2 to use any security label to open sockets.

All users on a TCP/IP connection have the security label that is associated with the IP address that is defined on the server. If a user requires a different security label, the user must enter through an IP address that has that security label associated with it. If you require multiple IP addresses on a remote z/OS server, a workstation, or a gateway, you can configure multiple virtual IP addresses. This strategy can increase the number of security labels that are available on a client.

Remote users that access DB2 by using a TCP/IP network connection use the security label that is associated with the RACF SERVAUTH class profile when the remote user is authenticated. Security labels are assigned to the database access thread when the DB2 server authenticates the remote server by using the RACROUTE REQUEST = VERIFY service.

If you use a trusted context for your TCP/IP connection, you can define a default security label for all users or specific security labels for individual users who use the trusted context. The security label that is defined in the trusted context overrides the one for the TCP/IP connection in RACF.

Configuring SNA with multilevel security

Security labels are assigned to the database access thread when the DB2 server authenticates the remote server by using the RACROUTE REQUEST = VERIFY service. The service establishes a security label for the authorization ID that is associated with the database access thread.

About this task

For SNA connections, this security label is the default security label that is defined for the remote user.

Chapter 3. Managing access through RACF

You can control whether a local or remote application can gain access to a specific DB2 subsystem from different environments. You can set different levels of security depending on whether the requesting application uses SNA or Transmission Control Protocol/Internet Protocol (TCP/IP) protocols to access DB2.

After the local system authenticates the incoming ID, it treats the ID like a local connection request or a local sign-on request. You can process the ID with your connection or sign-on exit routine and associate secondary authorization IDs with the ID. If you are sending a request to a remote DB2 subsystem, that subsystem can subject your request to various security checks.

You can use an external security system, such as RACF, IMS, or CICS, to authorize and authenticate a remote request before it reaches your DB2 subsystem. The discussion in the following topics assumes that you use RACF, or an equivalent system, for external access control.

Establishing RACF protection for DB2

You can install and use RACF to protect your DB2 resources.

Procedure

To establish RACF protection for DB2, complete the following steps in any order:

- Define DB2 resources to RACF for protection.
- Grant RACF access to the protected DB2 resources.

Defining DB2 resources to RACF

To establish RACF protection for your DB2 subsystem, you must define your DB2 resources to RACF and authorize RACF for authentication checking.

Procedure

To define your DB2 resources to RACF:

- Define the names of protected access profiles.
- Enable RACF checking for the DSNR and SERVER classes.

What to do next

You can also perform the following tasks:

- Control whether two DBMSs that use VTAM® LU 6.2 can establish sessions with each other.
- Authorize IDs that are associated with stored procedures address spaces to run the appropriate attachment facility.
- Authorize the ID that is associated with the DDF address space to use z/OS UNIX System Services if you use TCP/IP.

Related tasks:

"Permitting RACF access" on page 133

"Managing authorization for stored procedures" on page 142

"Protecting connection requests that use the TCP/IP protocol" on page 151

"Establishing Kerberos authentication through RACF" on page 152

Naming protected access profiles

The RACF resource class for DB2 is DSNR that is contained in the RACF class descriptor table. The profiles in that class help you control access to a DB2 subsystem from another environment. The environment can be IMS, CICS, the distributed data facility (DDF), Time Sharing Option (TSO), the call attachment facility (CAF), or batch.

About this task

Each profile has a name of the form *subsystem.environment*, where:

- *subsystem* is the name of a DB2 subsystem, of one to four characters; for example, DSN or DB2T.
- *environment* denotes the environment, by one of the following terms:
  - MASS for IMS (including MPP, BMP, Fast Path, and DL/I batch).
  - SASS for CICS.
  - DIST for DDF.
  - RRSAF for Resource Recovery Services attachment facility. Stored procedures use RRSAF in WLM-established address spaces.
  - BATCH for all others, including TSO, CAF, and utilities.

To control access, you need to define a profile, as a member of class DSNR, for every combination of subsystem and environment you want to use. For example, suppose that you want to access:

- Subsystem DSN from TSO and DDF
- Subsystem DB2P from TSO, DDF, IMS, and RRSAF
- Subsystem DB2T from TSO, DDF, CICS, and RRSAF

Then define the profiles with the following names:

```
DSN.BATCH   DSN.DIST
DB2P.BATCH  DB2P.DIST  DB2P.MASS  DB2P.RRSAF
DB2T.BATCH  DB2T.DIST  DB2T.SASS  DB2T.RRSAF
```

You can do that with a single RACF command, which also names an owner for the resources:

```
RDEFINE DSNR (DSN.BATCH  DSN.DIST  DB2P.BATCH  DB2P.DIST  DB2P.MASS DB2P.RRSAF
              DB2T.BATCH DB2T.DIST DB2T.SASS DB2T.RRSAF)  OWNER(DB2OWNER)
```

In order to access a subsystem in a particular environment, a user must be on the access list of the corresponding profile. You add users to the access list by using the RACF **PERMIT** command. If you do not want to limit access to particular users or groups, you can give universal access to a profile with a command like this:

```
RDEFINE DSNR (DSN.BATCH) OWNER(DB2OWNER) UACC(READ)
```

Enabling RACF checking for the DSNR and SERVER classes

You can allow RACF to check for the DSNR and SERVER classes.

About this task

If you are using stored procedures in a WLM-established address space, you might also need to enable RACF checking for the SERVER class.

Procedure

To enable RACF access control to check for resources in the DSNR resource class:

Issue the following command:

```
SETROPTS CLASSACT(DSNR)
```

Enabling partner LU verification

With RACF and VTAM, you can control whether two logical units (LU) that use LU 6.2 can connect to each other.

About this task

Each member of a connecting pair must establish a profile for the other member. For example, if LUAAA and LUBBB are to connect and know each other by those LUNAMES, issue RACF commands similar to these:

At LUAAA: `RDEFINE APPCLU netid.LUAAA.LUBBB UACC(NONE) ...`
At LUBBB: `RDEFINE APPCLU netid.LUBBB.LUAAA UACC(NONE) ...`

Here, *netid* is the network ID, given by the VTAM start option NETID.

When you create those profiles with RACF, use the SESSION operand to supply:

- The VTAM password as a session key (SESSKEY suboperand)
- The maximum number of days between changes of the session key (INTERVAL suboperand)
- An indication of whether the LU pair is locked (LOCK suboperand)

Finally, to enable RACF checking for the new APPCLU resources, issue this RACF command at both LUAAA and LUBBB:

```
SETROPTS CLASSACT(APPCLU)
```

Permitting RACF access

You must perform certain tasks in a required order to enable a process to use protected RACF resources.

Procedure

To enable a process to use protected RACF resources:

1. Define RACF user IDs for DB2-started tasks
2. Add RACF groups
3. Grant users and groups access

Related tasks:

"Defining DB2 resources to RACF" on page 131

"Managing authorization for stored procedures" on page 142

"Protecting connection requests that use the TCP/IP protocol" on page 151

"Establishing Kerberos authentication through RACF" on page 152

Defining RACF user IDs for DB2-started tasks

A DB2 subsystem provides started-task address spaces.

About this task

The following are DB2 started-task address spaces:

- *ssnm*DBM1 for database services
- *ssnm*MSTR for system services
- *ssnm*DIST for the distributed data facility
- Names for your WLM-established address spaces for stored procedures

You must associate each of these address spaces with a RACF user ID. You can also assign each of them to a RACF group name. The RACF user IDs and group names that are associated with DB2 address spaces are listed in the following table:

Table 35. DB2 address spaces and associated RACF user IDs and group names

Address Space	RACF User ID	RACF Group Name
DSNMSTR	SYSDSP	DB2SYS
DSNDBM1	SYSDSP	DB2SYS
DSNDIST	SYSDSP	DB2SYS
DSNWLM	SYSDSP	DB2SYS
DB2TMSTR	SYSDSPT	DB2TEST
DB2TDBM1	SYSDSPT	DB2TEST
DB2TDIST	SYSDSPT	DB2TEST
DB2TSPAS	SYSDSPT	DB2TEST
DB2PMSTR	SYSDSPD	DB2PROD
DB2PDBM1	SYSDSPD	DB2PROD
DB2PDIST	SYSDSPD	DB2PROD
CICSSYS	CICS	CICSGRP
IMSCNTL	IMS	IMSGRP

You can use one of the two ways that RACF provides to associate user IDs and groups with started tasks: the STARTED class and the started procedures table (ICHRIN03). If you use the STARTED class, the changes take effect without a subsequent IPL. If you use ICHRIN03, you must perform another IPL for the changes to take effect. You cannot start the DB2 address spaces with batch jobs.

If you have IMS or CICS applications issuing DB2 SQL requests, you must associate RACF user IDs, and can associate group names, with:

- The IMS control region
- The CICS address space

- The four DB2 address spaces

If the IMS and CICS address spaces are started as batch jobs, provide their RACF IDs and group names with the USER and GROUP parameters on the JOB statement. If they are started as started-tasks, assign the IDs and group names as you do for the DB2 address spaces, by changing the RACF STARTED class or the RACF started procedures table.

The RACF user ID and group name do not need to match those that are used for the DB2 address spaces, but they must be authorized to run the Resource Recovery Services attachment facility (for WLM-established stored procedures address spaces). Note that the WLM-established stored procedures started tasks IDs require an OMVS segment.

If your installation has implemented the RACF STARTED class, you can use it to associate RACF user IDs and group names with the DB2 started procedures address spaces. If you have not previously set up the STARTED class, you first need to enable generic profile checking for the class:

```
SETROPTS GENERIC(STARTED)
```

Then, you need to define the RACF identities for the DB2 started tasks:

```
RDEFINE STARTED DSNMSTR.**   STDATA(USER(SYSDP)   GROUP(DB2SYS)  TRUSTED(NO))
RDEFINE STARTED DSNDBM1.**   STDATA(USER(SYSDP)   GROUP(DB2SYS)  TRUSTED(NO))
RDEFINE STARTED DSNDIST.**   STDATA(USER(SYSDP)   GROUP(DB2SYS)  TRUSTED(NO))
RDEFINE STARTED DSNWLM.**    STDATA(USER(SYSDP)   GROUP(DB2SYS)  TRUSTED(NO))
RDEFINE STARTED DB2TMSTR.**  STDATA(USER(SYSDSPT) GROUP(DB2TEST) TRUSTED(NO))
...
```

Then, you need to activate the RACLIST processing to read the profiles into a data space:

```
SETROPTS CLASSACT(STARTED)
SETROPTS RACLIST(STARTED)
```

Lastly, you need to refresh the in-storage profiles:

```
SETROPTS RACLIST(STARTED) REFRESH
```

If you use the RACF-started procedures table (ICHRIN03) to associate RACF user IDs and group names with the DB2 started procedures address spaces, you need to change, reassemble, and link edit the resulting object code to z/OS. The following example shows a sample job that reassembles and link edits the RACF started-procedures table (ICHRIN03):

```
//*
//*  REASSEMBLE AND LINKEDIT THE RACF STARTED-PROCEDURES
//*  TABLE ICHRIN03 TO INCLUDE USERIDS AND GROUP NAMES
//*  FOR EACH DB2 CATALOGED PROCEDURE. OPTIONALLY, ENTRIES
//*  FOR AN IMS OR CICS SYSTEM MIGHT BE INCLUDED.
//*
//*  AN IPL WITH A CLPA (OR AN MLPA SPECIFYING THE LOAD
//*  MODULE) IS REQUIRED FOR THESE CHANGES TO TAKE EFFECT.
//*

ENTCOUNT DC    AL2(((ENDTABLE-BEGTABLE)/ENTLNGTH)+32768)
*              NUMBER OF ENTRIES AND INDICATE RACF FORMAT
*
*  PROVIDE FOUR ENTRIES FOR EACH DB2 SUBSYSTEM NAME.
*
BEGTABLE DS    0H
*        ENTRIES FOR SUBSYSTEM NAME "DSN"
         DC    CL8'DSNMSTR'        SYSTEM SERVICES PROCEDURE
```

```
         DC    CL8'SYSDSP'         USERID
         DC    CL8'DB2SYS'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
ENTLNGTH EQU   *-BEGTABLE     CALCULATE LENGTH OF EACH ENTRY
         DC    CL8'DSNDBM1'   DATABASE SERVICES PROCEDURE
         DC    CL8'SYSDSP'         USERID
         DC    CL8'DB2SYS'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DSNDIST'        DDF PROCEDURE
         DC    CL8'SYSDSP'         USERID
         DC    CL8'DB2SYS'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'SYSDSP'         USERID
         DC    CL8'DB2SYS'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DSNWLM'         WLM-ESTABLISHED S.P. ADDRESS SPACE
         DC    CL8'SYSDSP'         USERID
         DC    CL8'DB2SYS'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
*        ENTRIES FOR SUBSYSTEM NAME "DB2T"
         DC    CL8'DB2TMSTR'       SYSTEM SERVICES PROCEDURE
         DC    CL8'SYSDSPT'        USERID
         DC    CL8'DB2TEST'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DB2TDBM1'       DATABASE SERVICES PROCEDURE
         DC    CL8'SYSDSPT'        USERID
         DC    CL8'DB2TEST'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DB2TDIST'       DDF PROCEDURE
         DC    CL8'SYSDSPT'        USERID
         DC    CL8'DB2TEST'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'SYSDSPT'        USERID
         DC    CL8'DB2TEST'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
*        ENTRIES FOR SUBSYSTEM NAME "DB2P"
         DC    CL8'DB2PMSTR'       SYSTEM SERVICES PROCEDURE
         DC    CL8'SYSDSPD'        USERID
         DC    CL8'DB2PROD'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DB2PDBM1'       DATABASE SERVICES PROCEDURE
         DC    CL8'SYSDSPD'        USERID
         DC    CL8'DB2PROD'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'DB2PDIST'       DDF PROCEDURE
         DC    CL8'SYSDSPD'        USERID
         DC    CL8'DB2PROD'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'SYSDSPD'        USERID
         DC    CL8'DB2PROD'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
*        OPTIONAL ENTRIES FOR CICS AND IMS CONTROL REGION
         DC    CL8'CICSSYS'        CICS PROCEDURE NAME
         DC    CL8'CICS'           USERID
```

```
         DC    CL8'CICSGRP'        GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
         DC    CL8'IMSCNTL'   IMS CONTROL REGION PROCEDURE
         DC    CL8'IMS'            USERID
         DC    CL8'IMSGRP'         GROUP NAME
         DC    X'00'               NO PRIVILEGED ATTRIBUTE
         DC    XL7'00'             RESERVED BYTES
ENDTABLE DS    0D
         END
```

The example shows the sample entries for three DB2 subsystems (DSN, DB2T, and DB2P), optional entries for CICS and IMS, and DB2 started tasks for the DB2 subsystems, CICS, the IMS control region.

Related tasks:

"Adding RACF groups"

"Granting users and groups access" on page 138

Adding RACF groups

You can issue the **ADDGROUP** command to add a new RACF group.

About this task

You need first to issue the following **ADDUSER** command to add user DB2OWNER and give it class authorization for DSNR and USER.

```
ADDUSER  DB2OWNER  CLAUTH(DSNR USER) UACC(NONE)
```

DB2OWNER can now add users to RACF and issue the RDEFINE command to define resources in class DSNR. It also has control over and responsibility for the entire DB2 security plan in RACF.

To add group DB2 to the existing SYS1 group and make DB2OWNER the owner of the new group, issue the following RACF command:

```
ADDGROUP DB2 SUPGROUP(SYS1) OWNER(DB2OWNER)
```

To connect DB2OWNER to group DB2 with the authority to create new subgroups, add users, and manipulate profiles, issue the following RACF command:

```
CONNECT DB2OWNER GROUP(DB2) AUTHORITY(JOIN) UACC(NONE)
```

To make DB2 the default group for commands issued by DB2OWNER, issue the following RACF command:

```
ALTUSER DB2OWNER DFLTGRP(DB2)
```

To create the group DB2USER and add five users to it, issue the following RACF commands:

```
ADDGROUP DB2USER SUPGROUP(DB2)
ADDUSER (USER1 USER2 USER3 USER4 USER5) DFLTGRP(DB2USER)
```

To define a user to RACF, use the RACF ADDUSER command. That invalidates the current password. You can then log on as a TSO user to change the password.

DB2 considerations when using RACF groups:

- When a user is newly connected to, or disconnected from, a RACF group, the change is not effective until the next logon. Therefore, before using a new group name as a secondary authorization ID, a TSO user must log off and log on, or a CICS or IMS user must sign on again.

- A user with the SPECIAL, JOIN, or GROUP-SPECIAL RACF attribute can define new groups with any name that RACF accepts and can connect any user to them. Because the group name can become a secondary authorization ID, you should control the use of those RACF attributes.
- Existing RACF group names can duplicate existing DB2 authorization IDs. That duplication is unlikely for the following reasons:
  - A group name cannot be the same as a user name.
  - Authorization IDs that are known to DB2 are usually known to RACF.

  However, you can create a table with an owner name that is the same as a RACF group name and use the IBM-supplied sample connection exit routine. Then any TSO user with the group name as a secondary ID has ownership privileges on the table. You can prevent that situation by designing the connection exit routine to stop unwanted group names from being passed to DB2.

Related tasks:

"Defining RACF user IDs for DB2-started tasks" on page 134

"Granting users and groups access"

Granting users and groups access

You can use the PERMIT command to grant users or groups access to resources in class DSNR.

About this task

Suppose that the DB2OWNER group in the following example is authorized for class DSNR, owns the profiles, and has the right to change them. You can issue the following commands to authorize the DB2USER members, the system administrators, and operators to be TSO users.

These users can run batch jobs and DB2 utilities on the three systems: DSN, DB2P, and DB2T. The ACCESS(READ) operand allows use of DB2 without the ability to manipulate profiles.

```
PERMIT  DSN.BATCH  CLASS(DSNR) ID(DB2USER)  ACCESS(READ)
PERMIT  DB2P.BATCH CLASS(DSNR) ID(DB2USER)  ACCESS(READ)
PERMIT  DB2T.BATCH CLASS(DSNR) ID(DB2USER)  ACCESS(READ)
```

Defining profiles for IMS and CICS: You want the IDs for attaching systems to use the appropriate access profile. For example, to let the IMS user ID use the access profile for IMS on system DB2P, issue the following RACF command:

```
PERMIT  DB2P.MASS  CLASS(DSNR) ID(IMS)  ACCESS(READ)
```

To let the CICS group ID use the access profile for CICS on system DB2T, issue the following RACF command:

```
PERMIT  DB2T.SASS   CLASS(DSNR) ID(CICSGRP)  ACCESS(READ)
```

Providing installation authorities to default IDs: When DB2 is installed, IDs are named to have special authorities—one or two IDs for SYSADM and one or two IDs for SYSOPR. Those IDs can be connected to the group DB2USER; if they are not, you need to give them access. The next command permits the default IDs for the SYSADM and SYSOPR authorities to use subsystem DSN through TSO:

```
PERMIT  DSN.BATCH  CLASS(DSNR) ID(SYSADM,SYSOPR) ACCESS(READ)
```

Using secondary IDs: You can use secondary authorization IDs to define a RACF group. After you define the RACF group, you can assign privileges to it that are

shared by multiple primary IDs. For example, suppose that DB2OWNER wants to create a group GROUP1 and to give the ID USER1 administrative authority over the group. USER1 should be able to connect other existing users to the group. To create the group, DB2OWNER issues this RACF command:

```
ADDGROUP  GROUP1  OWNER(USER1) DATA('GROUP FOR DEPT. G1')
```

To let the group connect to the DSN system through TSO, DB2OWNER issues this RACF command:

```
PERMIT DSN.BATCH CLASS(DSNR) ID(GROUP1) ACCESS(READ)
```

USER1 can now connect other existing IDs to the group GROUP1 by using the RACF CONNECT command:

```
CONNECT (USER2 EPSILON1 EPSILON2) GROUP(GROUP1)
```

If you add or update secondary IDs for CICS transactions, you must start and stop the CICS attachment facility to ensure that all threads sign on and get the correct security information.

Allowing users to create data sets: You can use RACF to protect the data sets that store DB2 data. If you use the approach and when you create a new group of DB2 users, you might want to connect it to a group that can create data sets. To allow USER1 to create and control data sets, DB2OWNER creates a generic profile and permits complete control to USER1 and to the four administrators. The SYSDSP parameter also gives control to DB2.

```
ADDSD  'DSNC110.DSNDBC.ST*' UACC(NONE)

PERMIT 'DSNC110.DSNDBC.ST*'
       ID(USER1 SYSDSP SYSAD1 SYSAD2 SYSOP1 SYSOP2) ACCESS(ALTER)
```

Related tasks:

"Defining RACF user IDs for DB2-started tasks" on page 134

"Adding RACF groups" on page 137

Granting authorization on DB2 commands

IDs must be authorized to issue DB2 commands. If you authorize IDs by issuing DB2 GRANT statements, the GRANT statements must be made to a primary authorization ID, a secondary authorization ID, a role, or PUBLIC.

About this task

When RACF is used for access control, an ID must have appropriate RACF authorization on DB2 commands or must be granted authorization for DB2 commands to issue commands from a logged-on MVS console or from TSO SDSF.

Procedure

To ensure that an ID can issue DB2 commands from logged-on MVS consoles or TSO SDSF, choose one of the following:

- Grant authorization for DB2 commands to the primary, secondary authorization ID, or role.
- Define RACF classes and permits for DB2 commands.
- Grant SYSOPR authority to appropriate IDs.

Permitting access from remote requesters

You can use the DSNR RACF class to access the distributed data address space and to control access from remote requesters.

About this task

The following RACF commands let the users in the group DB2USER access DDF on the DSN subsystem. These DDF requests can originate from any partner in the network.

For example, to permit READ access on profile DSN.DIST in the DSNR class to DB2USER, issue the following RACF command:

```
PERMIT  DSN.DIST   CLASS(DSNR) ID(DB2USER)  ACCESS(READ)
```

If you want to ensure that a specific user can access only when the request originates from a specific LU name, you can use WHEN(APPCPORT) on the PERMIT command.

For example, to permit access to DB2 distributed processing on subsystem DSN when the request comes from USER5 at LUNAME equal to NEWYORK, issue the following RACF command:

```
PERMIT DSN.DIST CLASS(DSNR) ID(USER5) ACCESS(READ) +
       WHEN(APPCPORT(NEWYORK))
```

For connections that come through TCP/IP, use the RACF APPCPORT class or the RACF SERVAUTH class with TCP/IP Network Access Control to protect unauthorized access to DB2.

Example: To use the RACF APPCPORT class, perform the following steps:

1. Activate the ACCPORT class by issuing the following RACF command:
   ```
   SETROPTS CLASSACT(APPCPORT) REFRESH
   ```
2. Define the general resource profile and name it TCPIP. Specify NONE for universal access and APPCPORT for class. Issue the following RACF command:
   ```
   RDEFINE APPCPORT (TCPIP) UACC(NONE)
   ```
3. Permit READ access on profile TCPIP in the APPCPORT class. To permit READ access to USER5, issue the following RACF command:
   ```
   PERMIT TCPIP ACCESS(READ) CLASS(APPCPORT) ID(USER5)
   ```
4. Permit READ access on profile DSN.DIST in the DSNR class. To permit READ access to USER5, issue the following RACF command:
   ```
   PERMIT DSN.DIST CLASS(DSNR) ID(USER5) ACCESS(READ) +
          WHEN(APPCPORT(TCPIP))
   ```
5. Refresh the APPCPORT class by issuing the following RACF command:
   ```
   SETROPTS CLASSACT(APPCPORT) REFRESH RACLIST(APPCPORT)
   ```

If the RACF APPCPORT class is active on your system, and a resource profile for the requesting LU name already exists, you must permit READ access to the APPCPORT resource profile for the user IDs that DB2 uses. You must permit READ access even when you are using the DSNR resource class. Similarly, if you are using the RACF APPL class and that class restricts access to the local DB2 LU name or generic LU name, you must permit READ access to the APPL resource for the user IDs that DB2 uses.

Recommendation: Use z/OS Communications Server IP Network Access Control and z/OS Security Server RACF SERVAUTH class if you want to use the port of entry (POE) for remote TCP/IP connections.

Requirement: To use the RACF SERVAUTH class and TCP/IP Network Access Control, you must have z/OS V1.5 (or later) installed.

Example: To use the RACF SERVAUTH class and TCP/IP Network Access Control, perform the following steps:

1. Set up and configure TCP/IP Network Access Control by using the NETACCESS statement that is in your TCP/IP profile.

   For example, suppose that you need to allow z/OS system access only to IP addresses from 9.0.0.0 to 9.255.255.255. You want to define these IP addresses as a security zone, and you want to name the security zone IBM. Suppose also that you need to deny access to all IP addressed outside of the IBM security zone, and that you want to define these IP addresses as a separate security zone. You want to name this second security zone WORLD. To establish these security zones, use the following NETACCESS clause:

   ```
   NETACCESS INBOUND OUTBOUND
   ; NETWORK/MASK         SAF
     9.0.0.0/8           IBM
     DEFAULT             WORLD
   ENDNETACCESS
   ```

   Now, suppose that USER5 has an IP address of 9.1.2.3. TCP/IP Network Access Control would determine that USER5 has an IP address that belongs to the IBM security zone. USER5 would be granted access to the system. Alternatively, suppose that USER6 has an IP address of 1.1.1.1. TCP/IP Network Access Control would determine that USER6 has an IP address that belongs to the WORLD security zone. USER6 would not be granted access to the system.
2. Activate the SERVAUTH class by issuing the following TSO command:

   ```
   SETROPTS CLASSACT(SERVAUTH)
   ```
3. Activate RACLIST processing for the SERVAUTH class by issuing the following TSO command:

   ```
   SETROPTS RACLIST(SERVAUTH)
   ```
4. Define the IBM and WORLD general resource profiles in RACF to protect the IBM and WORLD security zones by issuing the following commands:

   ```
   RDEFINE SERVAUTH (EZB.NETACCESS.ZOSV1R5.TCPIP.IBM) UACC(NONE)
   RDEFINE SERVAUTH (EZB.NETACCESS.ZOSV1R5.TCPIP.WORLD) UACC(NONE)
   ```
5. Permit USER5 and SYSDSP read access to the IBM profile by using the following commands.

   ```
   PERMIT EZB.NETACCESS.ZOSV1R5.TCPIP.IBM ACCESS READ CLASS(SERVAUTH) ID(USER5)
   PERMIT EZB.NETACCESS.ZOSV1R5.TCPIP.IBM ACCESS READ CLASS(SERVAUTH) ID(SYSDSP)
   ```
6. Permit SYSDSP read access to the WORLD profile by using the following command:

   ```
   PERMIT EZB.NETACCESS.ZOSV1R5.TCPIP.WORLD ACCESS READ CLASS(SERVAUTH) ID(USER5)
   ```
7. For these permissions to take effect, refresh the RACF database by using the following command:

   ```
   SETROPTS CLASSACT(SERVAUTH) REFRESH RACLIST(SERVAUTH)
   ```

Enabling IMS transactions to use RACF authorization control of DB2 objects

You can enable IMS transactions to use RACF authorization control of DB2 objects and other resources.

Procedure

To enable IMS transactions to exploit RACF authorization of DB2 objects and resources:

1. Configure IMS to use APPC/OTMA security FULLor create an IMS Build Security Environment exit routine (DFSBSEX0). Code DFSBSEX0 to return RC4 in register 15, which will instruct IMS to create the ACEE in the dependent region.
2. Install the default DB2 exit routine DSNX@XAC.
3. Define a RACF profile for each DB2 object and resource to be accessed by IMS transactions.
4. Issue the RACF PERMIT command to authorize IMS transaction authorization IDs that are allowed to access these DB2 objects and resources.

Related concepts:

The default DB2 exit routine (RACF Access Control Module Guide)

Related information:

IMS build security environment exit routine

Administering APPC/IMS

Managing authorization for stored procedures

DB2 for z/OS provides a variety of methods to help you ensure that users are properly authorized to create and execute stored procedures. DB2 also provides ways for you to keep stored procedures secure.

About this task

- "Authorizing IDs for using RRSAF"
- "Specifying WLM-established server address spaces for stored procedures" on page 143
- "Managing authorizations for creation of stored procedures in WLM environments" on page 144
- "Authorizing users to refresh WLM environments" on page 145
- "Controlling stored procedure access to non-DB2 resources by using RACF" on page 145
- "Granting the CREATEIN privilege on schemas for stored procedures" on page 146
- "Granting privileges for using distinct types" on page 147
- "Granting privileges for using JAR files" on page 148
- "Granting privileges for executing stored procedures and stored procedure packages" on page 148
- "Controlling remote execution of stored procedures by using trusted contexts" on page 149

Authorizing IDs for using RRSAF

When started, WLM-established address spaces use the Resource Recovery Services attachment facility (RRSAF) to attach to DB2. You must authorize the IDs that are associated with WLM-established stored procedures address spaces so that they can use RRSAF.

Procedure

To authorize user IDs that are associated with WLM-established stored procedures address spaces to use RRSAF:

1. Create a *ssnm*.RRSAF profile in RACF. For example, you can define *ssnm*.RRSAF in the DSNR resource class with a universal access authority of NONE by issuing the following command:
   ```
   RDEFINE DSNR (DB2P.RRSAF  DB2T.RRSAF) UACC(NONE)
   ```
2. Refresh the in-storage profiles with the profile that you just defined. For example, you can issue the following command:
   ```
   SETROPTS RACLIST(DSNR) REFRESH
   ```
3. Add user IDs that are associated with WLM-established stored procedures address spaces to the RACF-started procedures table. For example, you can issue the following command:
   ```
   RDEFINE STARTED DSNWLM.**  STDATA(USER(SYSDP)   GROUP(DB2SYS)  TRUSTED(NO))
   ```
4. Refresh the in-storage profiles. For example, you can issue the following command:
   ```
   SETROPTS RACLIST(STARTED) REFRESH
   ```
5. Grant read access to *ssnm*.RRSAF to the IDs that are associated with the stored procedures address spaces. For example, you can issue the following command:
   ```
   PERMIT  DB2P.RRSAF  CLASS(DSNR) ID(SYSDSP)  ACCESS(READ)
   ```

Related information:

Summary of RACF commands (CICS Transaction Server for z/OS)

Specifying WLM-established server address spaces for stored procedures

You can manage access to WLM through the server resource class and specify address spaces as WLM-established server address spaces for running stored procedures.

Procedure

To specify address spaces as WLM-established server address spaces that can run stored procedures:

1. Define a new SERVER class by using the server resource class.

   If you do not define a SERVER class, any address space that connects to WLM as a server address space can run stored procedures.
2. Authorize a RACF profile to associate with the SERVER class. For example:
   ```
   RDEFINE SERVER (DB2.ssnm.applenv)
   ```

   In this command, *applenv* is the name of the application environment that is associated with the stored procedure. For example, assume that you want to define the following profile names:
   - DB2.DB2T.TESTPROC
   - DB2.DB2P.PAYROLL
   - DB2.DB2P.QUERY

   To define these profile names, use the following RACF command:
   ```
   RDEFINE SERVER (DB2.DB2T.TESTPROC DB2.DB2P.PAYROLL DB2.DB2P.QUERY)
   ```
3. Activate the resource class. For example, you can issue the following command:
   ```
   SETROPTS RACLIST(SERVER) REFRESH
   ```

4. Grant read access to the user IDs that are associated with the stored procedures address space. For example, you can issue the following commands:

```
PERMIT  DB2.DB2T.TESTPROC CLASS(SERVER) ID(SYSDSP) ACCESS(READ)
PERMIT  DB2.DB2P.PAYROLL  CLASS(SERVER) ID(SYSDSP) ACCESS(READ)
PERMIT  DB2.DB2P.QUERY    CLASS(SERVER) ID(SYSDSP) ACCESS(READ)
```

Related information:

Summary of RACF commands (CICS Transaction Server for z/OS)

Managing authorizations for creation of stored procedures in WLM environments

You can group and isolate applications into different WLM environments based on their security requirements. You can then authorize or prevent users from creating stored procedures in a security-sensitive environment.

About this task

DB2 invokes RACF to determine if users are allowed to create stored procedures in a WLM environment. The WLM ENVIRONMENT keyword on the CREATE PROCEDURE statement identifies the WLM environment to use for running a given stored procedure. DB2 performs a resource authorization check using the DSNR RACF class as follows:

- In a DB2 data sharing environment, DB2 uses the following RACF resource name:

  ```
  db2_groupname.WLMENV.wlm_environment
  ```

- In a non-data sharing environment, DB2 checks the following RACF resource name:

  ```
  db2_subsystem_id.WLMENV.wlm_environment
  ```

Attempts fail when unauthorized users try to create or run stored procedures.

Procedure

To manage authorizations for individual users or groups in the creation of stored procedures in a specific WLM environment:

Use RACF commands:

- To authorize individual users or groups of users to create stored procedures in a specific WLM environment, issue the RACF PERMIT command. For example, you can authorize the user whose ID is DB2USER1 to create stored procedures on the DB2 subsystem DB2A (non-data sharing) in a WLM environment named PAYROLL:

  ```
  PERMIT  DB2A.WLMENV.PAYROLL  CLASS(DSNR) ID(DB2USER1)  ACCESS(READ)
  ```

  When user ID DB2USER1 attempts to create a stored procedure in the PAYROLL WLM environment, DB2 performs a resource authorization check by using the DSNR RACF class and grants permission.

- To prevent users on a particular DB2 subsystem from creating stored procedures, issue the RACF **DEFINE** command. You can also use this command to revoke the default universal access of a WLM environment and set it to NONE,

  For example, you can issue the following command to prevent all users on DB2 subsystem DB2A (non-data sharing) from creating stored procedures or user-defined functions in the WLM environment named PAYROLL:

  ```
  RDEFINE DSNR (DB2A.WLMENV.PAYROLL) UACC(NONE)
  ```

Related information:

Summary of RACF commands (CICS Transaction Server for z/OS)

Authorizing users to refresh WLM environments

When you prepare a new version of a stored procedure in a WLM application environment, you need to activate the updated stored procedure by refreshing the application environment.

About this task

You can refresh the WLM environment by issuing a VARY REFRESH command at a z/OS command line. Alternatively, you can execute the WLM_REFRESH stored procedure, which is supplied by DB2 and executes the VARY REFRESH command. This stored procedure is useful when users need to refresh the WLM environment but are not authorized to issue operator commands.

Procedure

To authorize users to use the WLM_REFRESH stored procedure:

1. Grant access to the RACF resource profile for each application environment. For example, assume that you want to authorize RACF group DEVL7083 to access the WLM_REFRESH RACF resource profile for application environment DB9AWLM on subsystem DB9A. To authorize the RACF group in this way, you can issue this command:

   ```
   RDEFINE DSNR (DB9A.WLM_REFRESH.DB9AWLM)
   PE DB9A.WLM_REFRESH.DB9AWLM +
   CLASS(DSNR) ID(DEVL7083) ACCESS(READ)
   END
   ```

2. Grant the EXECUTE privilege on the stored procedure to users or groups who need to refresh the environment. For example, you can issue the following GRANT statement to authorize the RACF group DEVL7083 to execute the WLM_REFRESH stored procedure on application environment DB9AWLM:

   GUPI

   ```
   GRANT EXECUTE ON PROCEDURE SYSPROC.WLM_REFRESH TO DEVL7083;
   ```

   GUPI

   You need to grant the EXECUTE privilege only once because you supply the application environment name as a variable when you execute the stored procedure.

Related reference:

WLM_REFRESH stored procedure (DB2 Application programming and SQL)

GRANT (function or procedure privileges) (DB2 SQL)

Related information:

Summary of RACF commands (CICS Transaction Server for z/OS)

Controlling stored procedure access to non-DB2 resources by using RACF

You can control DB2 stored procedure access to non-DB2 resources (such as VSAM files) by using RACF (or another external security product).

Procedure

GUPI To control access to non-DB2 resources for an existing stored procedure that does not require RACF (or another external security product):

1. Issue the ALTER PROCEDURE statement with the SECURITY USER clause.
2. Ensure that the user ID that calls the stored procedure has RACF authority to the resources.
3. Enable RACF checking for the caller's ID.
4. For improved performance, specify the following keywords in the COFVLF*xx* member of library SYS1.PARMLIB to cache the RACF profiles in the virtual look-aside facility (VLF) of z/OS. For example:

   ```
   CLASS NAME(IRRACEE)
   EMAJ(ACEE)
   ```

GUPI

Related reference:

CREATE PROCEDURE (SQL - external) (DB2 SQL)

CREATE PROCEDURE (external) (DB2 SQL)

ALTER PROCEDURE (SQL - external) (DB2 SQL)

ALTER PROCEDURE (external) (DB2 SQL)

Related information:

COFVLFxx (virtual lookaside facility parameters) (MVS Initialization and Tuning Reference)

Granting the CREATEIN privilege on schemas for stored procedures

When a stored procedure is created, it is explicitly or implicitly qualified by a schema. Users must have the required CREATEIN privilege on the schema before they can create stored procedures.

About this task

GUPI Many users create stored procedures in the same schema at an application level. These users need the CREATEIN privilege on the schema. You can grant this privilege to a secondary ID or role that is associated with individual users. Those users can then issue a SET CURRENT SQLID statement to the secondary ID or role prior to creating stored procedures in the schema.

Procedure

To grant the CREATEIN privilege on schemas for stored procedures:

Issue a GRANT statement with the appropriate options, depending on whether you are granting the privilege to a secondary ID or to a role.

- For a secondary ID, issue a GRANT statement with the CREATEIN ON SCHEMA clause. Specify the schema name and secondary ID. For example, assume that you want a user with the secondary ID of PAOLORW to be able to create stored procedures in a schema named DEVL7083. To give this user the necessary privilege, you can issue this statement:

  ```
  GRANT CREATEIN ON SCHEMA DEVL7083 TO PAOLORW;
  ```

If the ID PAOLORW issues a CREATE PROCEDURE statement without having the required CREATEIN privilege on the schema, an error occurs, and the procedure is not created.

- For a role, issue a GRANT statement with the CREATEIN ON SCHEMA clause. Specify the schema name and the role that will be in effect when the stored procedure is created. (For users to be associated with a role, the trusted context that links them to the role needs to be defined with the ROLE AS OBJECT OWNER AND QUALIFIER clause.) For example, assume that you want to grant the CREATEIN privilege to a role named ADMINISTRATOR so that users who are associated with the ADMINISTRATOR role can create stored procedures in a schema named DEVL7083. To grant this privilege, you can issue this statement:

  ```
  GRANT CREATEIN ON SCHEMA DEVL7083 TO ROLE ADMINISTRATOR;
  ```

  If a user who is associated with the role named ADMINISTRATOR issues a CREATE PROCEDURE statement without having the required CREATEIN privilege on the schema, an error occurs, and the procedure is not created.

Results

After a secondary ID or role is granted the CREATEIN privilege for a stored procedure and then creates a stored procedure, that ID or role is the owner of that stored procedure. GUPI

Related reference:

GRANT (schema privileges) (DB2 SQL)

Granting privileges for using distinct types

Stored procedures can pass parameters that have a distinct type as a data type. When a distinct type is used as a stored procedure parameter, users who create the stored procedure need the USAGE privilege on the distinct type.

About this task

When you create a distinct type, you, as the owner of that type, implicitly have the USAGE privilege on the type. You also have the EXECUTE privilege on the associated cast functions. If other users want to create stored procedures that pass a parameter with that distinct type, you need to explicitly grant the USAGE privilege to them.

Procedure

To grant privileges for using distinct types:

Issue the GRANT statement with the USAGE ON TYPE clause, and specify the name of the distinct type.

- You can grant privileges for using distinct types to an authorization ID. For example, assume that you want the user whose authorization ID is PAOLORW to be able to use the US_DOLLARS distinct type, which you created. Specifically, this user needs to create a stored procedure that passes a parameter with this data type. To grant this privilege, you can issue this statement:

  GUPI

  ```
  GRANT USAGE ON TYPE US_DOLLARS TO PAOLORW;
  ```

  GUPI

- You can grant privileges for using distinct types to a role. For example, if you want the role named ADMINISTRATOR to be able to use the US_DOLLARS distinct type, you can issue this statement:

  GUPI

  ```
  GRANT USAGE ON TYPE US_DOLLARS TO ROLE ADMINISTRATOR;
  ```

  GUPI

Related reference:

GRANT (type or JAR file privileges) (DB2 SQL)

Granting privileges for using JAR files

To use Java archive (JAR) files, you need to have the USAGE privilege on the JAR.

About this task

If you have the USAGE privilege on the JAR, you can specify a JAR file in the EXTERNAL NAME clause of a stored procedure with a language type of Java.

Procedure

To grant privileges for using JAR files:

Issue the GRANT statement, specifying the USAGE clause. For example, assume that you want the user whose AUTHID is PAOLORW to create a Java stored procedure, EMPDTL1J. Assume that the external name of the stored procedure is to be DEVL7083.EmpJar:EmpDtl1J.GetEmpDtls, where:

DEVL7083.EmpJar
: Is the JAR file name.

EmpDtl1J
: Is the class name.

GetEmpDtls
: Is the method name.

AUTHID PAOLORW needs the USAGE privilege (from the JAR file owner ID or schema that was used for executing the INSTALL_JAR stored procedure). The following statement grants this privilege:

GUPI

```
GRANT USAGE ON JAR DEVL7083.EmpJar TO PAOLORW;
```

GUPI

In addition, if specified, the contents of the JAR file must already be installed in the DB2 catalog at the time the stored procedure is created.

Related reference:

GRANT (type or JAR file privileges) (DB2 SQL)

Granting privileges for executing stored procedures and stored procedure packages

After you create a stored procedure, you need to grant EXECUTE privilege to users who plan to run the stored procedure and the stored procedure package. You can use the GRANT statement to grant the required privileges.

About this task

GUPI Invoking a stored procedure requires the EXECUTE privilege on the stored procedure. For external stored procedures (including external SQL procedures), additional authority is needed for the stored procedure package and for most packages that run in the stored procedure.

Procedure

To grant privileges for executing stored procedures and stored procedure packages:

1. Issue the SQL GRANT statement with the EXECUTE ON PROCEDURE clause to the appropriate authorization ID or role.
   - To grant the EXECUTE privilege to an authorization ID, use the GRANT statement with the EXECUTE ON PROCEDURE clause. For example, to grant EXECUTE privilege for a stored procedure named SPNAME to a user whose authorization ID is PAOLORW, you can issue the following statement:
     ```
     GRANT EXECUTE ON PROCEDURE SPNAME TO PAOLORW;
     ```
   - To grant the EXECUTE privilege to a role, use the GRANT statement with the EXECUTE ON PROCEDURE clause and the ROLE clause. For example, to grant EXECUTE privilege for a stored procedure named SPNAME to a role named ADMINISTRATOR, you can issue the following statement:
     ```
     GRANT EXECUTE ON PROCEDURE SPNAME TO ROLE ADMINISTRATOR;
     ```

   The DYNAMICRULES behavior for the plan or package that contains the CALL statement determines which authorization ID or role holds the privilege.
2. Issue the SQL GRANT EXECUTE ON PACKAGE statement with the appropriate options, depending on whether you are granting the privilege to an authorization ID or a role:
   - To grant the EXECUTE privilege on the package to an authorization ID, issue the GRANT statement with the EXECUTE ON PACKAGE clause. For example, to grant the privilege to execute a package named PKGNAME to a user whose authorization ID is PAOLORW, you can issue this statement:
     ```
     GRANT EXECUTE ON PACKAGE PKGNAME TO PAOLORW;
     ```
   - To grant the EXECUTE privilege on the package to a role, issue the GRANT statement with the EXECUTE ON PACKAGE clause and the ROLE clause. For example, to grant this privilege to execute a package named PKGNAME to a role named ADMINISTRATOR, you can issue this statement:
     ```
     GRANT EXECUTE ON PACKAGE PKGNAME TO ROLE ADMINISTRATOR;
     ```

   The complete syntax of the GRANT statement that you should use depends on the type of package. GUPI

Related reference:

CALL (DB2 SQL)

GRANT (function or procedure privileges) (DB2 SQL)

GRANT (package privileges) (DB2 SQL)

Controlling remote execution of stored procedures by using trusted contexts

You can use trusted contexts and roles to control how a stored procedure can be executed. A *trusted context* is an independent database entity that is based on a system authorization ID (SYSTEM AUTHID) and connection trust attributes.

Before you begin

To use trusted connections, you cannot set the ALL subsystem parameter to ALL and set the RESTART subsystem parameter to DEFER on installation panel DSNTIPS.

About this task

GUPI For a remote stored procedure CALL, the SYSTEM AUTHID is derived from the system user ID that is provided by an external entity, such as a middleware server. This ID is derived when the connection is initiated. The connection trust attributes are as follows, specified in the CREATE TRUSTED CONTEXT statement:

ADDRESS
IP address or domain name. (The protocol is restricted to TCP/IP only.)

SERVAUTH
A resource in the RACF SERVAUTH class.

ENCRYPTION
Minimum level of encryption for the connection:

NONE
No encryption. This is the default value.

LOW DRDA data stream encryption.

HIGH Secure Sockets Layer (SSL) encryption.

Procedure

To call a stored procedure in trusted contexts:

1. Define a role by issuing the CREATE ROLE statement. A *role* is a database entity that groups together one or more privileges and that can be assigned to users by using a trusted context. A role can be used in conjunction with a trusted context and stored procedures to identify one or more authorization IDs that can execute a stored procedure. For example, assume that you want to call stored procedure DEVL7083.EMPDTL1C, which resides on DB2 subsystem DB9A by using authorization ID PAOLORW. Assume also that you want to define a role called SP_CALLER for use by PAOLORW. You can issue the following SQL statement:
   ```
   CREATE ROLE SP_CALLER;
   ```
2. Grant the EXECUTE privilege on a stored procedure to that role. For example, to grant the EXECUTE privilege to the role called SP_CALLER for the stored procedure named EMPDTL1C, you can issue the following statement:
   ```
   GRANT EXECUTE ON PROCEDURE DEVL7083.EMPDTL1C TO ROLE SP_CALLER;
   ```
3. Have an authorized user bind the stored procedure package. The user either needs SYSADM authority or must have explicitly bind authority for that stored procedure. For example, assume that an authorized user wants to bind stored procedure DEVL7083.EMPDTL1C into stored procedure package DEVL7083.EMPDTL1CPKG. You can issue the following statement:
   ```
   BIND PACKAGE(DEVL7083) MEMBER(EMPDTL1CPKG)
   ```
4. Grant the EXECUTE privilege on the stored procedure package to the authorization ID or role that needs to run it. For example, to grant the EXECUTE privilege on stored procedure package DEVL7083.EMPDTL1CPKG to the role named SP_CALLER, you can issue this statement:

```
GRANT EXECUTE ON PACKAGE DEVL7083.EMPDTL1CPKG TO ROLE SP_CALLER;
```

5. Define the trusted context. For example, assume that you want to define a trusted context named TRUSTED_EMPDTL1C that uses:
   - System authorization ID PAOLORW
   - Default role SP_CALLER
   - IP address 9.30.28.113

   To define this trusted context, you can issue the following statement:

```
CREATE TRUSTED CONTEXT TRUSTED_EMPDTL1C
BASED UPON CONNECTION USING SYSTEM AUTHID PAOLORW
ATTRIBUTES (ADDRESS '9.30.28.113')
DEFAULT ROLE SP_CALLER
ENABLE;
```

GUPI

6. Optional: Verify that the authorization ID can execute the stored procedure by running the application program that invokes the stored procedure and looking at the system output. For example, assume that an application named CALLEMPD uses a CALL *:host-variable* statement to invoke the stored procedure named DEVL7083.EMPDTL1C. Assume also that the application program generates trace output. You might see the following system output:

```
DEVL7083.CALLEMPD - Run started.
Data returned in result sets is limited to the first 50 rows.
Data returned in result set columns is limited to the first 100
     bytes or characters.
DEVL7083.CALLEMPD - Calling the stored procedure.
DEVL7083.CALLEMPD - Run completed.
```

Related reference:

CREATE TRUSTED CONTEXT (DB2 SQL)

CREATE ROLE (DB2 SQL)

GRANT (function or procedure privileges) (DB2 SQL)

Protecting connection requests that use the TCP/IP protocol

You can set your DB2 subsystem to send or receive connection requests that use the TCP/IP network protocol. You need to authorize the started task user ID (SYSDSP) that is associated with the DB2 distributed address space (ssnmDIST) to use the z/OS UNIX System Services.

Procedure

To secure connection requests over TCP/IP:

1. Create an OMVS segment in the RACF user profile for the started task user ID (SYSDSP)
2. Specify a z/OS UNIX user identifier of 0 and the maximum number of files of that the user is allowed to have concurrently active to 131702 in the following command:

   ```
   ADDUSER ddfuid OMVS(UID(0) FILEPROCMAX(131702))
   ```

   If the *ddfuid* ID already exists, use:

   ```
   ALTUSER ddfuid OMVS(UID(0) FILEPROCMAX(131702))
   ```

   The started task user ID of the DB2 distributed address space only needs a z/OS UNIX user identifier of 0 (UID(0)). A UID 0 is considered a superuser. If you don't want to grant the superuser authority to the started task user ID that

is associated with the ssnmDIST address space during the DB2 installation, you can specify a value other than 0 for the UID parameter. Make sure that the value is a valid z/OS UNIX user identifier.

3. If you want to assign a z/OS group name to the address space, assign an OMVS segment to the z/OS group name by using one of the following RACF commands:

   ```
   ADDGROUP ddfgnm OMVS(GID(nnn))...
   ALTGROUP ddfgnm OMVS(GID(nnn))...
   ```

   where *ddfgnm* is the z/OS group name and *nnn* is any valid, unique identifier.

   The standard way to assign a z/OS userid and a z/OS group name to a started address space is to use the z/OS Security Server (RACF) STARTED resource class. This method enables you to dynamically assign a z/OS user ID by using commands instead of requiring an IPL to have the assignment take effect. The alternative method to assign a z/OS user ID and a z/OS group name to a started address space is to change the RACF started procedures table, ICHRIN03.

Results

You can also manage TCP/IP requests in a trusted context. A trusted context allows you to use a trusted connection without needing additional authentication and to acquire additional privileges through the definition of roles.

The TCP/IP Already Verified (DSN6FAC TCPALVER) controls whether DB2 accepts TCP/IP connection requests that contain only a user ID. However, in the case of a trusted context, it is the definition of the trusted context, not the TCPALVER setting, handles the requirement for switching users of a trusted connection.

Do not set DSN6FAC TCPALVER to YES if you use a trusted context. If you set TCPALVER to YES in the definition of the trusted context, you need to define the authorization ID that establishes the trusted connection in the USER clause to enforce the authentication requirement.

Related tasks:

"Defining DB2 resources to RACF" on page 131

"Permitting RACF access" on page 133

"Managing authorization for stored procedures" on page 142

"Establishing Kerberos authentication through RACF"

Establishing Kerberos authentication through RACF

Kerberos security is a network security technology that was developed at the Massachusetts Institute of Technology. The Kerberos security technology does not require passwords to flow in readable text because it uses encrypted tickets that contain authentication information for the users.

About this task

DB2 can use Kerberos security services to authenticate remote users. With Kerberos security services, remote users need to issue their Kerberos name and password to access DB2. They can use the same name and password for access throughout the network, which makes a separate password to access DB2 unnecessary.

A remote user who is authenticated to DB2 by means of Kerberos authentication must be registered in RACF profiles. An organization that runs a Kerberos server establishes its own *realm*. The name of the realm in which a client is registered is part of the client's name and can be used by the application server to accept or reject a request.

Procedure

To authenticate and register a remote user in RACF profiles:

1. Define the Kerberos realm to RACF by issuing the following command:

   ```
   RDEFINE REALM KERBDFLT KERB(KERBNAME(localrealm) PASSWORD(mykerpw)
   ```

   You must specify the name of the local realm in the definition. You must also specify a Kerberos password for RACF to grant Kerberos tickets.
2. Define local principals to RACF by issuing the following command:

   ```
   AU RONTOMS KERB(KERBNAME(rontoms))
   ALU RONTOMS PASSWORD(new1pw) NOEXPIRE
   ```

   Make sure to change RACF passwords before the principals become active Kerberos users.
3. Map foreign Kerberos principals by defining KERBLINK profiles to RACF with a command similar to the following:

   ```
   RDEFINE KERBLINK /.../KERB390.ENDICOTT.IBM.COM/RWH APPLDATA('RONTOMS')
   ```

   You must also define a principal name for the user ID that is used in the *ssnmDIST* started task address space, as shown in the following example:

   ```
   ALU SYSDSP PASSWORD(pw) NOEXPIRE KERB(KERBNAME(SYSDSP))
   ```

   The ssnmDIST address space must have the RACF authority to use its SAF ticket parsing service. The user ID that is used for the *ssnmDIST* started task address space is SYSDSP.
4. Define foreign Kerberos authentication servers to the local Kerberos authentication server by issuing the following command:

   ```
   RDEFINE REALM /.../KERB390.ENDICOTT.IBM.COM/KRBTGT/KER2000.ENDICOTT.IBM.COM +
   KERB(PASSWORD(realm0pw))
   ```

   You must supply a password for the key to be generated. REALM profiles define the trust relationship between the local realm and the foreign Kerberos authentication servers. PASSWORD is a required keyword, so all REALM profiles have a KERB segment.

What to do next

Data sharing environment: Data sharing Sysplex environments that use Kerberos security must have a Kerberos Security Server instance running on each system in the Sysplex. The instances must either be in the same realm and share the same RACF database, or have different RACF databases and be in different realms.

Related tasks:

"Defining DB2 resources to RACF" on page 131

"Permitting RACF access" on page 133

"Managing authorization for stored procedures" on page 142

"Protecting connection requests that use the TCP/IP protocol" on page 151

Implementing DB2 support for enterprise identity mapping

Enterprise identity mapping (EIM) enables the mapping of user identities across servers that are integrated but that do not share user registries. DB2 supports the EIM capability by implementing the SAF user mapping plug-in callable service, which is part of the z/OS Security Server (RACF).

Before you begin

You can exploit the EIM support by using the IBM WebSphere Application Server 6.0.1, the IBM DB2 Driver for JDBC and SQLJ, and the IBM DB2 Driver for ODBC and CLI.

You must install the z/OS SAF user mapping plug-in service to implement the DB2 support for the EIM.

Procedure

To implement the DB2 support for EIM:

1. Configure the z/OS LDAP server with a TDBM backend
2. Set up RACF for the LDAP server
3. Configure the z/OS EIM domain controller
4. Add the SAF user mapping data set to LNKLIST

Results

If you enable DB2 support for EIM, DB2 can retrieve the mapped user ID from the SAF user mapping plug-in and specify the information in the ICTX structure. During the ENVIR=CREATE processing, DB2 passes the information to RACF through the RACROUTE REQUEST=VERIFY macro service. When RACF successfully authenticates the user, the ICTX structure is anchored in the ACEEICTX field.

Note: The SAF user identity mapping plug-in service will not be supported in the future release of DB2 for z/OS.

Related reference:

z/OS Security Server RACF Command Language Reference

z/OS Integrated Security Services LDAP Server Administration and Use

z/OS Integrated Security Services Enterprise Identity Mapping (EIM) Guide and Reference

Configuring the z/OS LDAP server

When DB2 receives an authenticated user registry name, it invokes the SAF user mapping plug-in service. This service uses the EIM domain, which is an LDAP server, to retrieve the z/OS user ID that is used as the primary authorization ID.

About this task

You can use the LDAP configuration (**ldapcnf**) utility to configure and set up a z/OS LDAP server. The LDAP configuration utility requires the `ldap.profile` input file that is shipped in the `/usr/lpp/ldap/etc` directory. The `ldap.profile` file contains the settings that you need to set up the LDAP server.

Procedure

To configure a z/OS LDAP server:

1. Copy and modify the `ldap.profile` file based on your own environment.
2. Issue the following command to run the LDAP configuration utility with the `ldap.profile` file that you modified:

   ```
   ldapcnf –i ldap.profile
   ```

   The LDAP configuration utility generates the following output files:
   - SLAPDCNF member as the LDAP server configuration file
   - SLAPDENV member as the LDAP server environment variable file
   - PROG member for APF authorization
   - GLDSRV procedure for starting the LDAP server
   - DSNAOINI configuration file for DB2 CLI
   - TDBSPUFI DB2 SQL DDL statements for creating the TDBM environment
   - DBCLI DB2 SQL BIND statements for binding the CLI/ODBC packages and plan
   - RACF member for creating the RACF profiles that protect the LDAP server service task and grant permissions for the user ID to run the LDAP server

   These output files are stored in the OUTPUT_DATASET_NAME that you specified in the `ldap.profile` file.
3. Submit the following output JCL files after DB2 is started:
   - DBCLI member file
   - RACF member file
4. Submit the TDBSPUFI member file by using the DB2 SPUFI interactive tool.
5. Start the LDAP server from SDSF or the operator's console.

   The name of the LDAP server procedure file is the same as the user ID that is specified on the LDAPUSRID statement. The pre-assigned value is GLDSRV.

   To start the LDAP server from SDSF, enter:

   ```
   /s GLDSRV
   ```

   To start the LDAP server from the operator's console, enter:

   ```
   s GLDSRV
   ```
6. Copy the `schema.user.ldif` file from the `/usr/lpp/ldap/etc` directory to a local directory
7. Use the following **ldapmodify** utility to modify the schema entry for the TDBM backend

   ```
   ldapmodify -h ldaphost -p ldapport -D binddn -w passwd -f file
   ```

   The following example shows how to use the **ldapmodify** utility:

   ```
   ldapmodify –h v25ec099.svl.ibm.com –p 3389
   –D "cn=LDAP Administrator"
   –w secret –f schema.user.ldif
   ```

   At the top of the `schema.user.ldif` file, find the following line, and supply the appropriate TDBM suffix in that line

```
dn: cn=schema, <suffix>
```

The suffix is the same value that is used in the TDBM_SUFFIX statement in the `ldap.profile` file, as in the following example:

```
dn: cn=schema, o=IBM, c=US
```

8. Use the **ldapadd** utility to load the suffix entry and to create a user ID that is used by the SAF user mapping plug-in for binding with the LDAP server. You can use the following **ldapadd** utility statement:

   ```
   ldapadd –h ldaphost –p ldapport –D binddn –w passwd –f file
   ```

   The following is an example of using the **ldapadd** utility:

   ```
   ldapadd –h v25ec099.svl.ibm.com –p 3389
   –D "cn=LDAP Administrator"
    –w secret –f setup.ldap.ldif
   ```

Setting up RACF for the z/OS LDAP server

After you configure the z/OS LDAP server, you need to set up RACF to activate identity mapping. You also need to grant DB2 authority to use the SAF user mapping plug-in service.

Procedure

To set up RACF for the z/OS LDAP server:

1. Enable identity mapping by activating the FACILITY class.

   The FACILITY class must be active to enable identity mapping. Use the following **SETROPTS** command if it is not already active at your installation:

   ```
   SETROPTS CLASSACT(FACILITY)
   ```

2. Define a KEYMSTR profile to store an encryption key.

   Make sure to choose a key that is known only to the security administrator, and store it in the KEYMSTR profile that you defined, as shown in the following example:

   ```
   RDEF KEYSMSTR LDAP.BINDPW.KEY SSIGNON(KEYMASKED(0123456789ABCDEF))
   ```

   The LDAP BIND passwords are encrypted with the key that is stored in the LDAP.BINDPW.KEY profile. The value of the key in this example is 0123456789ABCDEF.

3. Authorize DB2 to request lookup services by defining and granting READ access to the SYSDSP user in the following RACF profiles:

   ```
   RDEF FACILITY IRR.RGETINFO.EIM UACC(NONE)
   PE IRR.RGETINFO.EIM ACCESS(READ) ID(SYSDSP) CL(FACILITY)

   RDEF FACILITY IRR.RDCEKEY UACC(NONE)
   PE IRR.RDCEKEY ACCESS(READ) ID(SYSDSP) CL(FACILITY)
   ```

4. Define the IRR.PROXY.DEFAULTS profile in the FACILITY class, as follows:

   ```
   RDEF FACILITY IRR.PROXY.DEFAULTS
   PROXY(LDAPHOST('ldap://v25ec099.svl.ibm.com:3389')
   BINDDN('cn=eim user,o=IBM,c=US') BINDPW('secret'))
   EIM(DOMAINDN('ibm-eimDomainName=My Domain,o=IBM,c=US')
   LOCALREG('My Target Registry'))

   SETROPTS RACLIST(FACILITY) REFRESH
   ```

5. Grant DB2 the authority to use the SAF user mapping plug-in service by issuing the following commands:

   ```
   RDEF PROGRAM IRRSPIM ADDMEM ('USER.PRIVATE.DLLLIB'//NOPADCHK)
   PE IRRSPIM ACCESS(READ) ID(SYSDSP) CL(PROGRAM)
   ```

```
RDEF PROGRAM IRRSPIME ADDMEM ('USER.PRIVATE.DLLLIB'//NOPADCHK)
PE IRRSPIME ACCESS(READ) ID(SYSDSP) CL(PROGRAM)

SETROPTS WHEN(PROGRAM) REFRESH
```

Setting up the EIM domain controller

After you set up the LDAP server and RACF, you need to use the RACF *eimadmin* utility to create and configure an EIM domain controller.

Procedure

To create an EIM domain controller in this situation:

1. Create an EIM domain by issuing the following command:

   ```
   eimadmin –aD -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b "cn=LDAP Administrator" -w secret
   ```

   The example shows that the new domain name is "My Domain." It also shows that the TDBM_SUFFIX statement in the `ldap.profile` file is defined as o=IBM,c=US.

2. Grant the EIM user access to the EIM domain for performing lookup services by issuing the following command:

   ```
   eimadmin -aC -c MAPPING -q "cn=eim user, o=IBM, c=US" -f DN
   -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret
   ```

3. Create the source registry in the EIM domain by issuing the following command:

   ```
   eimadmin -aR -r "My Source Registry" -y KERBEROS
   -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret
   ```

4. Create the target registry in the EIM domain by issuing the following command:

   ```
   eimadmin -aR -r "My Target Registry" -y RACF
   -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret
   ```

5. Add the enterprise identifier “Cat” to the EIM domain by issuing the following command:

   ```
   eimadmin -aI -i "Cat" -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret
   ```

   You can add multiple enterprise identifiers to the same EIM domain at any time.

6. Associate registry user IDs with the identifiers in the EIM domain by issuing the following commands:

   ```
   eimadmin -aA -u "Kitty" -r "My Source Registry" -t SOURCE
   -i "Cat" -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret

   eimadmin -aA -u "Buffy" -r "My Target Registry" -t TARGET
   -o "db2/stlec1/va1adist" -i "Cat"
   -d 'ibm-eimDomainName=My Domain,o=IBM,c=US'
   -h ldap://v25ec099.svl.ibm.com:3389
   -b 'cn=LDAP Administrator' -w secret
   ```

Specify the "-o" flag with the "*db2/location-name/subsystem-name*"+ "dist" value when you define a user ID for DB2 to use as the primary authorization ID in your target registry. As the examples show, when DB2 calls the SAF user mapping plug-in service to retrieve the primary authorization ID, DB2 specifies the additional *db2/location-name/subsystem-name*"+ "dist" information for the plug-in service to look up.

If a target identity is found with the same information, the target identity "Buffy" is returned. If the target identity does not contain any additional information, user ID "Buffy" is also returned to DB2. However, if the target registry contains multiple user identities and if none of them contains the recommended additional information, no user identity is returned to DB2.

Adding the SAF user mapping plug-in data set to LNKLIST

The SAF user mapping plug-in IRRSPIME resides in a z/OS data set. This data set must be included in the LNKLST. If the data set is not included, you need to add it to the LNKLST.

Procedure

To add the z/OS data set that contains the SAF user mapping plug-in to the LNKLST:

1. Define a new LNKLST by issuing the following command from the operator console:

   ```
   SETPROG LNKLST,DEFINE,NAME=MYLNKLST,COPYFROM=CURRENT
   ```

2. Add the USER.PRIVATE.DLLLIB data set on the USER01 volume to the new MYLNKLST by issuing the following command:

   ```
   SETPROG LNKLST,ADD,NAME=MYLNKLST,DSNAME=USER.PRIVATE.DLLLIB,
   VOLUME=USER01
   ```

3. Activate the new MYLNKLST by issuing the following command:

   ```
   SETPROG LNKLST,ACTIVATE,NAME=MYLNKLST
   ```

4. Use the MYLNKLST to update the current tasks in the system by issuing the following command:

   ```
   SETPROG LNKLST,UPDATE,JOB=*
   ```

Implementing DB2 support for distributed identity filters

A *distributed identity filter* is a RACF mapping association between a RACF user ID and one or more distributed user identities. You can use the RACF **RACMAP** command to associate a distributed user identity with a RACF user ID.

Before you begin

RACF distributed identity filters are implemented through z/OS identify propagation. You must install and run z/OS Version 1 Release 11 to use distributed identity filters.

About this task

DB2 provides support for z/OS identify propagation and distributed identity filters. You need to create distributed identity filters to take advantage of this support.

Procedure

To create a distributed identity filter:

1. Activate the RACF general resource IDIDMAP class and enable it for RACLIST processing by issuing the following command:

   ```
   SETROPTS CLASSACT(IDIDMAP) RACLIST(IDIDMAP)
   ```

2. Define a distributed identity filter and associate the distributed user name with a RACF user ID by issuing the RACF **RACMAP** command. To define a filter for a non-LDAP user name, specify the user name as a simple character string to be defined in a non-LDAP registry. Suppose that the distributed user name is 'MARY' which is defined in user registry 'Registry01'. If you want to map this user name to RACF user ID 'DB2USER1', you can issue the **RACMAP** command, as follows

   ```
   RACMAP ID(DB2USER1) MAP
     USERIDFILTER(NAME('MARY'))
     REGISTRY(NAME('Registry01'))
     WITHLABEL('Filter for MARY from Registry01')
   ```

3. Refresh the IDIDMAP class profile by issuing the following command:

   ```
   SETROPTS RACLIST(IDIDMAP) REFRESH
   ```

4. If necessary, review the distributed identity filter by issuing the following RACMAP LISTMAP command:

   ```
   RACMAP ID(DB2USER1) LISTMAP
   ```

   If the new filter is successfully created, the following ouput is returned:

   ```
   Mapping information for user DB2USER1:
     Label: Filter for MARY from Registry01
     Distributed Identity User Name Filter:
       >MARY<
     Registry name:
       >Registry01<
   ```

Results

The new filter assigns RACF user ID DB2USER1 when the distributed identity is user MARY from Registry01. When user MARY authenticates her identity at her distributed application server and performs tasks that access a remote DB2 server system, DB2 passes distributed user name MARY and registry name Registry01 as character strings to RACF.

During DB2 remote connection processing, DB2 calls the RACF RACROUTE REQUEST=VERIFY ENVIR=CREATE macro service. RACF uses these data values to search the IDIDMAP profiles for a matching filter. RACF finds the matching filter labeled 'Filter for MARY from Registry01 and assigns it the DB2USER1 user ID. The remote connection then executes its transactions with the authority of the DB2USER1 user ID. If in place, audit records for this transaction contains both RACF user ID DB2USER1, distributed user MARY, and registry name Registry01 that DB2 passes to RACF.

Related reference:

z/OS Security Server RACF Security Administrator's Guide

Managing connection requests from local applications

Different local processes enter the access control procedure at different points, depending on the environment in which they originate.

The following processes go through connection processing only:

- Requests originating in TSO foreground and background (including online utilities and requests through the call attachment facility)
- JES-initiated batch jobs
- Requests through started task control address spaces (from the z/OS START command)

The following processes go through connection processing and can later go through the sign-on processing:

- The IMS control region.
- The CICS recovery coordination task.
- DL/I batch.
- Applications that connect using the Resource Recovery Services attachment facility (RRSAF).

The following processes go through sign-on processing:

- Requests from IMS dependent regions (including MPP, BMP, and Fast Path)
- CICS transaction subtasks

IMS, CICS, RRSAF, and DDF-to-DDF connections can send a sign-on request, typically to execute an application plan. That request must provide a primary ID, and can also provide secondary IDs. After a plan is allocated, it need not be deallocated until a new plan is required. A different transaction can use the same plan by issuing a new sign-on request with a new primary ID.

Processing of connection requests

A connection request makes a new connection to DB2; it does not reuse an application plan that is already allocated. Therefore, an essential step in processing the request is to check that the ID is authorized to use DB2 resources.

DB2 completes the following steps to process a connection request:

1. DB2 obtains the initial primary authorization ID. As shown in the following table, the source of the ID depends on the type of address space from which the connection was made.

Table 36. Sources of initial primary authorization IDs

Source	Initial primary authorization ID
TSO	TSO logon ID.
BATCH	USER parameter on JOB statement.
IMS control region or CICS	USER parameter on JOB statement.
IMS or CICS started task	Entries in the started task control table.
Remote access requests	Depends on the security mechanism used.

2. RACF is called through the z/OS system authorization facility (SAF) to check whether the ID that is associated with the address space is authorized to use the following resources:
   - The DB2 resource class (CLASS=DSNR)
   - The DB2 subsystem (SUBSYS=*ssnm*)
   - The requested connection type

   The SAF return code (RC) from the invocation determines the next step, as follows:
   - **If RC > 4**, RACF determined that the RACF user ID is not valid or does not have the necessary authorization to access the resource name. DB2 rejects the request for a connection.
   - **If RC = 4**, the RACF return code is checked.
     - If RACF return code value is **equal to 4**, the resource name is not defined to RACF and DB2 rejects the request with reason code X'00F30013'.
     - If RACF return code value is **not equal to 4**, RACF is not active. DB2 continues with the next step, but the connection request and the user are not verified.
   - **If RC = 0**, RACF is active and has verified the RACF user ID; DB2 continues with the next step.
3. If RACF is active and has verified the RACF user ID, DB2 runs the connection exit routine. To use DB2 secondary IDs, you must replace the exit routine.

   If you do not want to use secondary IDs, do nothing. The IBM-supplied default connection exit routine continues the connection processing. The process has the following effects:
   - The DB2 primary authorization ID is set based on the following rules:
     - If a value for the initial primary authorization ID exists, the value becomes the DB2 primary ID.
     - If no value exists (the value is blank), the primary ID is set by default, as shown in the following table.

Table 37. Sources of default authorization identifiers

Source	Default primary authorization ID
TSO	TSO logon ID
BATCH	USER parameter on JOB statement
Started task, or batch job with no USER parameter	Default authorization ID set when DB2 was installed (UNKNOWN AUTHID on installation panel DSNTIPP)
Remote request	None. The user ID is required and is provided by the DRDA requester.

   - The SQL ID is set equal to the primary ID.
   - No secondary IDs exist.
4. DB2 determines if TSO and BATCH connections that use DSN, RRSAF, and Utilities are trusted.

   For a TSO and BATCH connection that uses DSN, RRSAF, and Utilities, DB2 checks to see if a matching trusted context is defined for the primary authorization ID and the job name. If a matching trusted context is found, the connection is established as trusted.

Related concepts:

"Connection routines and sign-on routines" on page 245

Related tasks:

"Using sample connection and sign-on exit routines for CICS transactions" on page 165

"Specifying connection and sign-on routines" on page 245

"Debugging connection and sign-on routines" on page 254

Related reference:

"Processing of sign-on requests" on page 163

Using secondary IDs for connection requests

If you want to use DB2 secondary authorization IDs, you must replace the default connection exit routine. If you want to use RACF group names as DB2 secondary IDs, the easiest method is to use the IBM-supplied sample routine.

About this task

The following table lists the difference between the default and sample connection exit routines.

Table 38. Differences between the default and sample connection exit routines

Default connection exit routine	Sample connection exit routine
Supplied as object code.	Supplied as source code. You can change the code.
Installed as part of the normal DB2 installation procedure.	Must be compiled and placed in the DB2 library.
Provides values for primary IDs and SQL IDs, but does not provide values for secondary IDs.	Provides values for primary IDs, secondary IDs, and SQL IDs.

The sample connection exit routine has the following effects:

- The sample connection exit routine sets the DB2 primary ID in the same way that the default routine sets the DB2 primary ID, and according to the following rules:
  - If the initial primary ID is not blank, the initial ID becomes the DB2 primary ID.
  - If the initial primary ID is blank, the sample routine provides the same default value as does the default routine.
  - If the sample routine cannot find a nonblank primary ID, DB2 uses the default ID (UNKNOWN AUTHID) from the DSNTIPP installation panel. In this case, no secondary IDs are supplied.
- The sample connection exit routine sets the SQL ID based on the following criteria:
  - The routine sets the SQL ID to the TSO data set name prefix in the TSO user profile table if the following conditions are true:
    - The connection request is from a TSO-managed address space, including the call attachment facility, the TSO foreground, and the TSO background.
    - The TSO data set name prefix is equal to the primary ID or one of the secondary IDs.
  - In all other cases, the routine sets the SQL ID equal to the primary ID.

- The secondary authorization IDs depend on RACF options:
  - If RACF is not active, no secondary IDs exist.
  - If RACF is active but its "list of groups" option is not active, one secondary ID exists (the default connected group name) if the attachment facility supplied the default connected group name.
  - If RACF is active and the "list of groups" option is active, the routine sets the list of DB2 secondary IDs to the list of group names to which the RACF user ID is connected. Those RACF user IDs that are in REVOKE status do not become DB2 secondary IDs. The maximum number of groups is 1012. The list of group names is obtained from RACF and includes the default connected group name.

If the default connection exit routine and the sample connection exit routine do not provide the flexibility and features that your subsystem requires, you can write your own exit routine.

Processing of sign-on requests

Requests can come from IMS-dependent regions, CICS transaction subtasks, or RRS connections. For each of these types of requests, the initial primary ID is obtained immediately before a plan for the transaction is allocated. A new sign-on request can run the same plan without de-allocating and reallocating the plan.

Unlike the connection processing, the sign-on processing does not check the RACF for the user ID of the address space. DB2 completes the following steps to process sign-on requests:

1. DB2 determines the initial primary ID as follows:

   For IMS sign-ons from message-driven regions, if the user has signed on, the initial primary authorization ID is the user's sign-on ID. IMS passes to DB2 the IMS sign-on ID and the associated RACF connected group name, if one exists. If the user has not signed on, the primary ID is the LTERM name, or if that is not available, the PSB name. For a batch-oriented region, the primary ID is the value of the USER parameter on the job statement, if that is available. If that is not available, the primary ID is the program's PSB name.

   For remote requests, the source of the initial primary ID is determined by entries in the SYSIBM.USERNAMES table. For connections using Resource Recovery Services attachment facility, the processing depends on the type of signon request:
   - SIGNON
   - AUTH SIGNON
   - CONTEXT SIGNON

   For SIGNON, the primary authorization ID is retrieved from ACEEUSRI if an ACEE is associated with the TCB (TCBSENV). This is the normal case. However, if an ACEE is not associated with the TCB, SIGNON uses the primary authorization ID that is associated with the address space, that is, from the ASXB. If the new primary authorization ID was retrieved from the ACEE that is associated with the TCB and ACEEGRPN is not null, DB2 uses ACEEGRPN to establish secondary authorization IDs.

   With AUTH SIGNON, an APF-authorized program can pass a primary authorization ID for the connection. If a primary authorization ID is passed, AUTH SIGNON also uses the value that is passed in the secondary authorization ID parameter to establish secondary authorization IDs. If the primary authorization ID is not passed, but a valid ACEE is passed, AUTH SIGNON uses the value in ACEEUSRI for the primary authorization ID if

ACEEUSRL is not 0. If ACEEUSRI is used for the primary authorization ID, AUTH SIGNON uses the value in ACEEGRPN as the secondary authorization ID if ACEEGRPL is not 0.

For CONTEXT SIGNON, the primary authorization ID is retrieved from data that is associated with the current RRS context using the context_key, which is supplied as input. CONTEXT SIGNON uses the CTXSDTA and CTXRDTA functions of RRS context services. An authorized function must use CTXSDTA to store a primary authorization ID prior to invoking CONTEXT SIGNON. Optionally, CTXSDTA can be used to store the address of an ACEE in the context data that has a context_key that was supplied as input to CONTEXT SIGNON. DB2 uses CTXRDTA to retrieve context data. If an ACEE address is passed, CONTEXT SIGNON uses the value in ACEEGRPN as the secondary authorization ID if ACEEGRPL is not 0.

2. DB2 runs the sign-on exit routine. **User action:** To use DB2 secondary IDs, you must replace the exit routine.

   If you **do not** want to use secondary IDs, do nothing. Sign-on processing is then continued by the IBM-supplied default sign-on exit routine, which has the following effects:
   - The initial primary authorization ID remains the primary ID.
   - The SQL ID is set equal to the primary ID.
   - No secondary IDs exist.

   You can replace the exit routine with one of your own, even if it has nothing to do with secondary IDs. If you do, remember that IMS and CICS recovery coordinators, their dependent regions, and RRSAF take the exit routine only if they have provided a user ID in the sign-on parameter list.
3. DB2 determines if the user of a trusted RRSAF SIGNON connection is allowed to switch.

   For a RRSAF SIGNON connection that is trusted, DB2 checks to see if the primary authorization ID is allowed to switch in the trusted connection. If the primary authorization ID is not allowed to switch, the connection is returned to the unconnected state.

Related concepts:

"Connection routines and sign-on routines" on page 245

Related tasks:

"Using sample connection and sign-on exit routines for CICS transactions" on page 165

"Specifying connection and sign-on routines" on page 245

"Debugging connection and sign-on routines" on page 254

Related reference:

"Processing of sign-on requests" on page 163

Using secondary IDs for sign-on requests

If you want the primary authorization ID to be associated with DB2 secondary authorization IDs, you must replace the default sign-on exit routine.

About this task

The procedure is similar to that for connection processing. If you want to use RACF group names as DB2 secondary IDs, the easiest method is to use the IBM-supplied sample routine. An installation job can automatically replace the default routine with the sample routine.

Distinguish carefully between the two routines. The default sign-on routine provides no secondary IDs and has the following effects:
- The initial primary authorization ID remains the primary ID.
- The SQL ID is set equal to the primary ID.
- No secondary IDs exist.

Like the sample connection routine, the sample sign-on routine supports DB2 secondary IDs and has the following effects:
- The initial primary authorization ID is left unchanged as the DB2 primary ID.
- The SQL ID is made equal to the DB2 primary ID.
- The secondary authorization IDs depend on RACF options:
  - If RACF is not active, no secondary IDs exist.
  - If RACF is active but its "list of groups" option is not active, one secondary ID exists; it is the name passed by CICS or by IMS.
  - If RACF is active and you have selected the option for a list of groups, the routine sets the list of DB2 secondary IDs to the list of group names to which the RACF user ID is connected, up to a limit of 1012 groups. The list of group names includes the default connected groupname.

Using sample connection and sign-on exit routines for CICS transactions

For a CICS transaction to use the sample connection or sign-on exit routines, the external security system, such as RACF, must be defined to CICS.

About this task

Define an external security system, such as RACF, to CICS with the following specifications:
- The CICS system initialization table must specify external security.
  - For CICS Version 4 or later, specify SEC=YES.
  - For earlier releases of CICS, specify EXTSEC=YES.

  If you are using the CICS multiple region option (MRO), you must specify SEC=YES or EXTSEC=YES for every CICS system that is connected by interregion communication (IRC).
- If your version of CICS uses a sign-on table (SNT), the CICS sign-on table must specify EXTSEC=YES for each signed on user that uses the sign-on exit.
- When the user signs on to a CICS terminal-owning region, the terminal-owning region must propagate the authorization ID to the CICS application-owning region.

You must change the sample sign-on exit routine (DSN3SSGN) before using it if the following conditions are all true:
- You have the RACF list-of-groups option active.
- You have transactions whose initial primary authorization ID is not defined to RACF.

Related concepts:

"Connection routines and sign-on routines" on page 245

Related reference:

"Processing of connection requests" on page 160

"Processing of sign-on requests" on page 163

"Sample connection and sign-on routines" on page 246

"Exit parameter list for connection and sign-on routines" on page 247

Managing connection requests from remote applications

If you control requests from remote applications, your DB2 subsystem might be accepting requests from applications that use SNA network protocols, TCP/IP network protocols, or both.

Security mechanisms for DRDA and SNA

DRDA encryption is not intended to provide confidentiality and integrity of passwords or data over a network that is not secure, such as the Internet. DRDA encryption uses an anonymous key exchange, Diffie-Hellman, which does not provide authentication of the server or the client. DRDA encryption is vulnerable to man-in-the-middle attacks.

DB2 for z/OS and z/OS support a wide variety of cryptographic authentication schemes and protocols, such as the use of the z/OS Communications Server IP Application Transparent Transport Layer Security (AT-TLS), to provide an authenticated key agreement that helps prevent man-in-the-middle and related attacks. These methods mathematically bind the agreed-upon key to other agreed-upon data to secure data over a network that is not secure.

DRDA and SNA have different security mechanisms. DRDA allows a user to be authenticated by using SNA security mechanisms or DRDA mechanisms, which are independent of the underlying network protocol. Make sure to use network security, such as client certificate authentication, SSL connections that use AT-TLS, or IPSec, to secure DRDA authentication mechanisms over a network that is not secure.

For an SNA network connection, a DRDA requester can send security tokens by using a SNA attach or a DRDA command. DB2 for z/OS as a requester uses SNA security mechanisms if it uses a SNA network connection (except for Kerberos) and DRDA security mechanisms for TCP/IP network connections (or when Kerberos authentication is chosen, regardless of the network type).

Related concepts:

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Security mechanisms for DB2 for z/OS as a requester

As a requester, DB2 for z/OS chooses SNA or DRDA security mechanisms based on the network protocol and the authentication mechanisms that you use. Make sure to use network security, such as client certificate authentication, SSL connections that use AT-TLS, or IPSec, to secure DRDA authentication mechanisms over a network that is not secure.

If you use SNA protocols, DB2 supports the following SNA authentication mechanisms:

- User ID only (already verified)
- User ID and password
- User ID and PassTicket

Authentication is performed based on SNA protocols, which means that the authentication tokens are sent in an SNA attach (FMH-5).

If you use TCP/IP protocols, DB2 supports the following DRDA authentication mechanisms:

- User ID only (already verified)
- User ID and password
- User ID and PassTicke

If you use TCP/IP protocols with the z/OS Integrated Cryptographic Service Facility, DB2 also supports the following DRDA authentication mechanisms:

- Encrypted user ID and encrypted password
- Encrypted user ID and encrypted security-sensitive data

Authentication is performed based on DRDA protocols, which means that the authentication tokens are sent in DRDA security flows. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.

Related concepts:

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Security mechanisms for DB2 for z/OS as a server

As a server, DB2 for z/OS can accept either SNA or DRDA authentication mechanisms. Make sure to use network security, such as client certificate authentication, SSL connections that use AT-TLS, or IPSec, to secure DRDA authentication mechanisms over a network that is not secure.

DB2 authenticates remote users from the security tokens that are obtained from the SNA ATTACH (FMH-5) or from the DRDA security commands that are described by each of the protocols. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.

DB2 for z/OS accepts connection requests from remote clients that use an AES or DES encryption algorithm to protect user IDs and passwords over a TCP/IP network. Specifically, DB2 supports the following authentication methods:

- User ID only (already verified at the requester)
- User ID and password
- User ID and PassTicket
- Kerberos tickets
- Unencrypted user ID and encrypted password
- Encrypted user ID and encrypted password
- User ID, password, and new password

DB2 for z/OS as a server also supports the following authentication mechanisms if the z/OS Integrated Cryptographic Service Facility is installed and active:

- Encrypted user ID and encrypted security-sensitive data
- Encrypted user ID, encrypted password, and encrypted security-sensitive data
- Encrypted user ID, encrypted password, encrypted new password, and encrypted security-sensitive data

Related concepts:

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Communications database for the server

The *communications database* (CDB) is a set of DB2 catalog tables that let you control aspects of how requests leave a DB2 subsystem and how requests come in. Columns in the SYSIBM.LUNAMES and SYSIBM.USERNAMES tables pertain to security on the inbound side (the server).

SYSIBM.LUNAMES columns

The SYSIBM.LUNAMES table is used only for requests that use SNA protocols.

GUPI

LUNAME CHAR(8)

The LUNAME of the remote system. A blank value identifies a default row that serves requests from any system that is not specifically listed elsewhere in the column.

SECURITY_IN CHAR(1)

The *acceptance option* for a remote request from the corresponding LUNAME:

V The option is "verify." An incoming request must include one of the following authentication entities:

- User ID and password
- User ID and RACF PassTicket
- User ID and RACF encrypted password (not recommended)
- Kerberos security tickets
- User ID and DRDA encrypted password
- User ID, password, and new password
- User ID and encrypted password, or encrypted user ID and encrypted password

A The option is "already verified." This is the default. With A, a request does not need an authentication token, although the token is checked if it is sent.

With this option, an incoming connection request is accepted if it includes any of the following authentication tokens:

- User ID only
- All authentication methods that option V supports

If the USERNAMES column of SYSIBM.LUNAMES contains I or B, RACF is not invoked to validate incoming connection requests that contain only a user ID.

ENCRYPTPSWDS CHAR(1)
This column only applies to DB2 for z/OS or DB2 for z/OS partners when passwords are used as authentication tokens. It indicates whether passwords received from and sent to the corresponding LUNAME are encrypted:

Y Yes, passwords are encrypted. For outbound requests, the encrypted password is extracted from RACF and sent to the server. For inbound requests, the password is treated as if it is encrypted.

N No, passwords are not encrypted. This is the default; any character other than Y is treated as N. Specify N for CONNECT statements that contain a USER parameter.

Recommendation: When you connect to a DB2 for z/OS partner that is at Version 5 or a subsequent release, use RACF PassTickets (SECURITY_OUT='R') instead of using passwords.

USERNAMES CHAR(1)
This column indicates whether an ID accompanying a remote request, sent from or to the corresponding LUNAME, is subject to translation and "come from" checking. When you specify I, O, or B, use the SYSIBM.USERNAMES table to perform the translation.

I An inbound ID is subject to translation.

O An outbound ID, sent to the corresponding LUNAME, is subject to translation.

B Both inbound and outbound IDs are subject to translation.

blank No IDs are translated.

GUPI

SYSIBM.USERNAMES columns

The SYSIBM.USERNAMES table is used by both SNA and TCP/IP connections.

GUPI

TYPE CHAR(1)
Indicates whether the row is used for inbound or outbound translation:

S The row is used to obtain the system authorization ID for establishing a trusted connection.

I The row applies to inbound IDs (not applicable for TCP/IP connections).

O The row applies to outbound IDs.

The field should contain only I or O. Any other character, including blank, causes the row to be ignored.

AUTHID VARCHAR(128)
An authorization ID that is permitted and perhaps translated. If blank, any authorization ID is permitted with the corresponding LINKNAME; all authorization IDs are translated in the same way. Outbound translation is not performed on CONNECT statements that contain an authorization ID for the value of the USER parameter.

LINKNAME CHAR(8)
Identifies the VTAM or TCP/IP network locations that are associated with this row. A blank value in this column indicates that this name translation rule applies to any TCP/IP or SNA partner.

If you specify a nonblank value for this column, one or both of the following situations must be true:

- A row exists in table SYSIBM.LUNAMES that has an LUNAME value that matches the LINKNAME value that appears in this column.
- A row exists in table SYSIBM.IPNAMES that has a LINKNAME value that matches the LINKNAME value that appears in this column.

NEWAUTHID VARCHAR(128)
The translated authorization ID. If blank, no translation occurs.

GUPI

Enabling change of user passwords

You can specify YES in the EXTENDED SECURITY field of the DSNTIPR installation panel so that DB2 can return information about errors and expired passwords to the DRDA requester.

About this task

When the DRDA requester is notified that the RACF password has expired, and the requester has implemented function to allow passwords to be changed, the requester can prompt the user for the old password and a new password. The requester sends the old and new passwords to the DB2 server. This function is supported through DB2 Connect™.

With the extended security option, DB2 passes the old and new passwords to RACF. If the old password is correct, and the new password meets the installation's password requirements, the user's password is changed and the DRDA connection request is honored.

When a user changes a password, the user ID, the old password, and the new password are sent to DB2 by the client system. The client system can optionally encrypt these three tokens before they are sent.

Authorization failure code

If the EXTENDED SECURITY field is set to YES on the DSNTIPR installation panel, DB2 returns detailed reason codes to a DRDA client when a DDF connection request fails.

When using SNA protocols, the requester must have included support for extended security sense codes. One such product is DB2 Connect.

If the proper requester support is present, the requester generates SQLCODE -30082 (SQLSTATE '08001') with a specific indication for the failure. Otherwise, a generic security failure code is returned.

Global authentication cache

DB2 can cache user credentials when processing remote TCP/IP connections.

When processing a TCP/IP connection, DB2 authenticates a user ID by using RACF. If the user ID is successfully authenticated, DB2 caches the user credentials for three minutes during which DB2 reuses the cached credentials for subsequent connection requests from the same user ID. DB2 deletes the cache entries if the password is changed through a DRDA password change request or if the AUTHEXIT_CACHEREFRESH system parameter is set and the user permissions are changed in RACF.

DB2 does not differentiate PassTickets from passwords while caching user credentials.

Managing inbound SNA-based connection requests

Requests from a remote LU are subject to security checks before they come into contact with DB2. Those checks control what LUs can attach to the network and verify the identity of a partner LU.

About this task

DB2 itself imposes several checks before accepting an attachment request.

Processing of remote attachment requests

The DB2 server completes a specific sequence of authentication process before accepting a remote attachment request that uses the SNA protocol.

1. As the following diagram shows, if the remote request has no authentication token, DB2 checks the security acceptance option in the SECURITY_IN column of table SYSIBM.LUNAMES. No password is sent or checked for the plan or package owner that is sent from a DB2 subsystem.

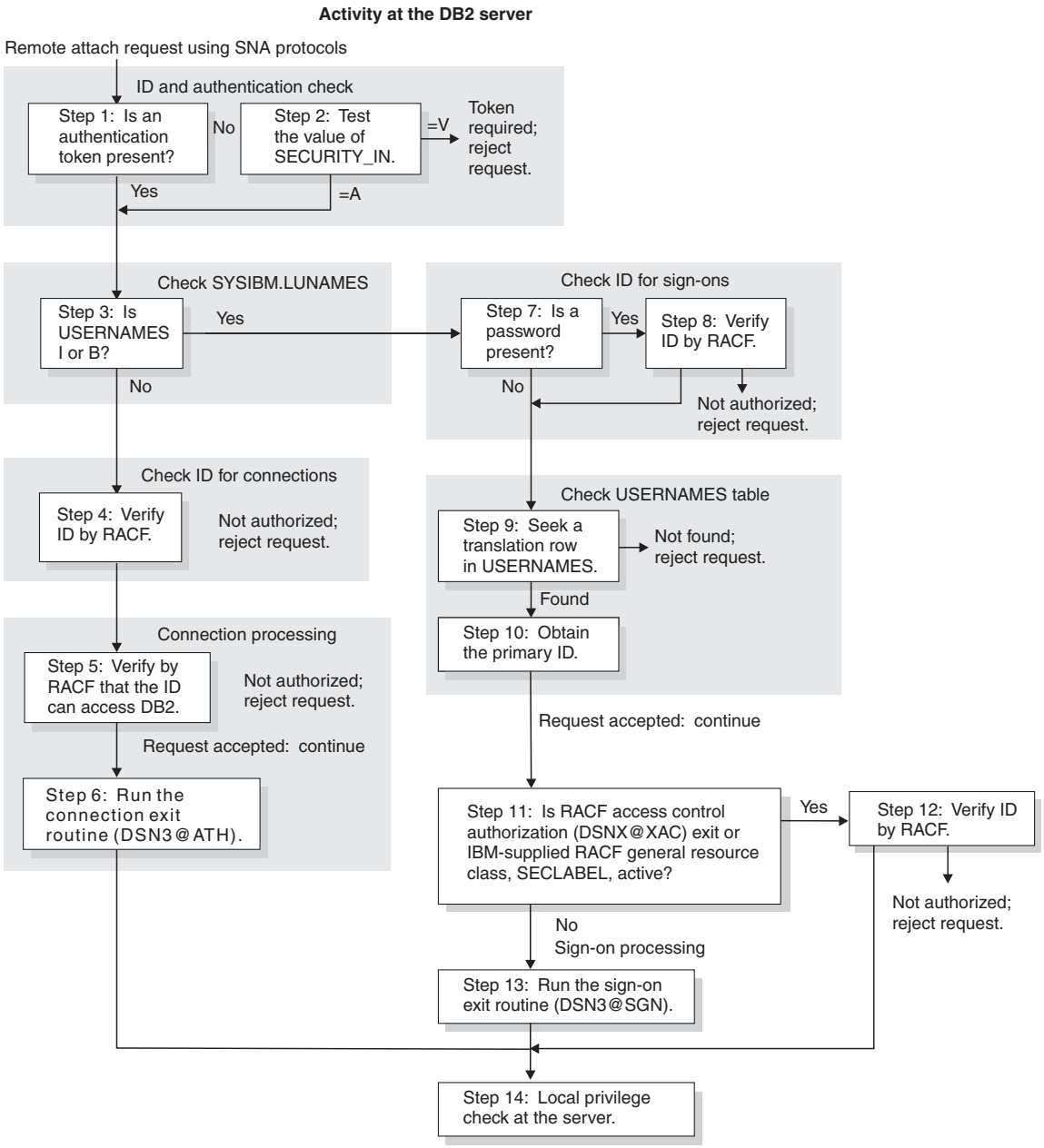


Figure 8. DB2 processing of remote attachment requests

2. If the acceptance option is "verify" (SECURITY_IN = V), a security token is required to authenticate the user. DB2 rejects the request if the token missing.
3. If the USERNAMES column of SYSIBM.LUNAMES contains I or B, the authorization ID, and the plan or package owner that is sent by a DB2 subsystem, are subject to translation under control of the SYSIBM.USERNAMES table. If the request is allowed, it eventually goes through sign-on processing. If USERNAMES does not contain I or B, the authorization ID is not translated.
4. DB2 calls RACF by the RACROUTE macro with REQUEST=VERIFY to check the ID. DB2 uses the PASSCHK=NO option if no password is specified and ENCRYPT=YES if the ENCRYPTPSWDS column of SYSIBM.LUNAMES contains Y. If the ID, password, or PassTicket cannot be verified, DB2 rejects the request.

In addition, depending on your RACF environment, the following RACF checks may also be performed:

- If the RACF APPL class is active, RACF verifies that the ID has been given access to the DB2 APPL. The APPL resource that is checked is the LU name that the requester used when the attachment request was issued. This is either the local DB2 LU name or the generic LU name.
- If the RACF APPCPORT class is active, RACF verifies that the ID is authorized to access z/OS from the Port of Entry (POE). The POE that RACF uses in the verify call is the requesting LU name.

5. The remote request is now treated like a local connection request with a DIST environment for the DSNR resource class. DB2 calls RACF by the RACROUTE macro with REQUEST=AUTH, to check whether the authorization ID is allowed to use DB2 resources that are defined to RACF.

   The RACROUTE macro call also verifies that the user is authorized to use DB2 resources from the requesting system, known as the port of entry (POE).
6. DB2 invokes the connection exit routine. The parameter list that is passed to the routine describes where a remote request originated.
7. If no password exists, RACF is not called. The ID is checked in SYSIBM.USERNAMES.
8. If a password exists, DB2 calls RACF through the RACROUTE macro with REQUEST=VERIFY to verify that the ID is known with the password. ENCRYPT=YES is used if the ENCRYPTPSWDS column of SYSIBM.LUNAMES contains Y. If DB2 cannot verify the ID or password, the request is rejected.
9. DB2 searches SYSIBM.USERNAMES for a row that indicates how to translate the ID. The need for a row that applies to a particular ID and sending location imposes a “come-from” check on the ID: If no such row exists, DB2 rejects the request.
10. If an appropriate row is found, DB2 translates the ID as follows:
    - If a nonblank value of NEWAUTHID exists in the row, that value becomes the primary authorization ID.
    - If NEWAUTHID is blank, the primary authorization ID remains unchanged.
11. The remote request is now treated like a local sign-on request. DB2 invokes the sign-on exit routine. The parameter list that is passed to the routine describes where a remote request originated.
12. The remote request now has a primary authorization ID, possibly one or more secondary IDs, and an SQL ID. A request from a remote DB2 is also known by a plan or package owner. Privileges and authorities that are granted to those IDs at the DB2 server govern the actions that the request can take.

Controlling LU attachments to the network

VTAM checks to prevent an unauthorized logical unit (LU) from attaching to the network and presenting itself to other LUs as an acceptable partner in communication. It requires each LU that attaches to the network to identify itself by a password.

About this task

If that requirement is in effect for your network, your DB2 subsystem, like every other LU on the network, must:

1. Choose a VTAM password.

2. Code the password with the PRTCT parameter of the VTAM APPL statement, when you define your DB2 to VTAM.

Verifying partner LUs

RACF and VTAM check the identity of a logical unit (LU) that sends a request to your DB2 subsystem.

Procedure

Perform the following steps to specify partner-LU verification:

1. Code VERIFY=REQUIRED on the VTAM APPL statement, when you define your DB2 to VTAM.
2. Establish a RACF profile for each LU from which you permit a request.

Accepting remote attachment requests

When VTAM has established a conversation for a remote application, that application sends a remote request, which is a request to attach to your local DB2 subsystem.

About this task

Make sure that you do not confuse the remote request with a local attachment request that comes through one of the DB2 attachment facilities—IMS, CICS, TSO, and so on. A remote attachment request is defined by Systems Network Architecture and LU 6.2 protocols; specifically, it is an SNA Function Management Header 5.

In order to accept remote attachment requests, you must first define your DB2 to VTAM with the conversation-level security set to “already verified”. That is, you need to code SECACPT=ALREADYV on the VTAM APPL statement. The SECACPT=ALREADYV setting provides more options than does SECACPT=CONV or “conversation”, which is not recommended.

The primary tools for controlling remote attachment requests are entries in tables SYSIBM.LUNAMES and SYSIBM.USERNAMES in the communications database. You need a row in SYSIBM.LUNAMES for each system that sends attachment requests, a dummy row that allows any system to send attachment requests, or both. You might need rows in SYSIBM.USERNAMES to permit requests from specific IDs or specific LUNAMES, or to provide translations for permitted IDs.

Managing inbound IDs through DB2

If you manage incoming IDs through DB2, you can avoid calls to RACF. You can accept many IDs by specifying them in a single row in the SYSIBM.USERNAMES table.

About this task

To manage incoming IDs through DB2, put an I in the USERNAMES column of SYSIBM.LUNAMES for the particular LU. If an O is already specified because you are also sending requests to that LU, change O to B. Attachment requests from that LU now go through the sign-on processing, and its IDs are subject to translation.

Managing inbound IDs through RACF

If you manage incoming IDs through RACF, you must register every acceptable ID with RACF, and DB2 must call RACF to process every request.

About this task

You can use RACF or Kerberos can authenticate the user. Kerberos cannot be used if you do not have RACF on the system.

To manage incoming IDs through RACF, leave USERNAMES blank for that LU, or leave the O unchanged, if already specified. Requests from that LU now go through the connection processing, and its IDs are not subject to translation.

Authenticating partner LUs

If RACF has already validated the identity of an LU and if you trust incoming IDs from the LU, you do not need to validate them by an authentication token.

About this task

You can choose whether to require an authentication token from a particular LU.

Procedure

To authenticate partner LUs, choose one of the following options:

- If you do not want DB2 to require an authentication token from a particular LU, check that you have defined DB2 to VTAM with SECACPT=ALREADYV. Then put an A in the SECURITY_IN column of the row in the SYSIBM.LUNAMES table that corresponds to the other LU. Your acceptance level for requests from that LU is now “already verified”. Requests from that LU are accepted without an authentication token.
- If you want DB2 to require an authentication token from a particular LU, put a V in the SECURITY_IN column in the SYSIBM.LUNAMES table. Your acceptance level for requests from that LU is now “verify”.

What to do next

If you require an authentication token, you must register every acceptable incoming ID and its password with RACF.

If an authentication token does accompany a request, DB2 calls RACF to check the authorization ID against it.

: Each request to RACF to validate authentication tokens results in an I/O operation, which has a high performance cost.

: To eliminate the I/O, allow RACF to cache security information in VLF. To activate this option, add the IRRACEE class to the end of z/OS VLF member COFVLFxx in SYS1.PARMLIB, as follows:

```
CLASS NAME(IRRACEE)
EMAJ (ACEE)
```

Related reference:

SYSIBM.LUNAMES table (DB2 SQL)

Encrypting passwords

You can encrypt passwords to secure network connection requests.

Procedure

To encrypt passwords, use one of the following methods:

- RACF using PassTickets.
- DRDA password encryption support. DB2 for z/OS as a server supports DRDA encrypted passwords and encrypted user IDs with encrypted passwords. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.
- The SET ENCRYPTION PASSWORD statement. This encryption method should not be used for distributed access because the unencrypted passwords in the SET ENCRYPTION PASSWORD statement flow from the client to the server.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Authenticating users through Kerberos

If your distributed environment uses Kerberos to manage users and perform user authentication, DB2 for z/OS can use Kerberos security services to authenticate remote users.

Related tasks:

"Establishing Kerberos authentication through RACF" on page 152

Translating inbound IDs

Duplication of authorization IDs on different logical units (LUs) is a serious security exposure. For tighter security, make sure that each of the authorization IDs has the same meaning throughout your entire network.

About this task

Example: Suppose that the ID DBADM1 is known to the local DB2 and has DBADM authority over certain databases there; suppose also that the same ID exists in some remote LU. If an attachment request comes in from DBADM1, and if nothing is done to alter the ID, the wrong user can exercise privileges of DBADM1 in the local DB2. The way to protect against that exposure is to translate the remote ID into a different ID before the attachment request is accepted.

You must be prepared to translate the IDs of plan owners, package owners, and the primary IDs of processes that make remote requests. Do not plan to translate all IDs in the connection exit routine—the routine does not receive plan and package owner IDs.

If you have decided to manage inbound IDs through DB2, you can translate an inbound ID to some other value. Within DB2, you grant privileges and authorities

only to the translated value. The "translation" is not affected by anything you do in your connection or sign-on exit routine. The *output* of the translation becomes the *input* to your sign-on exit routine.

Recommendation: Do not translate inbound IDs in an exit routine; translate them only through the SYSIBM.USERNAMES table.

The examples in the following table shows the possibilities for translation and how to control translation by SYSIBM.USERNAMES. You can use entries to allow requests only from particular LUs or particular IDs, or from combinations of an ID and an LU. You can also translate any incoming ID to another value.

Table 39. Your SYSIBM.USERNAMES table. (Row numbers are added for reference.)

Row	TYPE	AUTHID	LINKNAME	NEWAUTHID
1	I	blank	LUSNFRAN	blank
2	I	BETTY	LUSNFRAN	ELIZA
3	I	CHARLES	blank	CHUCK
4	I	ALBERT	LUDALLAS	blank
5	I	BETTY	blank	blank

The following table shows the search order of the SYSIBM.USERNAMES table.

Table 40. Precedence search order for SYSIBM.USERNAMES table

AUTHID	LINKNAME	Result
Name	Name	If NEWAUTHID is specified, AUTHID is translated to NEWAUTHID for the specified LINKNAME.
Name	Blank	If NEWAUTHID is specified, AUTHID is translated to NEWAUTHID for all LINKNAMEs.
Blank	Name	If NEWAUTHID is specified, it is substituted for AUTHID for the specified LINKNAME.
Blank	Blank	Unavailable resource message (SQLCODE -904) is returned.

DB2 searches SYSIBM.USERNAMES to determine how to translate for each of the requests that are listed in the following table.

Table 41. How DB2 translates inbound authorization ids

Request	How DB2 translates request
ALBERT requests from LUDALLAS	DB2 searches for an entry for AUTHID=ALBERT and LINKNAME=LUDALLAS. DB2 finds one in row 4, so the request is accepted. The value of NEWAUTHID in that row is blank, so ALBERT is left unchanged.
BETTY requests from LUDALLAS	DB2 searches for an entry for AUTHID=BETTY and LINKNAME=LUDALLAS; none exists. DB2 then searches for AUTHID=BETTY and LINKNAME=blank. It finds that entry in row 5, so the request is accepted. The value of NEWAUTHID in that row is blank, so BETTY is left unchanged.

Table 41. How DB2 translates inbound authorization ids (continued)

Request	How DB2 translates request
CHARLES requests from LUDALLAS	DB2 searches for AUTHID=CHARLES and LINKNAME=LUDALLAS; no such entry exists. DB2 then searches for AUTHID=CHARLES and LINKNAME=blank. The search ends at row 3; the request is accepted. The value of NEWAUTHID in that row is CHUCK, so CHARLES is translated to CHUCK.
ALBERT requests from LUSNFRAN	DB2 searches for AUTHID=ALBERT and LINKNAME=LUSNFRAN; no such entry exists. DB2 then searches for AUTHID=ALBERT and LINKNAME=blank; again no entry exists. Finally, DB2 searches for AUTHID=blank and LINKNAME=LUSNFRAN, finds that entry in row 1, and the request is accepted. The value of NEWAUTHID in that row is blank, so ALBERT is left unchanged.
BETTY requests from LUSNFRAN	DB2 finds row 2, and BETTY is translated to ELIZA.
CHARLES requests from LUSNFRAN	DB2 finds row 3 before row 1; CHARLES is translated to CHUCK.
WILBUR requests from LUSNFRAN	No provision is made for WILBUR, but row 1 of the SYSIBM.USERNAMES table allows any ID to make a request from LUSNFRAN and to pass without translation. The acceptance level for LUSNFRAN is “already verified”, so WILBUR can pass without a password check by RACF. After accessing DB2, WILBUR can use only the privileges that are granted to WILBUR and to PUBLIC (for DRDA access).
WILBUR requests from LUDALLAS	Because the acceptance level for LUDALLAS is “verify” as recorded in the SYSIBM.LUNAMES table, WILBUR must be known to the local RACF. DB2 searches in succession for one of the combinations WILBUR/LUDALLAS, WILBUR/blank, or blank/LUDALLAS. None of those is in the table, so the request is rejected. The absence of a row permitting WILBUR to request from LUDALLAS imposes a “come-from” check: WILBUR can attach from some locations (LUSNFRAN), and some IDs (ALBERT, BETTY, and CHARLES) can attach from LUDALLAS, but WILBUR cannot attach if coming from LUDALLAS.

In the process of accepting remote attachment requests, any step that calls RACF is likely to have a relatively high performance cost. To trade some of that cost for a somewhat greater security exposure, have RACF check the identity of the other LU just once. Then trust the partner LU, translating the inbound IDs and not requiring or using passwords. In this case, no calls are made to RACF from within DB2; the penalty is only that you make the partner LU responsible for verifying IDs.

If you update tables in the CDB while the distributed data facility is running, the changes might not take effect immediately. If incoming authorization IDs are managed through DB2 and if the ICSF is installed and properly configured, you can use the DSNLEUSR stored procedure to encrypt translated authorization IDs and store them in the NEWAUTHID column of the SYSIBM.USERNAMES table. DB2 decrypts the translated authorization IDs during connection processing.

Associating inbound IDs with secondary IDs

Your decisions on password encryption and ID translation determine the value that you use for the primary authorization ID on an attachment request.

About this task

They also determine whether those requests are next treated as connection requests or as sign-on requests. That means that the remote request next goes through the same processing as a local request, and that you have the opportunity to associate the primary ID with a list of secondary IDs in the same way you do for local requests.

Managing inbound TCP/IP-based connection requests

DRDA connections that use TCP/IP have fewer security controls than do connections that use SNA protocols. When planning to control inbound TCP/IP connection requests, you must decide whether you want the requests to have authentication information, such as RACF passwords, RACF PassTickets, and Kerberos tickets, passed along with authorization IDs.

About this task

Attention: To protect your authentication information, use the z/OS Communications Server IP Application Transparent Transport Layer Security (AT-TLS) to secure your network connections. To complement the use of AT-TLS, set the TCPALVER subsystem parameter of installation panel DSNTIP5 to SERVER_ENCRYPT. Setting this parameter to SERVER_ENCRYPT provides the strongest level of security. Connections are accepted only if user credentials are provided to authenticate the user ID, and strong encryption is used to protect the user ID and credentials.

Procedure

To manage inbound TCP/IP-based connection requests:

- For requests that use RACF passwords or PassTickets, enter the following RACF command to indicate which user IDs that use TCP/IP are authorized to access DDF (the distributed data facility address space):

  ```
  PERMIT ssnm.DIST CLASS(DSNR) ID(yyy) ACCESS(READ)
    WHEN(APPCPORT(TCPIP))
  ```

  Consider the following questions:

  Do you permit access by TCP/IP? If the serving DB2 for z/OS subsystem has a DRDA port and resynchronization port specified in the BSDS, DB2 is enabled for TCP/IP connections.

  Do you manage inbound IDs through DB2 or RACF? All IDs must be passed to RACF or Kerberos for processing. No option exists to handle incoming IDs through DB2.

  Do you trust the partner? TCP/IP does not verify partner LUs, as SNA does. If your requesters support mutual authentication, use Kerberos to handle this authentication on the requester side.

  If you use passwords, are they encrypted? Passwords can be encrypted through:

  – RACF using PassTickets
  – DRDA password encryption support. DB2 for z/OS as a server supports DRDA-encrypted passwords and encrypted user IDs with encrypted passwords. See “Security mechanisms for DRDA and SNA” on page 166 for more information about using DRDA encryption.

  If you use Kerberos, are users authenticated? If your distributed environment uses Kerberos to manage users and perform user authentication, DB2 for z/OS can use Kerberos security services to authenticate remote users.

Do you translate inbound IDs? Inbound IDs are not translated when you use TCP/IP.

How do you associate inbound IDs with secondary IDs? To associate an inbound ID with secondary IDs, modify the default connection exit routine (DSN3@ATH). TCP/IP requests do not use the sign-on exit routine.

- To receive requests from a DB2 for z/OS requester over TCP/IP connections that use RACF-protected user IDs and RACF PassTickets (as passwords), you must take the following additional actions in RACF:
  1. Create a RACF PTKTDATA resource profile at the server system or sysplex by issuing one of the following commands:

     ```
     RDEFINE PTKTDATA IRRPTAUTH.applname.userid
     ```

     ```
     RDEFINE PTKTDATA IRRPTAUTH.applname.*
     ```

     where
     - *applname* is either the generic LU name, the IPNAME assigned to each member of a serving data sharing group, or the LUNAME or IPNAME assigned to the serving non-data sharing subsystem.
     - *userid* is either an asterisk ("*") or a RACF-protected user ID that you want to allow into the serving subsystem or a member of a data sharing group.
  2. Refresh and load the PTKTDATA resource profile by issuing the following command:

     ```
     SETROPTS RACLIST(PTKTDATA) REFRESH
     ```
  3. Permit the user ID that is assigned in the STARTED profile in the ssidDIST address space to read the new profile by issuing one of the following commands:

     ```
     PERMIT IRRPTAUTH.applanme.userid CLASS(PTKTDATA) -
       ID(dist_userid) ACCESS(READ)
     ```

     ```
     PERMIT IRRPTAUTH.applname.* CLASS(PTKTDATA) -
       ID(dist_userid) ACCESS(READ)
     ```

     where *userid* and *dist_userid* are not the same.

  You need to take these additional actions in RACF if RACF-protected user IDs are used in connection requests from a DB2 for z/OS requester to a DB2 for z/OS server.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Sending encrypted passwords or password phrases from DB2 for z/OS clients" on page 198

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Processing of TCP/IP-based connection requests

The DB2 server completes a sequence of authentication tasks when handling a remote connection request that uses the TCP/IP protocol.

1. As the following diagram shows, DB2 checks to see if an authentication token (RACF encrypted password, RACF PassTicket, DRDA encrypted password, or

Kerberos ticket) accompanies the remote request. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.

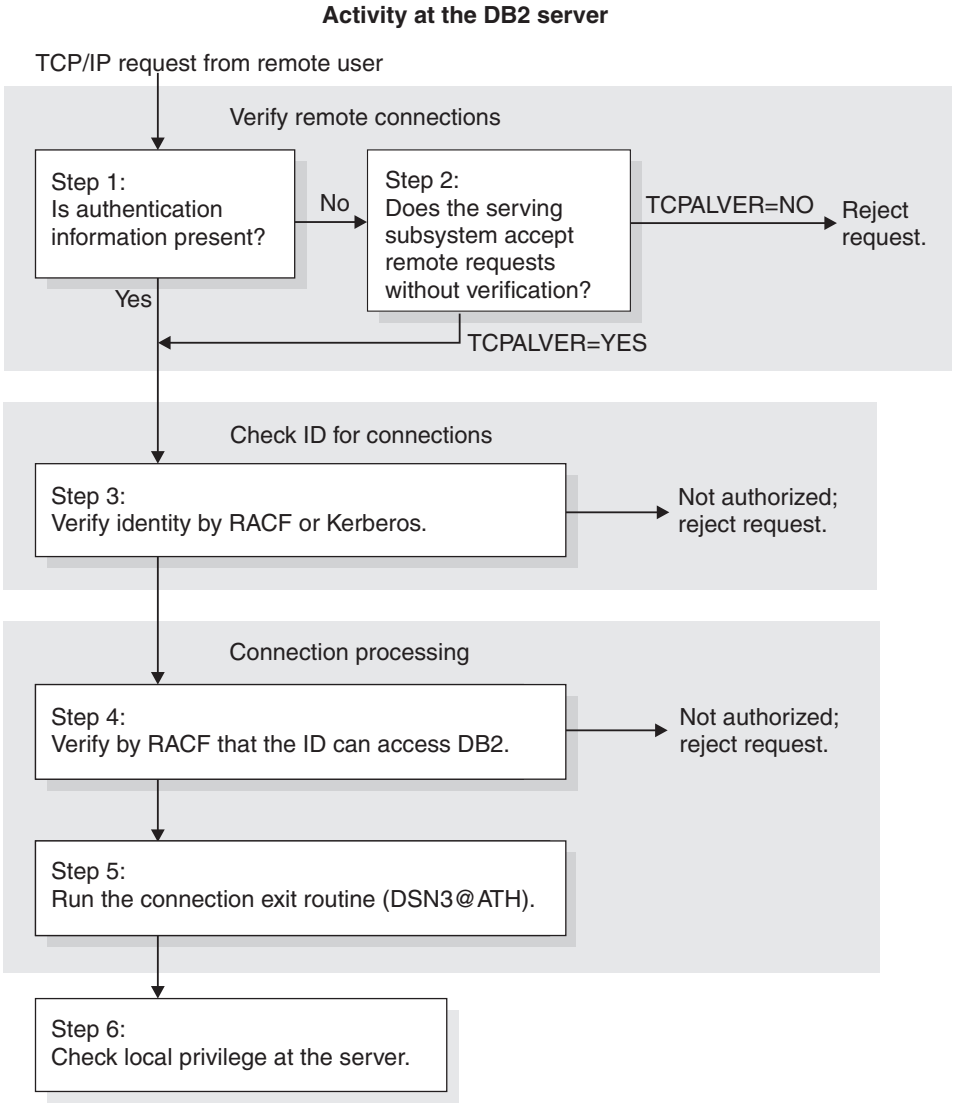


Figure 9. DB2 processing of TCP/IP-based connection requests

2. If no authentication token is supplied, DB2 checks the TCPALVER subsystem parameter to see if DB2 accepts IDs without authentication information.
   - If TCPALVER=NO | SERVER, DB2 requires the minimum of a userid and a password.
   - If TCPALVER=SERVER_ENCRYPT, DB2 requires a userid and a password. In addition, it requires that the security credentials be AES-encrypted or that the connection is accepted on a port that ensures AT-TLS policy protection, such as a DB2 Security Port (SECPORT). Kerberos tickets are accepted. RACF PassTickets, or non-encrypted security credentials, are accepted only when the connection is secured by the TCP/IP network.
   - If TCPALVER=YES | CLIENT, DB2 accepts TCP/IP connection requests that contain only a userid.

3. The identity is a RACF ID that is authenticated by RACF if a password or PassTicket is provided, or the identity is a Kerberos principal that is validated by Kerberos Security Server, if a Kerberos ticket is provided. Ensure that the ID is defined to RACF in all cases. When Kerberos tickets are used, the RACF ID is derived from the Kerberos principal identity. To use Kerberos tickets, ensure that you map Kerberos principal names with RACF IDs.

   In addition, depending on your RACF environment, the following RACF checks may also be performed:

   - If the RACF APPL class is active, RACF verifies that the ID has access to the DB2 APPL. The APPL resource that is checked is the LU name that the requester used when the attachment request was issued. This is either the local DB2 LU name or the generic LU name.
   - If the RACF APPCPORT class is active, RACF verifies that the ID is authorized to access z/OS from the port of entry (POE). The POE that RACF uses in the RACROUTE VERIFY call depends on whether all the following conditions are true:
     – The current operating system is z/OS V1.5 or later
     – The TCP/IP Network Access Control is configured
     – The RACF SERVAUTH class is active

     If all these conditions are true, RACF uses the remote client's POE security zone name that is defined in the TCP/IP Network Access Control file. If one or more of these conditions is not true, RACF uses the literal string 'TCPIP'.

     If this is a request to change a password, the password is changed.
4. The remote request is now treated like a local connection request (using the DIST environment for the DSNR resource class). DB2 calls RACF to check the ID's authorization against the *ssnm*.DIST resource.
5. DB2 invokes the connection exit routine. The parameter list that is passed to the routine describes where the remote request originated.
6. The remote request has a primary authorization ID, possibly one or more secondary IDs, and an SQL ID. (The SQL ID cannot be translated.) The plan or package owner ID also accompanies the request. Privileges and authorities that are granted to those IDs at the DB2 server govern the actions that the request can take.

Related concepts:

“Security mechanisms for DRDA and SNA” on page 166

“Encrypting your data with Secure Socket Layer support” on page 287

Related tasks:

“Managing inbound TCP/IP-based connection requests” on page 180

“Sending encrypted passwords from workstation clients” on page 199

Related reference:

“Processing of outbound connection requests” on page 191

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, “Protecting data through encryption and RACF,” on page 287

Managing denial-of-service attacks

With DB2, you can manage denial-of-service attacks in the network connections to a DB2 server.

About this task

The most common type of denial-of-service attack occurs when an attacker "floods" a network with connection requests to a DB2 server. If this occurs, the attacker quickly exhausts the threshold for the maximum number of remote connections that are defined to the DB2 server system. As a result, no additional remote connections can be accepted by the DB2 server, including those from legitimate client systems.

To prevent the typical denial-of-service attacks, DB2 monitors the traffic of inbound connections and terminates those that don't contain data for establishing a valid connection.

Preventing SQL injection attacks

SQL injection attacks might occur when dynamic SQL statements are constructed from user input and the input is inadequately checked. You can use several techniques to prevent or reduce SQL injection attacks.

Procedure

To eliminate or reduce the risk of SQL injection attacks:

- Avoid dynamic SQL, whenever possible.
- Use pureQuery or SQLJ rather than JDBC for Java.
- Use system security techniques, such as views and access control mechanisms, whenever possible.

  Understand the limitations of security within an application. System security can use security and integrity mechanisms that are not available to application programs. The level of assurance that can be provided in system security can be much higher. If the applications are run on the client or have fewer protection layers and firewalls than the database, make sure to address those limitations.
- Use row permissions and column masks to protect data even if the statement is compromised by SQL injection attacks.
- Put input data into host variables with just the value or use a parameter marker in dynamic SQL.
- Make sure to check all input:
  - Check that the input is the intended data type and format. This is generally required for all programs to ensure that they work properly but especially crucial for data intended as part of an SQL statement.
  - Accept numbers for a numeric comparison only.
  - Do not allow special characters if they do not apply.

Managing outbound connection requests

If you plan to send requests to another DB2 subsystem, you need to consider the subsystem's security measures for network connections. You need to know what those measures are and make entries in your CDB to correspond to them.

About this task

If you are planning to send remote requests to a DBMS that is not DB2 for z/OS, you need to satisfy the requirements of that system.

DB2 chooses how to send authentication tokens based on the network protocols that are used (SNA or TCP/IP). If the request is sent using SNA, the authentication tokens are sent in the SNA attachment request (FMH5), unless you are using Kerberos. If you use Kerberos, authentication tokens are sent with DRDA security commands. If the request uses TCP/IP, the authentication tokens are always sent using DRDA security commands. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.

At least one authorization ID is always sent to the server to be used for authentication. That ID is one of the following values:

- The primary authorization ID of the process.
- If you connect to the server using a CONNECT statement with the USER keyword, the ID that you specify as the USER ID. The CONNECT statement allows non-RACF user IDs on the USER keyword. If connecting to a remote location, the user ID is not authenticated by RACF.

However, other IDs can accompany some requests. You need to understand what other IDs are sent because they are subject to translation. You must include these other IDs in table SYSIBM.USERNAMES to avoid an error when you use outbound translation. The following table shows the IDs that you send in the different situations:

Table 42. IDs that accompany the primary ID on a remote request

In this situation:	You send this ID also:
An SQL query, using DB2 DRDA-protocol access	The plan owner
A remote BIND, COPY, or REBIND PACKAGE command	The package owner

If the connection is to a remote non-DB2 for z/OS server using DRDA protocol and if the outbound translation is specified, a row for the plan owner in the USERNAMES table is optional.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Communications database for the requester

The *communications database* (CDB) is a set of DB2 catalog tables that let you control aspects of remote requests. Columns in the SYSIBM.LUNAMES, SYSIBM.IPNAMES, SYSIBM.USERNAMES, and SYSIBM.LOCATIONS tables pertain to security that related to the requesting system.

SYSIBM.LUNAMES columns:

The SYSIBM.LUNAMES table is used only for outbound requests that use SNA protocols.

GUPI

LUNAME CHAR(8)
The LUNAME of the remote system. A blank value identifies a default row that serves requests from any system that is not specifically listed elsewhere in the column.

SECURITY_OUT (CHAR 1)
Indicates the security option that is used when local DB2 SQL applications connect to any remote server that is associated with the corresponding LUNAME.

A The letter A signifies the security option of already verified, and it is the default. With A, outbound connection requests contain an authorization ID and no authentication token. The value that is used for an outbound request is either the DB2 user's authorization ID or a translated ID, depending on the value in the USERNAMES column.

R The letter R signifies the RACF PassTicket security option. Outbound connection requests contain a user ID and a RACF PassTicket. The LUNAME column is used as the RACF PassTicket application name.

The value that is used for an outbound request is either the DB2 user's authorization ID or a translated ID, depending on the value in the USERNAMES column. The translated ID is used to build the RACF PassTicket. Do not specify R for CONNECT statements with a USER parameter.

P The letter P signifies the password security option. Outbound connection requests contain an authorization ID and a password. The password is obtained from RACF if ENCRYPTPSWDS=Y, or from SYSIBM.USERNAMES if ENCRYPTPSWDS=N. If you get the password from SYSIBM.USERNAMES, the USERNAMES column of SYSIBM.LUNAMES must contain B or O. The value that is used for an outbound request is the translated ID.

ENCRYPTPSWDS CHAR(1)
Indicates whether passwords received from and sent to the corresponding LUNAME are encrypted. This column only applies to DB2 for z/OS and DB2 for z/OS partners when passwords are used as authentication tokens.

Y Yes, passwords are encrypted. For outbound requests, the encrypted password is extracted from RACF and sent to the server. For inbound requests, the password is treated as encrypted.

N No, passwords are not encrypted. This is the default; any character but Y is treated as N.

Recommendation: When you connect to a DB2 for z/OS partner that is at Version 5 or a subsequent release, use RACF PassTickets (SECURITY_OUT='R') instead of encrypting passwords.

USERNAMES CHAR(1)
Indicates whether an ID accompanying a remote attachment request, which

is received from or sent to the corresponding LUNAME, is subject to translation and "come from" checking. When you specify I, O, or B, use the SYSIBM.USERNAMES table to perform the translation.

I An inbound ID is subject to translation.

O An outbound ID, sent to the corresponding LUNAME, is subject to translation.

B Both inbound and outbound IDs are subject to translation.

blank No IDs are translated.

GUPI

SYSIBM.IPNAMES columns:

The SYSIBM.IPNAMES table is used only for outbound requests that use TCP/IP protocols.

GUPI

LINKNAME CHAR(8)
The name used in the LINKNAME column of SYSIBM.LOCATIONS to identify the remote system.

IPADDR
Specifies an IP address or domain name of a remote TCP/IP host.

SECURITY_OUT
Indicates the DRDA security option that is used when local DB2 SQL applications connect to any remote server that is associated with this TCP/IP host.

A The letter A signifies the security option of already verified, and it is the default. Outbound connection requests contain an authorization ID and no password. The value that is used for an outbound request is either the DB2 user's authorization ID or a translated ID, depending on the value in the USERNAMES column.

The authorization ID is not encrypted when it is sent to the partner. For encryption, see option D.

R The letter R signifies the RACF PassTicket security option. Outbound connection requests contain a user ID and a RACF PassTicket. When a RACF PassTicket is generated, the LINKNAME column value is used as the RACF PassTicket application name and must match the following at the target server

- LUNAME - if the remote site is a DB2 subsystem that is defined with only an LUNAME value and no GENERIC LU name value or IPNAME value
- GENERIC - if the remote site is a DB2 subsystem that is defined with a GENERIC LU name value in addition to an LUNAME value but no IPNAME value
- IPNAME - if the remote site is a DB2 subsystem that is defined with an IPNAME value that triggers the remote DB2 subsystem's DDF to activate only its TCP/IP communications support.

The value that is used for an outbound request is either the DB2 user's authorization ID or a translated ID, depending on the value in the USERNAMES column. The translated ID is used to build the RACF PassTicket. Do not specify R for CONNECT statements with a USER parameter.

The authorization ID is not encrypted when it is sent to the partner.

D The letter D signifies the security option of user ID and security-sensitive data encryption. Outbound connection requests contain an authorization ID and no password. The authorization ID that is used for an outbound request is either the DB2 user's authorization ID or a translated ID, depending on the USERNAMES column.

This option indicates that the user ID and the security-sensitive data are to be encrypted. If you do not require encryption, see option A.

E The letter E signifies the security option of user ID, password, and security-sensitive data encryption. Outbound connection requests contain an authorization ID and a password. The password is obtained from the SYSIBM.USERNAMES table. The USERNAMES column must specify "O".

This option indicates that the user ID, password, and security-sensitive data are to be encrypted. If you do not require security-sensitive data encryption, see option P.

P The letter P signifies the password security option. Outbound connection requests contain an authorization ID and a password. The password is obtained from the SYSIBM.USERNAMES table. If you specify P, the USERNAMES column must specify "O".

If you specify P and the server supports encryption, the user ID and the password are encrypted. If the server does not support encryption, the user ID and the password are sent to the partner in clear text. If you also need to encrypt security-sensitive data, see option E.

USERNAMES CHAR(1)

This column indicates whether an outbound request translates the authorization ID. When you specify O, use the SYSIBM.USERNAMES table to perform the translation.

O The letter O signifies an outbound ID that is subject to translation. Rows in the SYSIBM.USERNAMES table are used to perform ID translation. If a connection to any remote server is to be established as trusted, a row in the SYSIBM.USERNAMES table is used to obtain the system authorization ID.

S The letter S signifies the system authorization ID, within a trusted context, obtained from the SYSIBM.USERNAMES table. If the system authorization ID that is specified in the AUTHID column is different from the primary authorization ID, DB2 sends the user switch request on behalf of the primary authorization ID after successfully establishing the trusted connection.

blank No translation is done.

GUPI

SYSIBM.USERNAMES columns:

The SYSIBM.USERNAMES table is used by outbound connection requests that use SNA and TCP/IP protocols.

GUPI

TYPE CHAR(1)
Indicates whether the row is used for inbound or outbound translation:

S The row is used to obtain the outbound system authorization ID for establishing a trusted connection.

I The row applies to inbound IDs.

O The row applies to outbound IDs.

The field should contain only I, O, or S. Any other character, including blank, causes the row to be ignored.

AUTHID VARCHAR(128)
An authorization ID that is permitted and perhaps translated. If blank, any authorization ID is permitted with the corresponding LINKNAME, and all authorization IDs are translated in the same way.

LINKNAME CHAR(8)
Identifies the VTAM or TCP/IP network locations that are associated with this row. A blank value in this column indicates that this name translation rule applies to any TCP/IP or SNA partner.

If you specify a nonblank value for this column, one or both of the following situations must be true:

- A row exists in table SYSIBM.LUNAMES that has an LUNAME value that matches the LINKNAME value that appears in this column.
- A row exists in table SYSIBM.IPNAMES that has a LINKNAME value that matches the LINKNAME value that appears in this column.

NEWAUTHID VARCHAR(128)
The translated authorization ID. If blank, no translation occurs.

PASSWORD VARCHAR(255)
A password or password phrase that is sent with an outbound request if passwords or phrases are not encrypted by RACF. The column is not used if passwords or phrases are encrypted or if the row is for inbound requests. A password or password phrase can be stored as encrypted data by calling the DSNLEUSR stored procedure. To send the encrypted value of the PASSWORD column through a network, you must specify one of the encryption options in the SYSIBM.IPNAMES table.

GUPI

SYSIBM.LOCATIONS columns:

The SYSIBM.LOCATIONS table contains a row for every accessible remote server. Each row associates a LOCATION name with the TCP/IP or SNA network attributes for the remote server. Requesters are not defined in the SYSIBM.LOCATIONS table.

GUPI

LOCATION CHAR(16)
Indicates the unique location name by which the the remote server is known to local DB2 SQL applications.

LINKNAME CHAR(8)
Identifies the VTAM or TCP/IP network locations that are associated with this row. A blank value in this column indicates that this name translation rule applies to any TCP/IP or SNA partner.

If you specify a nonblank value for this column, one or both of the following situations must be true:

- A row exists in table SYSIBM.LUNAMES that has an LUNAME value that matches the LINKNAME value that appears in this column.
- A row exists in table SYSIBM.IPNAMES that has a LINKNAME value that matches the LINKNAME value that appears in this column.

PORT CHAR(32)
Indicates that TCP/IP is used for outbound connections when the following statement is true:

- A row exists in SYSIBM.IPNAMES, where the LINKNAME column matches the value that is specified in the SYSIBM.LOCATIONS LINKNAME column.

If the previously mentioned row is found, and the SECURE column has a value of 'N', the value of the PORT column is interpreted as follows:

- If PORT is blank, the default DRDA port (446) is used.
- If PORT is nonblank, the value that is specified for PORT can take one of two forms:
  - If the value in PORT is left-justified with one to five numeric characters, the value is assumed to be the TCP/IP port number of the remote database server.
  - Any other value is assumed to be a TCP/IP service name, which you can convert to a TCP/IP port number by using the TCP/IP getservbyname socket call. TCP/IP service names are not case-sensitive.

If the previously mentioned row is found, and the SECURE column has a value of 'Y', the value of the PORT column is interpreted as follows:

- If PORT is blank, the default secure DRDA port (448) is used.
- If PORT is nonblank, the value that is specified for PORT takes the value of the configured secure DRDA port at the remote server.

TPN VARCHAR(64)
Used only when the local DB2 begins an SNA conversation with another server. When used, TPN indicates the SNA LU 6.2 transaction program name (TPN) that will allocate the conversation. A length of zero for the column indicates the default TPN. For DRDA conversations, this is the DRDA default, which is X'07F6C4C2'.

DBALIAS(128)
Used to access a remote database server. If DBALIAS is blank, the location name is used to access the remote database server. This column does not change the name of any database objects sent to the remote site that contains the location qualifier.

TRUSTED

Indicates whether the connection to the remote server can be trusted. This is restricted to TCP/IP only. This column is ignored for connections that use SNA.

Y The location is trusted. Access to the remote location requires a trusted context that is defined at the remote location.

N The location is not trusted.

SECURE

Indicates the use of the Secure Socket Layer (SSL) protocol for outbound connections when local DB2 applications connect to the remote database server by using TCP/IP.

Y A secure SSL connection is required for the outbound connection.

N A secure connection is not required for the outbound connection.

GUPI

Processing of outbound connection requests

A DB2 subsystem completes a sequence of tasks when sending out a connection request.

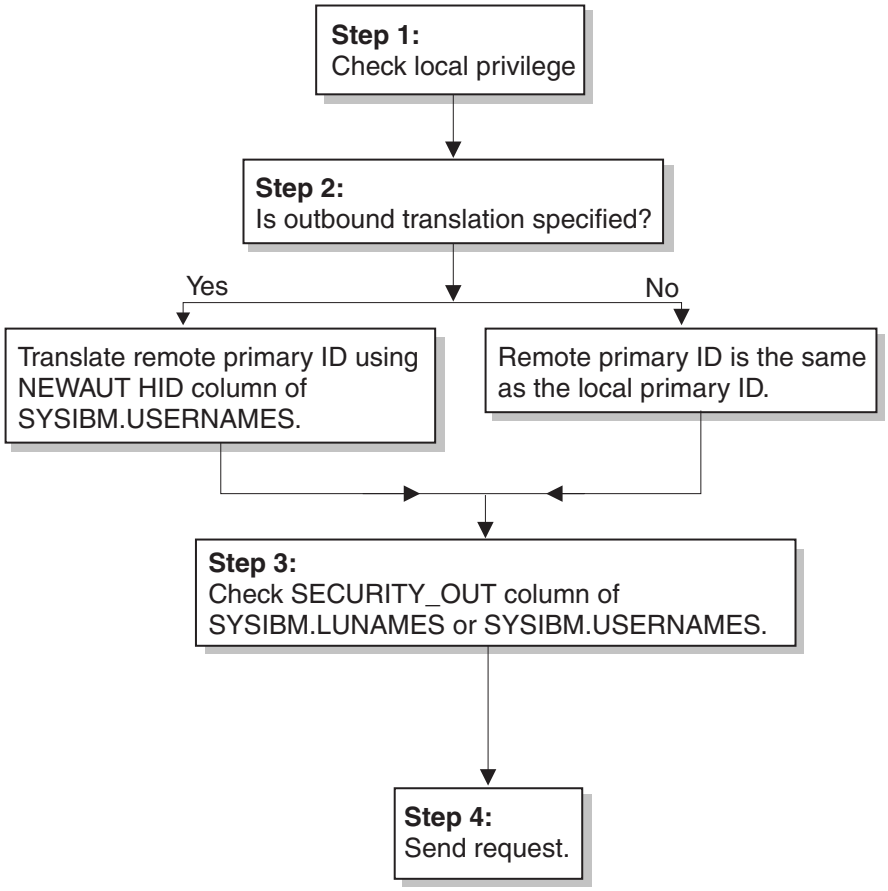


Figure 10. Steps in sending a request from a DB2 subsystem

1. The DB2 subsystem that sends the request checks whether the primary authorization ID has the privilege to execute the plan or package.

   DB2 determines which value in the LINKNAME column of the SYSIBM.LOCATIONS table matches either the LUNAME column in the SYSIBM.LUNAMES table or the LINKNAME column in the SYSIBM.IPNAMES table. This check determines whether SNA or TCP/IP protocols are used to carry the DRDA request. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption.
2. When a plan is executed, the authorization ID of the plan owner is sent with the primary authorization ID. When a package is bound, the authorization ID of the package owner is sent with the primary authorization ID. If the USERNAMES column of the SYSIBM.LUNAMES table contains O or B, or if the USERNAMES column of the SYSIBM.IPNAMES table contains O, both IDs are subject to translation under control of the SYSIBM.USERNAMES table. Ensure that these IDs are included in SYSIBM.USERNAMES, or SQLCODE -904 is issued. DB2 translates the ID as follows:
   - If a nonblank value of NEWAUTHID is in the row, that value becomes the new ID.
   - If NEWAUTHID is blank, the ID is not changed.

   If the SYSIBM.USERNAMES table does not contain a new authorization ID to which the primary authorization ID is translated, the request is rejected with SQLCODE -904.

   If the USERNAMES column does not contain O or B, the IDs are not translated.
3. SECURITY_OUT is checked for outbound security options as shown in the following diagram.

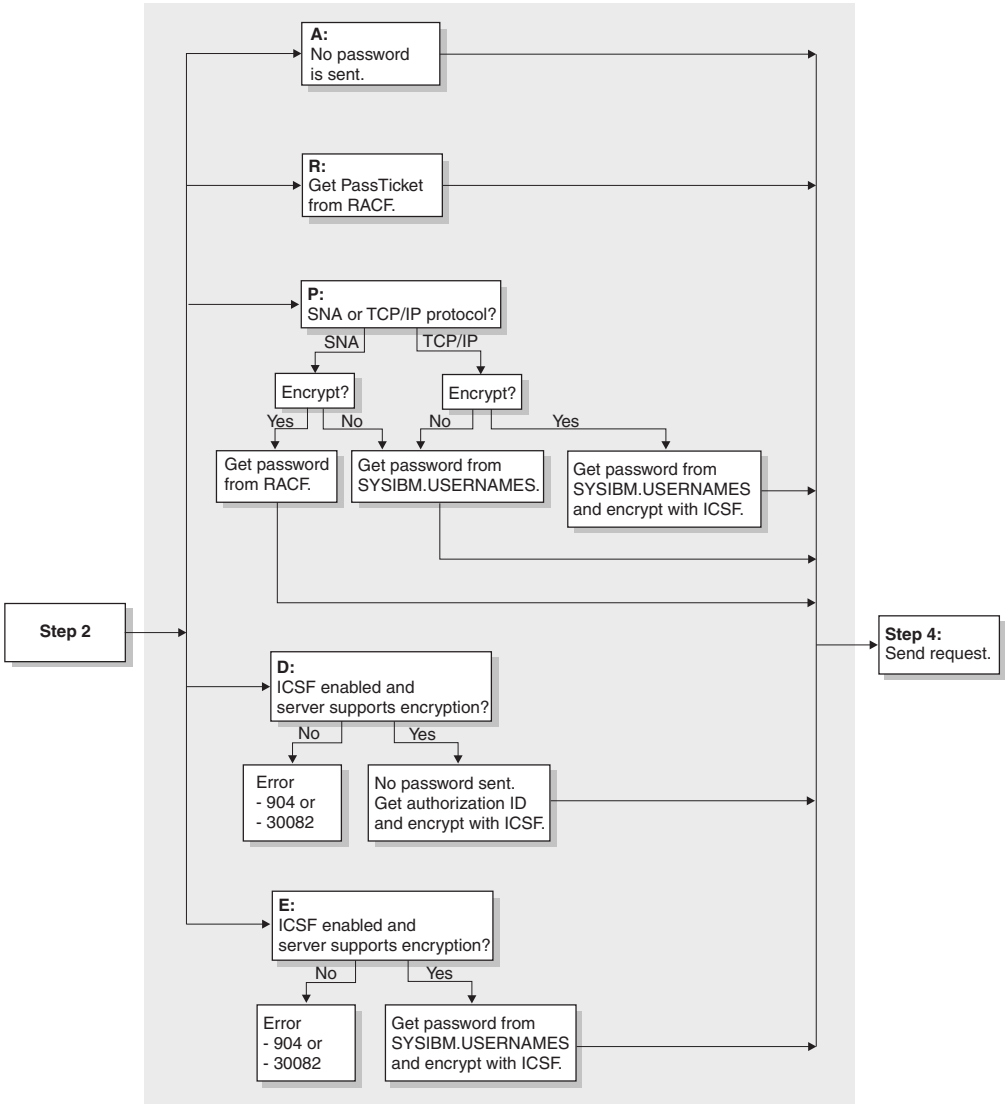


Figure 11. Details of Step 3

A Already verified. No password is sent with the authorization ID. This option is valid only if the server accepts already verified requests.

- For SNA, the server must have specified A in the SECURITY_IN column of SYSIBM.LUNAMES.
- For TCP/IP, the server must have specified YES in the TCP/IP ALREADY VERIFIED field of installation panel DSNTIP5.

R RACF PassTicket. If the primary authorization ID was translated, that translated ID is sent with the PassTicket.

P Password. The outbound request must be accompanied by a password:

- If the requester is DB2 for z/OS and uses SNA protocols, passwords can be encrypted if you specify Y in the ENCRYPTPSWDS column of SYSIBM.LUNAMES. If passwords are encrypted, the password is obtained from RACF. If passwords are not encrypted, the password is obtained from the PASSWORD column of SYSIBM.USERNAMES.
- If the requester uses TCP/IP protocols, the password is obtained from the PASSWORD column of SYSIBM.USERNAMES. If the

Integrated Cryptographic Service Facility is enabled and properly configured and the server supports encryption, the password is encrypted.

Recommendation: Use RACF PassTickets to avoid sending unencrypted passwords over the network.

D User ID and security-sensitive data encryption. No password is sent with the authorization ID. If the Integrated Cryptographic Service Facility (ICSF) is enabled and properly configured and the server supports encryption, the authorization ID is encrypted before it is sent. If the ICSF is not enabled or properly configured, SQL return code –904 is returned. If the server does not support encryption, SQL return code –30082 is returned.

E User ID, password, and security-sensitive data encryption. If the ICSF is enabled and properly configured and the server supports encryption, the password is encrypted before it is sent. If the ICSF is not enabled or properly configured, SQL return code –904 is returned. If the server does not support encryption, SQL return code –30082 is returned.

4. Send the request.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

"Processing of TCP/IP-based connection requests" on page 181

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Translating outbound IDs

If an ID on your system is duplicated on a remote system, you can translate outbound IDs to avoid confusion. You can also translate IDs to ensure that they are accepted by the remote system.

Procedure

To indicate that you want to translate outbound user IDs, perform the following steps:

1. Specify an O in the USERNAMES column of the SYSIBM.IPNAMES or SYSIBM.LUNAMES table.
2. Use the NEWAUTHID column of the SYSIBM.USERNAMES table to specify the ID to which the outbound ID is translated.

Example

Suppose that the remote system accepts from you only the IDs XXGALE, GROUP1, and HOMER.

1. Specify that outbound translation is in effect for the remote system LUXXX by specifying in SYSIBM.LUNAMES the values that are shown in the following table.

Table 43. SYSIBM.LUNAMES to specify that outbound translation is in effect for the remote system LUXXX

LUNAME	USERNAMES
LUXXX	O

   If your row for LUXXX already has I for the USERNAMES column (because you translate inbound IDs that come from LUXXX), change I to B for both inbound and outbound translation.

2. Translate the ID GALE to XXGALE on all outbound requests to LUXXX by specifying in SYSIBM.USERNAMES the values that are shown in the following table.

Table 44. Values in SYSIBM. USERNAMES to translate GALE to XXGALE on outbound requests to LUXXX

TYPE	AUTHID	LINKNAME	NEWAUTHID	PASSWORD
O	GALE	LUXXX	XXGALE	GALEPASS

3. Translate EVAN and FRED to GROUP1 on all outbound requests to LUXXX by specifying in SYSIBM.USERNAMES the values that are shown in the following table.

Table 45. Values in SYSIBM. USERNAMES to translate EVAN and FRED to GROUP1 on outbound requests to LUXXX

TYPE	AUTHID	LINKNAME	NEWAUTHID	PASSWORD
O	EVAN	LUXXX	GROUP1	GRP1PASS
O	FRED	LUXXX	GROUP1	GRP1PASS

4. Do not translate the ID HOMER on outbound requests to LUXXX. (HOMER is assumed to be an ID on your DB2, and on LUXXX.) Specify in SYSIBM.USERNAMES the values that are shown in the following table.

Table 46. Values in SYSIBM. USERNAMES to not translate HOMER on outbound requests to LUXXX

TYPE	AUTHID	LINKNAME	NEWAUTHID	PASSWORD
O	HOMER	LUXXX	(blank)	HOMERSPW

5. Reject any requests from BASIL to LUXXX before they are sent. To do that, leave SYSIBM.USERNAMES empty. If no row indicates what to do with the ID BASIL on an outbound request to LUXXX, the request is rejected.

If you send requests to another LU, such as LUYYY, you generally need another set of rows to indicate how your IDs are to be translated on outbound requests to LUYYY.

However, you can use a single row to specify a translation that is to be in effect on requests to all other LUs. For example, if HOMER is to be sent untranslated everywhere, and DOROTHY is to be translated to GROUP1 everywhere, specify in SYSIBM.USERNAMES the values that are shown in the following table.

Table 47. Values in SYSIBM. USERNAMES to not translate HOMER and to translate DOROTHY to GROUP1

TYPE	AUTHID	LINKNAME	NEWAUTHID	PASSWORD
O	HOMER	(blank)	(blank)	HOMERSPW
O	DOROTHY	(blank)	GROUP1	GRP1PASS

You can also use a single row to specify that all IDs that accompany requests to a single remote system must be translated. For example, if every one of your IDs is to be translated to THEIRS on requests to LUYYY, specify in SYSIBM.USERNAMES the values that are shown in the following table.

Table 48. Values in SYSIBM. USERNAMES to translate every ID to THEIRS

TYPE	AUTHID	LINKNAME	NEWAUTHID	PASSWORD
O	(blank)	LUYYY	THEIR	THEPASS

If the ICSF is installed and properly configured, you can use the DSNLEUSR stored procedure to encrypt the translated outbound IDs that are specified in the NEWAUTHID column of SYSIBM.USERNAMES. DB2 decrypts the translated outbound IDs during connection processing.

Sending passwords or password phrases

DB2 provides several security mechanisms to send password or password phrase information.

About this task

Specifically, DB2 supports the following security mechanisms:

- RACF encrypted passwords
- RACF PassTickets
- Kerberos tickets
- DRDA-encrypted passwords or password phrases or DRDA-encrypted user IDs with encrypted passwords or password phrases. See “Security mechanisms for DRDA and SNA” on page 166 for more information about using DRDA encryption.

If you have to send passwords or password phrases through the network, you can put the password or password phrase for a user ID in the PASSWORD column of the SYSIBM.USERNAMES table.

Recommendation: Use the DSNLEUSR stored procedure to encrypt passwords or password phrases in SYSIBM.USERNAMES. If the ICSF is installed and properly configured, you can use the DSNLEUSR stored procedure to encrypt passwords or password phrases in the SYSIBM.USERNAMES table. DB2 decrypts the password or password phrase during connection processing.

DB2 for z/OS allows the use of RACF encrypted passwords or RACF PassTickets. However, workstations, such as Windows workstations, do not support these security mechanisms. RACF encrypted passwords are not a secure mechanism because they can be replayed. RACF PassTickets are not compatible with SECURITY_ENCRYPT; they are allowed only when the connections are secured by the TCP/IP network.

Recommendation: Do not use RACF encrypted passwords unless you are connecting to a previous release of DB2 for z/OS.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients" on page 199

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

Chapter 9, "Protecting data through encryption and RACF," on page 287

Sending RACF-encrypted passwords

For DB2 subsystems that use SNA protocols to communicate with each other, you can specify password encryption in the SYSIBM.LUNAMES table.

About this task

Table 49. Specifying password encryption in SYSIBM.LUNAMES

LUNAME	USERNAMES	ENCRYPTPSWDS
LUXXX	O	Y

The partner DB2 must also specify password encryption in its SYSIBM.LUNAMES table. Both partners must register each ID and its password with RACF. Then, for every request to LUXXX, your DB2 calls RACF to supply an encrypted password to accompany the ID. With password encryption, you do not use the PASSWORD column of SYSIBM.USERNAMES, so the security of that table becomes less critical.

Sending RACF PassTickets

To send RACF PassTickets with your remote requests to a particular remote system, you can specify 'R' in the SECURITY_OUT column of the SYSIBM.IPNAMES or SYSIBM.LUNAMES table for that system.

Procedure

To set up RACF to generate PassTickets:

1. Activate the RACF PTKTDATA class by issuing the following RACF commands:

   ```
   SETROPTS CLASSACT(PTKTDATA)
   SETROPTS RACLIST(PTKTDATA)
   ```

2. Define a RACF profiles for each remote system by entering the system name as it appears in the LINKNAME column in the SYSIBM.LOCATIONS table.

   For example, issue the following command defines a profile for a remote system, DB2A, in the RACF PTKTDATA class:

   ```
   RDEFINE PTKTDATA DB2A SSIGNON(KEYMASKED(E001193519561977))
   ```

3. Refresh the RACF PTKTDATA definition with the new profiles by issuing the following command:

   ```
   SETROPTS RACLIST(PTKTDATA) REFRESH
   ```

Sending encrypted passwords or password phrases from DB2 for z/OS clients

As a requester, a DB2 for z/OS client can send connection requests that use 256-bit Advanced Encryption Standard (AES) or 56-bit Data Encryption Standards (DES) encryption security through a TCP/IP network to remote servers.

About this task

If the DB2 for z/OS client supports DRDA Security Manager (SECMGR) 9 or higher, and if z/OS ICSF is configured and started, the DB2 for z/OS client can send AES requests to a remote server. After the first successful connection, the DB2 for z/OS client can determine whether the remote server supports AES encryption security. If the remote server supports DRDA SECMGR 9 (or higher), the remote server accepts AES requests and encrypts the user IDs and passwords or password phrases that the client sends in AES.

If AES encryption is not available for the remote DB2 for z/OS server, the DB2 for z/OS client tries DES encryption. If DES encryption fails, the DB2 for z/OS client sends the user ID and password or password phrase in clear text.

See “Security mechanisms for DRDA and SNA” on page 166 for more information about using DRDA encryption. See the DB2 for z/OS Program Directory for ICSF hardware and software requirements for AES encryption.

As a client, DB2 for z/OS supports only the IPNAMES.SECURITY_OUT option 'P' ("password") for AES encryption and decryption. DB2 for z/OS does not support the IPNAMES.SECURITY_OUT option 'D' ("user ID and security-sensitive data encryption") or 'E' ("user ID, password, and security-sensitive data encryption"). These outbound security options remain encrypted in DES.

Attention: To protect your authentication information, use the z/OS Communications Server IP Application Transparent Transport Layer Security (AT-TLS) to secure your network connections. To complement the use of AT-TLS, set the TCPALVER subsystem parameter of installation panel DSNTIP5 to SERVER_ENCRYPT. Setting this parameter to SERVER_ENCRYPT provides the strongest level of security. Connections are accepted only if user credentials are provided to authenticate the user ID, and strong encryption is used to protect the user ID and credentials.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Encrypted password, user ID, or data security under the IBM Data Server Driver for JDBC and SQLJ (DB2 Application Programming for Java)

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords from workstation clients"

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

DB2 for z/OS Program Directories

Chapter 9, "Protecting data through encryption and RACF," on page 287

Sending encrypted passwords from workstation clients

As a server, DB2 for z/OS can accept requests from remote workstation clients that use 256-bit Advanced Encryption Standard (AES) or 56-bit Data Encryption Standards (DES) encryption security over a TCP/IP network connection.

About this task

Depending on the DRDA level, a remote client can use AES or DES encryption algorithm for sending passwords, user IDs and associated passwords, or other security-sensitive data to a DB2 for z/OS server. If the client explicitly requests AES encryption, only user IDs, passwords, or both are encrypted in AES, and any data in the request is encrypted in DES. Any persistent attempt to encrypt the data in AES causes the client to reject the connection request. See "Security mechanisms for DRDA and SNA" on page 166 for more information about using DRDA encryption. See the DB2 for z/OS Program Directory for ICSF hardware and software requirements for AES encryption.

To enable the DB2 for z/OS AES server support, you must install and configure z/OS Integrated Cryptographic Services Facility (ICSF). During DB2 startup, DSNXINIT invokes the MVS LOAD macro service to load various ICSF services, including the ICSF CSNESYE and CSNESYD modules that DB2 calls for processing AES encryption and decryption requests. If ICSF is not installed or if ICSF services are not available, DB2 cannot provide AES support, and DB2 terminates the connection.

To use DES encryption, you can enable DB2 Connect to send encrypted passwords by setting database connection services (DCS) authentication to DCS_ENCRYPT in the DCS directory entry. When a client application issues an SQL CONNECT statement, the client negotiates this support with the database server. If supported, a shared private key is generated by the client and server using the Diffie-Hellman public key technology, and the password is encrypted using 56-bit DES with the shared private key. The encrypted password cannot be replayed, and the shared private key is generated on every connection. If the server does not support password encryption, the application receives SQLCODE -30073 (DRDA security manager level 6 is not supported).

Attention: To protect your authentication information, use the z/OS Communications Server IP Application Transparent Transport Layer Security (AT-TLS) to secure your network connections. To complement the use of AT-TLS, set the TCPALVER subsystem parameter of installation panel DSNTIP5 to SERVER_ENCRYPT. Setting this parameter to SERVER_ENCRYPT provides the strongest level of security. Connections are accepted only if user credentials are provided to authenticate the user ID, and strong encryption is used to protect the user ID and credentials.

Related concepts:

"Security mechanisms for DRDA and SNA" on page 166

"Encrypting your data with Secure Socket Layer support" on page 287

Encrypted password, user ID, or data security under the IBM Data Server Driver for JDBC and SQLJ (DB2 Application Programming for Java)

Related tasks:

"Managing inbound TCP/IP-based connection requests" on page 180

"Sending encrypted passwords or password phrases from DB2 for z/OS clients" on page 198

Related reference:

TCP/IP ALREADY VERIFIED field (TCPALVER subsystem parameter) (DB2 Installation and Migration)

Related information:

DB2 for z/OS Program Directories

Chapter 9, "Protecting data through encryption and RACF," on page 287

Chapter 4. Managing access through row permissions and column masks

Row and column access control enables you to manage access to a table at the level of a row, a column, or both. You can implement row access control through row permissions and column access control through column masks.

Row and column access control

Row and column access control is a DB2 security solution that uses SQL to control access to a table at the level of a row, a column, or both.

Traditionally, access control at the row and column level is implemented through views. Using views as an access control method works well only when access rules, restrictions, and conditions are monolithic and simple. It however becomes ineffective when view definitions become too complex because of the complexity and granularity of privacy and security policies. It also becomes costly when a large number of views must be manually updated and maintained. In addition, the ability to update views proves to be challenging. As privacy and security policies evolve, required updates to views may negatively affect the security logic particularly when database applications reference the views directly by name. DB2 row and column access control helps resolve all these problems.

Implemented through SQL and managed by the DB2 security administrator, row and column access control allows you to manage access to a table with filtering and data masking. Unlike multilevel security, row and column access control is integrated into a database system, and all applications and tools that use SQL to access the database are automatically subject to the same control. This effectively eliminates the need to filter security-sensitive data at the application level and ensures that the data is protected when the applications and tools use SQL to access it.

Row and column access control is based on a security policy that specifies the rules and conditions under which a user, group, or role can access rows, columns, or both of a base table. The access control is not needed at the view level because the view automatically receives row and column access control that is activated on the underlining base table. The row and column access control rules do not affect how a read-only view is determined. All users access the same base table (as opposed to alternative views of a table), but access restrictions are based on individual user permissions and masks that are specified by a policy associated with the table.

An authorization ID or role with the SECADM authority can manage row and column access control. The SECADM authority can activate or deactivate row and column access control for a table, grant or revoke the CREATE_SECURE_OBJECT system privilege, and create, alter, or drop row permissions and column masks. The SYSADM authority can perform the same tasks if the SEPARATE SECURITY system parameter on panel DSNTIPP1 is set to NO during installation.

Row and column access control can be activated for a table before or after row permissions or column masks are created for the table. If row permissions or column masks already exist, activating row and column access control simply makes the permissions or masks become effective. If row permissions or column

masks do not yet exist, activating row access control for a table means that DB2 will generate a default row permission that prevents any access to the table by SQL, and activating column access control means to wait for the column masks to be created.

When a table is activated for row or column access control, all users, including the table owner and the SECADM, SYSDM, or DBADM authorities, are subject to the same security rules and restrictions. This ensures that access to security-sensitive data is truly on a need basis and prevents system and database administrators from unnecessarily accessing it. Since security policies or rules are expressed and enforced through SQL, row and column access control is inherently flexible.

Row access control and multilevel security are mutually exclusive. If a table is activated for row access control, it cannot be altered to include a security label column; if a table has a security label column, it cannot be activated for row access control. Column access control, on the other hand, is not affected by multilevel security. If a table is activated for column level access control, it can be altered to include a security label column, and vice versa.

Related concepts:

"Row permission"

"Column mask" on page 203

Related reference:

"Explicit system privileges" on page 25

"SECADM" on page 39

Row permission

A *row permission* is a database object that describes a specific row access control rule for a table. In the form of an SQL search condition, the rule specifies the conditions under which a user, group, or role can access the rows of data in the table.

Stored in the system catalog, row permissions can be created on all base tables except materialized query tables, and they are maintained on an individual basis. The definition of each row permission may reference the user, group, or role in the search condition.

If multiple row permissions are defined for a table and when row access control is activated, the search condition in each row permission is connected by the logical OR operator to form the row access control search condition. This row access control search condition is applied whenever the table is accessed. It acts as a filter to the table before any other user-specified operations, such as predicates and ordering, are processed. It also acts like the WITH CHECK OPTION clause of a view to ensure that a row to be inserted or updated conforms to the definitions of the row permissions in an INSERT, UPDATE, or MERGE statement.

Only an authorization ID or role with the SECADM or SYSADM authority can manage row permissions. If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to create, alter, or drop row permissions. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

Related concepts:

"Column mask"

Related tasks:

"Creating row permissions" on page 208

"Creating column masks" on page 210

Related reference:

"Rules of row and column access control" on page 204

"Explicit system privileges" on page 25

"SECADM" on page 39

Column mask

A *column mask* is a database object that describes a specific column access control rule for a column. In the form of an SQL CASE expression, the rule specifies the condition under which a user, group, or role can receive the masked values that are returned for a column.

Stored in the system catalog, column masks can be created on all base tables except materialized query tables and maintained on an individual basis. The definition of each column mask may reference the user, group, or role in the search conditions in the CASE WHEN clause.

While multiple columns in a table may have column masks, only one column mask can be created for a single column. When column access control is activated for the table, the CASE expression in the column mask definition is applied to an output column to determine the masked values that are returned to an application. The application of column masks affects the final output only; it does not impact the operations, such as predicates and ordering, in an SQL statement. In addition, the application of column masks must not change the values in a row that is being inserted or updated in an INSERT, UPDATE, or MERGE statement.

Only an authorization ID or role with the SECADM or SYSADM authority can manage column masks. If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to create, alter, or drop column masks. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

Related concepts:

"Row permission" on page 202

Related tasks:

"Creating row permissions" on page 208

"Creating column masks" on page 210

Related reference:

"Rules of row and column access control"

"Explicit system privileges" on page 25

"SECADM" on page 39

Rules of row and column access control

The rules of row and column access control apply to both read and write operations on a table. The conditions that are specified in row permissions and column masks apply to both data retrieval operations and data change operations.

GUPI

The following table shows an example of how row and column access control rules are applied depending on the types of data operations. Assume that tables T1 and T2 are activated for row and column access control and that both tables include columns C1 and C2.

Table 50. Rules and access types for row and column access control

SQL statement	Row permission	Column mask (defined for column C1)
SELECT SUBSTR(C1,8,4) FROM T1;	• If user-defined row permissions exist for the table, only the rows that satisfy the permissions are returned. • If no user-defined row permissions exist for the table, the default row permission is applied and no row is returned.	• The column mask is applied to column C1 that is referenced in the select list of the outermost SELECT clause. It does not interfere with the operations of other clauses within the statement, such as the WHERE, GROUP BY, HAVING, SELECT DISTINCT, or ORDER BY clauses. Some column mask restrictions may apply to the other clauses within the statement. • The masked value that is determined by the evaluation of the CASE expression in the column mask is returned in place of the column value in the output row. If column C1 is embedded in an expression, the column mask is applied to the input column before the evaluation of the expression takes place.

Table 50. Rules and access types for row and column access control (continued)

SQL statement	Row permission	Column mask (defined for column C1)
INSERT INTO T1(C1, C2) VALUES('A', 'B');	For each row to be inserted: • If a user-defined row permission exists, the row can be inserted only when that row can be subsequently retrieved by the authorization ID of the INSERT statement. If the row cannot be inserted, the INSERT statement returns an error. • If no user-defined row permissions exist for the table only the default row permission is applied and no row is inserted. The INSERT statement returns an error. The ENFORCED FOR ALL ACCESS clause ensures that users cannot insert data that they cannot read.	

Table 50. Rules and access types for row and column access control (continued)

SQL statement	Row permission	Column mask (defined for column C1)
INSERT INTO T1(C1) SELECT SUBSTR(T2.C1, 8, 4) FROM T2 WHERE T2.C2 > 10;		• When the columns are used to derive the new values for an INSERT statement, the original column values, not the masked values, are used. If the columns have column masks, those column masks are applied to ensure the evaluation of the access control rules at run time masks the column to itself, not to a constant or an expression. This ensures that the masked values are the same as the original column values. If a column mask does not mask the column to itself, the new row is not inserted and an error is returned at run time. For example, column T2.C1 is used to derive the value of a new row for INSERT. The column value of T2.C1, not the masked value, is used to derive the new value. Because column T2.C1 has a column mask, the column mask is applied to ensure the evaluation of the access control rule in the column mask masks column T2.C1 to itself, not to a constant or an expression. This ensures the masked value is the same as the original column value. If the column mask of T2.C1 does not mask column T2.C1 to itself, the new value cannot be used and an error is returned at run time. • The column mask rules that apply to the new value for INSERT are the same as those for SELECT.

Table 50. Rules and access types for row and column access control (continued)

SQL statement	Row permission	Column mask (defined for column C1)
UPDATE T1 SET C2 = (SELECT SUBSTR(T2.C1, 8, 4) FROM T2 WHERE T2.C2 > 10);	The following rules are applied in the order as shown: 1. Identify candidate rows for updates: If a user-defined row permission exists, only the rows of the table that satisfy the row permission can be the candidate rows for UPDATE. If no user-defined row permissions exist for the table, only the default row permission is applied and no rows are updated. 2. If there are rows to be updated, for each row to be updated: • When the columns are used to derive the new values for an UPDATE statement, the original column values, not the masked values, are used. If the columns have column masks, those column masks are applied to ensure that the evaluation of the access control rules at run time masks the column to itself, not to a constant or an expression. This ensures the masked values are the same as the original column values. If a column mask does not mask the column to itself, the new rvalue cannot be used for the update and an error is returned at run time. For example, column T2.C1 is used to derive the new value for the update. The column value of T2.C1, not the masked value, is used to derive the new value. Because column T2.C1 has a column mask, the column mask is applied to ensure that the evaluation of the access control rule in the column mask masks column T2.C1 to itself, not to a constant or an expression. This ensures that the masked value is the same as the original column value. If the column mask of T2.C1 does not mask column T2.C1 to itself, the new value cannot be used for the update and an error is returned at run time • The column mask rules that apply to the new value for UPDATE are the same as those for SELECT. 3. If there are rows to be updated, for each row to be updated: • If a user-defined row permission exists, the row can be updated only when that row can be subsequently retrieved by the authorization ID of the UPDATE statement. If the row cannot be updated, the UPDATE statement returns an error. The ENFORCED FOR ALL ACCESS clause ensures that users cannot update data that they cannot read. • The column mask is not applicable in this retrieval.	
MERGE	The row and column access control rules for the UPDATE and INSERT operations in the MERGE statement are the same as those for the UPDATE and INSERT statements.	
DELETE	• If a user-defined row permission exists for the table, only the rows that satisfy the permission are the candidate rows for an DELETE statement. • If no user-defined row permissions exist for the table, the default row permission is applied and no row can be deleted.	

GUPI

Related concepts:

"Row permission" on page 202

"Column mask" on page 203

Related tasks:

"Creating row permissions"

"Creating column masks" on page 210

"Using INSERT on tables with row access control" on page 214

"Creating triggers for tables with row and column access control" on page 215

"Modifying column masks to reference UDFs" on page 212

Creating row permissions

A *row permission* specifies the conditions under which users can access a row. With the SECADM authority, you can use the CREATE PERMISSION statement to create a row permission.

Before you begin

If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to create a row permission. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

About this task

Suppose that you are a data security administrator (SECADM) for a national health organization (NetHMO) and responsible for safeguarding sensitive patient information. You want to create a data privacy and security policy and implement it through row permissions on tables that are enabled with row access control. The permission definitions prescribe the conditions under which patients, physicians, pharmacists, or account administrators can only receive certain rows based on their roles or account authentication IDs.

Procedure

To create a row permission:

1. Issue the CREATE TABLE statement to create table HOSPITAL.PATIENT.

   The HOSPITAL.PATIENT table contains columns for recording a patient's social security number (SSN), account authorization ID (USERID), name (NAME), address (ADDRESS), pharmacy (PHARMACY), account balance (ACCT_BALANCE), and doctor (PCP_ID), as shown below: GUPI

```
CREATE TABLE HOSPITAL.PATIENT (
       SSN CHAR(11),
       USERID VARCHAR(18),
       NAME VARCHAR(128),
       ADDRESS VARCHAR(128),
       PHARMACY VARCHAR(5000),
       ACCT_BALANCE DECIMAL(12,2) WITH DEFAULT,
       PCP_ID VARCHAR(18));
```

   GUPI

2. Issue the CREATE ROLE statements to create the following roles and determine the rules for each role to access the HOSPITAL.PATIENT table

   The row access control rules specify the specific types of information that users in a specific role can access and the conditions under which the role can access the information. GUPI

```
CREATE ROLE PCP;
CREATE ROLE DRUG_RESEARCH;
CREATE ROLE ACCOUNTING;
CREATE ROLE MEMBERSHIP;
CREATE ROLE PATIENT;
```

   GUPI

3. Issue the CREATE PERMISSION statement to create row permissions that allow each role to access data in specific rows.

   You can use the built-in function VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER to determine whether the user identified in special register SESSION_USER is associated with a particular ROLE that is specified as the input argument to the function.

   In the following example, Role PATIENT is allowed to access his or her own row. Role PCP is allowed to access his or her patients' rows. Roles MEMBERSHIP, ACCOUNTING, and DRUG_RESEARCH are allowed to access all rows. GUPI

```
CREATE PERMISSION NETHMO.ROW_ACCESS ON HOSPITAL.PATIENT
   FOR ROWS WHERE (VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                       'PATIENT') = 1 AND
                       HOSPITAL.PATIENT.USERID = SESSION_USER) OR
                   (VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                       'PCP') = 1 AND
                       HOSPITAL.PATIENT.PCP_ID = SESSION_USER) OR
                   (VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                       'MEMBERSHIP') = 1 OR
                   VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                       'ACCOUNTING') = 1 OR
                   VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                       'DRUG_RESEARCH') = 1)
     ENFORCED FOR ALL ACCESS
    ENABLE;

COMMIT;
```

   GUPI

   The definitions of the new row permissions are stored in the new catalog table SYSIBM.SYSCONTROLS.

4. Issue the ALTER TABLE statement with the ACTIVATE ROW ACCESS CONTROL clause to activate row access control for table HOSPITAL.PATIENT.

   GUPI

```
ALTER TABLE HOSPITAL.PATIENT ACTIVATE ROW ACCESS CONTROL;

COMMIT;
```

   GUPI

   The ALTER TABLE serialization process takes place and invalidates all packages and dynamic cached statements that reference table

HOSPITAL.PATIENT. The value 'R' in the new column SYSTABLES.CONTROL indicates that the table is activated for row access control.

DB2 also implicitly creates a default row permission which restricts all access from HOSPITAL.PATIENT. The default row permission definition is stored in the new catalog table SYSIBM.SYSCONTROLS.

Whenever table HOSPITAL.PATIENT is referenced in a data manipulation statement, all row permissions that have been created for it, including the default row permission, are implicitly applied by DB2 to control the rows in the table that are accessible. A row access control search condition is derived from the logical OR operators that connect the search condition in each row permission. This search condition acts as a filter to HOSPITAL.PATIENT before any user-specified operations, such as predicates, grouping, ordering. are processed.

If necessary, SECADM can deactivate row access control from table HOSPITAL.PATIENT by simply issuing the following ALTER TABLE statement:

GUPI

```
ALTER TABLE HOSPITAL.PATIENT DEACTIVATE ROW ACCESS CONTROL;

COMMIT;
```

GUPI

DB2 invalidates all packages and dynamic cached statements that reference HOSPITAL.PATIENT. DB2 reflects the removal of row access control by setting SYSTABLES.CONTROL to blank. This also means that table HOSPITAL.PATIENT does not have any access control and that users can retrieve data from all its rows.

Related concepts:

"Row permission" on page 202

"Column mask" on page 203

Related tasks:

"Creating column masks"

"Using INSERT on tables with row access control" on page 214

"Creating triggers for tables with row and column access control" on page 215

"Modifying column masks to reference UDFs" on page 212

Related reference:

"Rules of row and column access control" on page 204

"Explicit system privileges" on page 25

"SECADM" on page 39

Creating column masks

A *column mask* specifies the rules for users to receive the masked values that are returned for the column. With the SECADM authority, you can use the CREATE MASK statement to create a column mask.

Before you begin

GUPI If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to create a column mask. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

About this task

Suppose that you are a data security administrator (SECADM) for a national health organization (NetHMO) and responsible for safeguarding sensitive patient information. You want to create a data privacy and security policy and implement it through column masks on tables that are enabled with column access control. The mask definitions prescribe the conditions under which patients, physicians, pharmacists, or account administrators can only receive certain masked values from the column based on their roles or account authentication IDs.

Procedure

To create a column mask:

1. Issue the CREATE TABLE statement to create table HOSPITAL.PATIENT

   The HOSPITAL.PATIENT table contains columns for recording a patient's social security number (SSN), account authorization ID (USERID), name (NAME), address (ADDRESS), pharmacy (PHARMACY), account balance (ACCT_BALANCE), and doctor (PCP_ID), as shown below:

   ```
   CREATE TABLE HOSPITAL.PATIENT (
          SSN CHAR(11),
          USERID VARCHAR(18),
          NAME VARCHAR(128),
          ADDRESS VARCHAR(128),
          PHARMACY VARCHAR(5000),
          ACCT_BALANCE DECIMAL(12,2) WITH DEFAULT,
          PCP_ID VARCHAR(18));
   ```

2. Issue the CREATE ROLE statements to create the following roles that access the HOSPITAL.PATIENT table.

   ```
   CREATE ROLE PCP;
   CREATE ROLE DRUG_RESEARCH;
   CREATE ROLE ACCOUNTING;
   CREATE ROLE MEMBERSHIP;
   CREATE ROLE PATIENT;
   ```

3. Issue the CREATE MASK statement to create column masks that allow each role to receive certain masked values from specific columns.

   You can use the built-in function VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER to determine whether the user identified in special register SESSION_USER is associated with a particular ROLE that is specified as the input argument to the function.

   The following example shows how column mask SSN_MASK is created. Roles PATIENT and ACCOUNTING are allowed to receive column values from column SSN. Other roles that access the column will receive masked values.

   ```
   CREATE MASK NETHMO.SSN_MASK ON HOSPITAL.PATIENT FOR
      COLUMN SSN RETURN
         CASE WHEN VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                        'PATIENT') = 1 OR
                   VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                        'ACCOUNTING') = 1
              THEN SSN
              ELSE CHAR('XXX-XX-') || SUBSTR(SSN,8,4)
              END
         ENABLE;

   COMMIT;
   ```

You can issue the CREATE MASK statements to create column masks USERID_MASK, NAME_MASK, and ADDRESS_MASK. The definitions of all these column masks are stored in the new catalog table SYSIBM.SYSCONTROLS.

4. Use the ALTER TABLE statement with the ACTIVATE COLUMN ACCESS CONTROL clause to activate column access control for table HOSPITAL.PATIENT

```
ALTER TABLE HOSPITAL.PATIENT ACTIVATE COLUMN ACCESS CONTROL;

COMMIT;
```

The ALTER TABLE serialization process takes place and invalidates all packages and dynamic cached statements that reference table HOSPITAL.PATIENT. The value 'C' in the new column SYSTABLES.CONTROL indicates that the table is activated for column access control.

Whenever column SSN of table HOSPITAL.PATIENT is referenced in the outermost SELECT clause of a data manipulation statement, column mask SSN_MASK is implicitly applied by DB2 to control the masked values that are returned for it.

If necessary, SECADM can deactivate column access control from table HOSPITAL.PATIENT by simply issuing the following ALTER TABLE statement:

```
ALTER TABLE HOSPITAL.PATIENT DEACTIVATE COLUMN ACCESS CONTROL;

COMMIT;
```

DB2 invalidates all packages and dynamic cached statements that reference HOSPITAL.PATIENT. DB2 reflects the removal of column access control by setting SYSTABLES.CONTROL to blank. GUPI

Related concepts:

"Row permission" on page 202

"Column mask" on page 203

Related tasks:

"Creating row permissions" on page 208

"Using INSERT on tables with row access control" on page 214

"Creating triggers for tables with row and column access control" on page 215

"Modifying column masks to reference UDFs"

Related reference:

"Rules of row and column access control" on page 204

"Explicit system privileges" on page 25

"SECADM" on page 39

Modifying column masks to reference UDFs

With the SECADM authority, you can modify column masks on tables that are activated for column access control.

Before you begin

GUPI If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to modify a column mask. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

About this task

Suppose that table HOSPITAL.PATIENT contains columns to record a patient's social security number (SSN), account authorization ID (USERID), name (NAME), address (ADDRESS), pharmacy (PHARMCY), account balance (ACCT_BALANCE), and doctor (PCD_ID). The table is activated for column access control.

Also, suppose that database developer Paul has created a new powerful accounting application NetHMLAccountingUDF (an external scalar user-defined function). You want to modify column mask ACCT_BALANCE_MASK for column HOSPITAL.PATIENT.ACCT_BALANCE to include NetHMLAccountingUDF.

Procedure

To modify column mask ACCT_BALANCE_MASK to include NetHMLAccountingUDF:

1. Make sure that all the operations in the new UDF are secure.

   Only secure UDFs can be invoked in a column mask. The SECURED attribute is required if the user-defined function is referenced in the definition of a row permission or column mask. This is because the user-defined function may access sensitive data. The SECURED attribute is also required for a user-defined function that is invoked in an SQL statement when the function arguments reference columns that are activated with column access control.

   Make sure that all the operations inside the new application NetHMLAccountingUDF are actually secure. Then, you can issue the following GRANT CREATE_SECURE_OBJECT statement to allow userid PAUL the privilege for creating a secure UDF:

   ```
   GRANT CREATE_SECURE_OBJECT TO PAUL;

   COMMIT;
   ```

   DB2 records the grant in SYSUSERAUTH: GRANTOR = GRANTORID, GRANTEE = PAUL, AUTHHOWGOT = E, and CREATESECUREAUTH = Y. This means that authid GRANTORID has used the SECADM authority (AUTHHOWGOT = E) to grant userid PAUL the CREATE_SECURE_OBJECT privilege.

   With the CREATE_SECURE_OBJECT privilege, Paul issues the following ALTER FUNCTION statement to secure NetHMLAccountingUDF:

   ```
   ALTER FUNCTION NETHMOACCOUNTINGUDF(ACCT_BALANCE) SECURED;

   COMMIT;
   ```

   DB2 sets the new column in catalog SYSROUTINES.SECURE to Y and invalidates all packages and dynamic cached statements that reference NetHMOAccountingUDF(ACCT_BALANCE).

2. After the UDF has been altered to be secure, revoke the CREATE_SECURE_OBJECT privilege from userid PAUL by issuing the following REVOKE CREATE_SECURE_OBJECT statement:

   ```
   REVOKE CREATE_SECURE_OBJECT FROM PAUL;

   COMMIT;
   ```

   DB2 completes the privilege removal by deleting the row from SYSUSERAUTH with GRANTOR = GRANTORID, GRANTEE = PAUL, AUTHHOWGOT = E, and CREATESECUREAUTH = Y.

3. Drop the existing column mask ACCT_BALANCE_MASK for column ACCT_BALANCE

You can issue the DROP MASK statement to remove the existing column mask, but do not follow it with the COMMIT statement. This will prevent any ongoing transactions from accessing table HOSPITAL.PATIENT before you can put a new column mask in place.

```
DROP MASK ACCT_BALANCE_MASK;
```

DB2 invalidates all packages and dynamic cached statements that reference table HOSPITAL.PATIENT. It also deletes the row for ACCT_BALANCE_MASK in the catalog table SYSIBM.SYSCONTROLS. Since there isn't a COMMIT statement immediately after the DROP MASK statement, DB2 keeps possessing the lock on HOSPITAL.PATIENT and doesn't commit the work it has done for the DROP MASK statement. Any transactions that try to access HOSPITAL.PATIENT may be timed out.

4. Create a new column mask ACCT_BALANCE_MASK for column ACCT_BALANCE

   You can issue the CREATE MASK statement to create a new column mask and follow it immediately with the COMMIT statement. This will enable DB2 to commit all the work it has done so far for HOSPITAL.PATIENT and allow other transactions to access HOSPITAL.PATIENT.

```
CREATE MASK NETHMO.ACCT_BALANCE_MASK ON HOSPITAL.PATIENT FOR
    COLUMN ACCT_BALANCE RETURN
       CASE WHEN VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER
            (SESSION_USER,'ACCOUNTING') = 1

            THEN NETHMOACCOUNTINGUDF(ACCT_BALANCE)
            ELSE 0.00
       END
    ENABLE;

COMMIT;
```

   DB2 invalidates all packages and dynamic cached statements that reference table HOSPITAL.PATIENT and inserts the new ACCT_BALANCE_MASK definition into the catalog table SYSIBM.SYSCONTROLS. It also records the dependency on NetHMOAccountingUDF in SYSIBM.SYSDEPENDENCIES for ACCT_BALANCE_MASK.

   The COMMIT statement immediately after the CREATE MASK statement ensures that DB2 commits all the work it has done so far on HOSPITAL.PATIENT and releases the lock from the table. This allows other transactions to access the same table without being timed out. GUPI

Using INSERT on tables with row access control

You can use the INSERT statement on tables that are activated for row access control.

About this task

Suppose that you are responsible for managing patient memberships and you are associated with role MEMBERSHIP that is already created for table HOSPITAL.PATIENT. Table HOSPITAL.PATIENT is also activated for row access control, and Role MEMBERSHIP is allowed to access, create, and retrieve rows in the table.

Suppose that table HOSPITAL.PATIENT contains columns to record a patient's social security number (SSN), account authorization ID (USERID), name (NAME), address (ADDRESS), pharmacy (PHARMCY), account balance (ACCT_BALANCE),

and doctor (PCD_ID). You want to add a new row for a new patient Bob.

Procedure

GUPI To add a row to a table that is enforced with row access control:

1. Ensure that role MEMBERSHIP is allowed to access, insert, and update rows when row permission rules are set for table HOSPITAL.PATIENT by the SECADM authority.

```
CREATE PERMISSION NETHMO.ROW_ACCESS ON HOSPITAL.PATIENT
   FOR ROWS WHERE (VERIFY_TRUSTED_CONTEXT_ROLE_FOR_USER(SESSION_USER,
                     'MEMBERSHIP') = 1 )
      ENFORCED FOR ALL ACCESS
    ENABLE;

COMMIT;
```

2. Issue the INSERT statement to insert a new row for patient Bob:

```
INSERT INTO HOSPITAL.PATIENT(SSN, USERID, NAME, ADDRESS)
     VALUES('123-45-6789','BobXYZ100','Bob','123 Some St.');

COMMIT;
```

3. Verify that Bob was successfully added by issuing the following SELECT statement:

```
SELECT * FROM HOSPITAL.PATIENT WHERE SSN = '123-45-6789';

COMMIT;
```

   The following result is returned and shows that a new row for Bob was successfully added to the table.

```
SSN          USERID     NAME  ADDRESS       PHARMACY  ACCT_BALANCE  PCP_ID
-----------  ---------  ----  ------------  --------  ------------  ------
123-45-6789  BobXYZ100  Bob   123 Some St.  ?         0.00          ?

DSNT400I SQLCODE = 000, SUCCESSFUL EXECUTION
         SUCCESSFUL RETRIEVAL OF 1 ROW(S)
```

GUPI

Creating triggers for tables with row and column access control

With the required authority and privileges, you can create triggers for tables that are activated for row and access control.

Before you begin

If the SEPARATE_SECURITY system parameter on panel DSNTIPP1 is set to YES during installation or migration, you must have the SECADM authority to create triggers for tables that are activated with row and column access control. If SEPARATE_SECURITY is set to NO, you must have the SECADM or SYSADM authority.

About this task

Suppose that table HOSPITAL.PATIENT is activated for row and column access control. The table contains columns to record a patient's social security number (SSN), account authorization ID (USERID), name (NAME), address (ADDRESS), pharmacy (PHARMCY), account balance (ACCT_BALANCE), and doctor (PCD_ID). Paul, a database developer, needs to create a new AFTER UPDATE

trigger for HOSPITAL.PATIENT to monitor the history of the ACCT_BALANCE column.

Procedure

To create a trigger for a table that is enforced with row and access control:

1. Make sure that all operations on the transition variables and transition tables inside the new trigger body are secure.

   Only secure triggers can be defined on tables that are already enforced with row and column access control. The SECURED attribute is required for a trigger when the associated table is row or column access control enforced or the associated view whose underlying table is enforced with row or column access control. If a trigger exists but is not secure, row or column access control cannot be activated for the associated table.

   Make sure that all operations on the transition variables and transition tables inside the new trigger body are actually secure. Then, you can issue the following GRANT CREATE_SECURE_OBJECT statement to allow userid PAUL the privilege for creating secure triggers for table HOSPITAL.PATIENT: GUPI

   ```
   GRANT CREATE_SECURE_OBJECT TO PAUL;

   COMMIT;
   ```

   GUPI

   DB2 records the grant in SYSUSERAUTH: GRANTOR = GRANTORID, GRANTEE = PAUL, AUTHHOWGOT = E, and CREATESECUREAUTH = Y. This means that authid GRANTORID has used the SECADM authority (AUTHHOWGOT = E) to grant userid PAUL the CREATE_SECURE_OBJECT privilege.

2. Create a new trigger for table HOSPITAL.PATIENT

   With the CREATE_SECURE_OBJECT privilege, Paul can create a secure NETHMO_ACCT_BALANCE_TRIGGER by issuing the following CREATE TRIGGER statement: GUPI

   ```
   CREATE TRIGGER NETHMO_ACCT_BALANCE_TRIGGER NO CASCADE
       AFTER UPDATE OF ACCT_BALANCE ON HOSPITAL.PATIENT SECURED
       REFERENCING OLD AS O NEW AS N
       FOR EACH ROW MODE DB2SQL
       BEGIN ATOMIC
           INSERT INTO ACCT_HISTORY
                (SSN, BEFORE_BALANCE, AFTER_BALANCE, WHEN, BY_WHO)
                VALUES(O.SSN, O.ACCT_BALANCE, N.ACCT_BALANCE,
                       CURRENT TIMESTAMP, SESSION_USER);
       END!

   COMMIT!
   ```

   GUPI

   DB2 inserts a new row into SYSIBM.SYSTRIGGERS with SYSTRIGGERS.SECURE = 'Y'. DB2 completes other catalog table updates for the trigger creation.

3. After trigger NETHMO_ACCT_BALANCE_TRIGGER is created, revoke the CREATE_SECURE_OBJECT privilege from userid PAUL by issuing the following REVOKE CREATE_SECURE_OBJECT statement:

   GUPI

```
REVOKE CREATE_SECURE_OBJECT FROM PAUL;

COMMIT;
```

GUPI

DB2 completes the privilege removal by deleting the row with GRANTOR = GRANTORID, GRANTEE = PAUL, AUTHHOWGOT = E, and CREATESECUREAUTH = Y from SYSUSERAUTH. This means that authid GRANTORID has used the SECADM authority (AUTHHOWGOT = E) to revoke the CREATE_SECURE_OBJECT privilege from userid PAUL.

Chapter 5. Managing access through trusted contexts

You can use trusted contexts to manage access to your DB2 subsystems, which helps you improve data security.

You can use trusted connections within a trusted context. When you do this, you can reuse the authorization and switch users of the connection without the database server needing to authenticate the IDs. To use trusted connections, you cannot set the ALL subsystem parameter to ALL and set the RESTART subsystem parameter to DEFER on installation panel DSNTIPS

Trusted contexts

A *trusted context* is an independent database entity that you can define based on a system authorization ID and connection trust attributes.

The trust attributes specify a set of characteristics about a specific connection. These attributes include the IP address, domain name, or SERVAUTH security zone name of a remote client and the job or task name of a local client.

A trusted context allows for the definition of a unique set of interactions between DB2 and the external entity, including the following abilities:

- The ability for the external entity to use an established database connection with a different user without the need to authenticate that user at the DB2 server. This ability eliminates the need to manage end-user passwords by the external entity. Also, a database administrator can assume the identity of other users and perform actions on their behalf.
- The ability for a DB2 authorization ID to acquire one or more privileges within a trusted context that are not available to it outside of that trusted context. This is accomplished by associating a role with the trusted context.

The following client applications provide support for the trusted context:

- The DB2 Universal Java Driver introduces new APIs for establishing trusted connections and switching users of a trusted connection.
- The DB2 CLI/ODBC Driver introduces new keywords for connecting APIs to establish trusted connections and switch users of a trusted connection.
- The WebSphere Application Server 6.0 exploits the trusted context support through its "propagate client identity" property.

Related concepts:

"Trusted connections"

"Roles in a trusted context" on page 21

Related tasks:

"Defining trusted contexts"

"Creating local trusted connections" on page 221

"Establishing remote trusted connections by DB2 for z/OS requesters" on page 222

"Establishing remote trusted connections to DB2 for z/OS servers" on page 223

Related reference:

"Establishing plan and package ownership in a trusted context" on page 81

"Ownership of objects within a trusted context" on page 79

Trusted connections

A *trusted connection* is a database connection that is established when the connection attributes match those of a trusted context that is defined at the server. A trusted connection can be established locally or at a remote location.

A trusted context allows you to establish a trusted relationship between DB2 and an external entity, such as a middleware server. DB2 evaluates a series of trust attributes to determine if a specific context is to be trusted. Currently, the only attribute that DB2 considers is the database connection. The relationship between a connection and a trusted context is established when the connection to the server is first created, and that relationship remains as long as that connection exists.

Related concepts:

"Trusted contexts" on page 219

"Roles in a trusted context" on page 21

Related tasks:

"Defining trusted contexts"

"Creating local trusted connections" on page 221

"Establishing remote trusted connections by DB2 for z/OS requesters" on page 222

"Establishing remote trusted connections to DB2 for z/OS servers" on page 223

Defining trusted contexts

Before you can create a trusted connection, you must define a trusted context by using a system authorization ID and connection trust attributes.

About this task

A system authorization ID is the DB2 primary authorization ID that is used to establish the trusted connection. For local connections, the system authorization ID is derived as shown in the following table.

Table 51. System authorization ID for local connections

Source	System authorization ID
Started task (RRSAF)	USER parameter on JOB statement or RACF USER
TSO	TSO logon ID
BATCH	USER parameter on JOB statement

For remote connections, the system authorization ID is derived from the system user ID that is provided by an external entity, such as a middleware server.

The connection trust attributes identify a set of characteristics about the specific connection. The connection trust attributes are required for the connection to be considered a trusted connection. For a local connection, the connection trust attribute is the job or started task name. For a remote connection, the connection trust attribute is the client's IP address, domain name, or SERVAUTH security zone name. The connection trust attributes are as follows:

ADDRESS
Specifies the client's IP address or domain name, used by the connection to communicate with DB2. The protocol must be TCP/IP.

SERVAUTH
Specifies the name of a resource in the RACF SERVAUTH class. This resource is the network access security zone name that contains the IP address of the connection to communicate with DB2.

ENCRYPTION
Specifies the minimum level of encryption of the data stream (network encryption) for the connection. Supported values are as follows:
- NONE - No encryption. This is the default.
- LOW - DRDA data stream encryption.
- HIGH - Secure Socket Layer (SSL) encryption.

JOBNAME
Specifies the local z/OS started task or job name. The value of JOBNAME depends on the source of the address space, as shown in the following table.

Table 52. JOBNAME for local connections

Source	JOBNAME
Started task (RRSAF)	Job or started task name
TSO	TSO logon ID
BATCH	Job name on JOB statement

The JOBNAME attribute cannot be specified with the ADDRESS, SERVAUTH, or ENCRYPTION attributes.

Related concepts:

"Trusted contexts" on page 219

"Trusted connections" on page 220

"Roles in a trusted context" on page 21

Related tasks:

"Creating local trusted connections"

"Establishing remote trusted connections by DB2 for z/OS requesters" on page 222

"Establishing remote trusted connections to DB2 for z/OS servers" on page 223

Creating local trusted connections

You can establish a trusted connection to a local DB2 subsystem by using RRSAF, CAF, or the DSN command processor under TSO and DB2I.

About this task

When you attempt to create a local trusted connection, DB2 searches for a trusted context that matches the primary authorization ID and the job or started task name that you supply. If DB2 finds a matching trusted context, DB2 checks if the DEFAULT SECURITY LABEL attribute is defined in the trusted context.

If the DEFAULT SECURITY LABEL attribute is defined with a security label, DB2 verifies the security label with RACF. This security label is used for multilevel security verification for the system authorization ID. If verification is successful, the connection is established as trusted. If the verification is not successful, the connection is established as a normal connection without any additional privileges.

In addition, the DB2 online utilities can run in a trusted connection if a matching trusted context is defined, if the primary authorization ID matches the SYSTEM AUTHID value of the trusted context, and if the job name matches the JOBNAME attribute defined for the trusted context.

Related concepts:

"Trusted contexts" on page 219

"Trusted connections" on page 220

"Roles in a trusted context" on page 21

Related tasks:

"Defining trusted contexts" on page 220

"Establishing remote trusted connections by DB2 for z/OS requesters"

"Establishing remote trusted connections to DB2 for z/OS servers" on page 223

Establishing remote trusted connections by DB2 for z/OS requesters

A DB2 for z/OS requester can establish a trusted connection to a remote location by setting up the new TRUSTED column in the SYSIBM.LOCATIONS table.

About this task

How DB2 obtains the system authorization ID to establish the trusted connection depends on the value of the SECURITY_OUT option in the SYSIBM.IPNAMES table. The SECURITY_OUT option in the SYSIBM.IPNAMES table must be 'E', 'P', or 'R'.

When the z/OS requester receives an SQL CONNECT with or without the USER and USING clauses to a remote location or if an application references a remote table or procedure, DB2 looks at the SYSIBM.LOCATIONS table to find a matching row. If DB2 finds a matching row, it checks the TRUSTED column. If the value of TRUSTED column is set to 'Y', DB2 looks at the SYSIBM.IPNAMES table. The values in the SECURITY_OUT column and USERNAMES column are used to determine the system authorization ID as follows:

SECURITY_OUT = 'P' or 'E' and USERNAMES = 'S'

The system authorization ID credentials that are used to establish the trusted connection are obtained from the row in the SYSIBM.USERNAMES table with TYPE 'S'.

DB2 sends the user switch request on behalf of the primary authorization ID without authentication under two conditions. First, the system

authorization ID value in the AUTHID column is different from the primary authorization ID. Second, a trusted connection is successfully established.

SECURITY_OUT='P' or 'E' and USERNAMES = 'O'
If a row with TYPE 'S' is defined in the SYSIBM.USERNAMES table, the system authorization ID credentials that are used to establish the trusted connection are obtained from the row.

After successfully establishing the trusted connection, DB2 obtains the translated authorization ID information for the primary authorization ID from the row in the SYSIBM.USERNAMES table with TYPE 'O'. DB2 sends the user switch request on behalf of the primary authorization ID with authentication.

If a row with TYPE 'S' is not defined in the SYSIBM.USERNAMES table, DB2 obtains the system authorization ID information that is used to establish the trusted connection from the row in the SYSIBM.USERNAMES table with TYPE 'O'.

SECURITY_OUT = 'R' and USERNAMES = ' '
The primary authorization ID is used as the system authorization ID to establish the trusted connection.

SECURITY_OUT = 'R' and USERNAMES = 'S'
The system authorization ID that is used to establish the trusted connection is obtained from the row in the SYSIBM.USERNAMES table with TYPE='S'.

After establishing the trusted connection successfully, DB2 sends the user switch request on behalf of the primary authorization ID without authentication.

SECURITY_OUT = 'R' and USERNAMES = 'O'
The system authorization ID that is used to establish the trusted connection is obtained from the row in the SYSIBM.USERNAMES table with TYPE 'S'.

After successfully establishing the trusted connection, DB2 obtains the translated authorization ID for the primary authorization ID from the row in the SYSIBM.USERNAMES table with TYPE 'O'. DB2 sends the user switch request on behalf of the primary authorization ID with RACF passticket authentication.

If the SECURITY_OUT option is not correctly set up, DB2 returns an error.

Related concepts:

“Trusted contexts” on page 219

“Trusted connections” on page 220

“Roles in a trusted context” on page 21

Related tasks:

“Defining trusted contexts” on page 220

“Creating local trusted connections” on page 221

“Establishing remote trusted connections to DB2 for z/OS servers”

Establishing remote trusted connections to DB2 for z/OS servers

When the DB2 for z/OS server receives a remote request to establish a trusted connection, DB2 checks to see if an authentication token accompanies the request.

About this task

The authentication token can be a password, a RACF passticket, or a Kerberos ticket. The requester goes through the standard authorization processing at the server. If the authorization is successful, DB2 invokes the connection exit routine, which associates the primary authorization ID, possibly one or more secondary authorization IDs, and an SQL ID with the remote request. DB2 searches for a matching trusted context. If DB2 finds a matching trusted context, it validates the following attributes:

- If the SERVAUTH attribute is defined for the identified trusted context and TCP/IP provides a RACF SERVAUTH profile name to DB2 during the establishment of the connection, DB2 matches the SERVAUTH profile name with the SERVAUTH attribute value.
- If the SERVAUTH attribute is not defined or the SERVAUTH name does not match the SERVAUTH that is defined for the identified trusted context, DB2 matches the remote client's TCP/IP address with the ADDRESS attribute that is defined for the identified trusted context.
- If the ENCRYPTION attribute is defined, DB2 validates whether the connection is using the proper encryption as specified in the value of the ENCRYPTION attribute.
- If the DEFAULT SECURITY LABEL attribute is defined for the system authorization ID, DB2 verifies the security label with RACF. This security label is used for verifying multilevel security for the system authorization ID. However, if the system authorization ID is also in the ALLOW USER clause with SECURITY LABEL, then that one is used.

If the validation is successful, DB2 establishes the connection as trusted. If the validation is not successful, the connection is established as a normal connection without any additional privileges, DB2 returns a warning, and SQLWARN8 is set.

Related concepts:

"Trusted contexts" on page 219

"Trusted connections" on page 220

"Roles in a trusted context" on page 21

Related tasks:

"Defining trusted contexts" on page 220

"Creating local trusted connections" on page 221

"Establishing remote trusted connections by DB2 for z/OS requesters" on page 222

Switching users of a trusted connection

When a trusted connection is established, DB2 enables the trusted connection to be reused by a different user on a transaction boundary.

You can reuse a trusted connection at a local DB2 subsystem by using RRSAF, the DSN command processor under TSO, DB2I, and the SQL CONNECT statement with the USER and USING clauses. To reuse the trusted connection, you must add the specific user to the trusted context. If you specify 'PUBLIC' as the user, DB2 allows the trusted connection to be used by any authorization ID; the trusted connection can be used by a different user with or without authentication. However, you can require authentication by specifying the WITH AUTHENTICATION clause.

You can use RRSAF, the DSN command processor under TSO, and DB2I to switch to a new user on a trusted connection without authentication. If authentication is required, you can use the SQL CONNECT statement with the USER and USING clauses. The SQL CONNECT semantics prevent the use of CONNECT TO with the USER and USING clauses to switch authorization IDs on a remote connection.

Related tasks:

"Enabling users to perform actions on behalf of others" on page 228

"Performing tasks on objects for other users" on page 228

Reusing a local trusted connection through the DSN command processor and DB2I

You can use the DSN command processor and DB2I to switch the user on a trusted connection if the DSN ASUSER option is specified.

About this task

DB2 establishes a trusted connection if the primary authorization ID and job name match a trusted context that is defined in DB2. The user ID that is specified for the ASUSER option goes through the standard authorization processing. If the user ID is authorized, DB2 runs the connection exit routine to associate the primary and secondary IDs.

DB2 then searches to see if the primary authorization ID is allowed to use the trusted connection without authentication. If the primary authorization ID is allowed to use the trusted connection without authentication, DB2 determines if the SECURITY LABEL attribute is defined in the trusted context for the user either explicitly or implicitly. If the SECURITY LABEL attribute is defined with a security label, DB2 verifies the security label with RACF. If the verification of the security label is successful, the trusted connection is established and used by the user ID that is specified for the ASUSER option. DB2 uses the security label for multilevel security verification for the user.

If the primary authorization ID that is associated with the user ID that is specified for the ASUSER option is not allowed or requires authentication information, the connection request fails. If the security label verification is not successful, the connection request fails.

Reusing a remote trusted connection by DB2 for z/OS requesters

After establishing a trusted connection with a system authorization ID, the DB2 for z/OS requester automatically switches the user on the connection to the primary authorization ID on the remote trusted connection.

About this task

The DB2 for z/OS requester reuses a remote trusted connection in the following scenarios:

- The system authorization ID is different from the primary authorization ID that is associated with the application user.
- The system authorization ID is different from the authorization ID that is specified in the SQL CONNECT statement with the USER and USING clauses.
- Outbound translation is required for the primary authorization ID.

Reusing a remote trusted connection through DB2 for z/OS servers

The DB2 for z/OS server performs a sequence of tasks when it receives a request to switch users on a trusted connection.

About this task

The DB2 z/OS server performs these tasks in the following sequence:

1. DB2, on successful authorization, invokes the connection exit routine. The invocation associates the primary authorization ID, possibly one or more secondary authorization IDs, and an SQL ID with the remote request. This new set of IDs replaces the previous set of IDs that was associated with the request.
2. DB2 determines if the primary authorization ID is allowed to use the trusted connection. If the WITH AUTHENTICATION clause is specified for the user, DB2 requires an authentication token for the user. The authentication token can be a password, a RACF passticket, or a Kerberos ticket.
3. Assuming that the primary authorization ID is allowed, DB2 determines the trusted context for any SECURITY LABEL definition. If a specific SECURITY LABEL is defined for this user, it becomes the SECURITY LABEL for this user. If no specific SECURITY LABEL is defined for this user but a DEFAULT SECURITY LABEL is defined for the trusted context, DB2 verifies the validity of this SECURITY LABEL for this user through RACF by issuing the RACROUTE VERIFY request.

   If the primary authorization ID is allowed, DB2 performs a connection initialization. This results in an application environment that truly mimics the environment that is initialized if the new user establishes the connection in the normal DB2 manner. For example, any open cursor is closed, and temporary table information is dropped.
4. If the primary authorization ID is not allowed to use the trusted connection or if SECURITY LABEL verification fails, the connection is returned to an unconnected state. The only operation that is allowed is to establish a valid authorization ID to be associated with the trusted connection. Until a valid authorization is established, if any SQL statement is issued, an error (SQLCODE -900) is returned.

Reusing a local trusted connection through RRSAF

If you use Resource Recovery Services Attachment Facility (RRSAF) to switch to a new user on a trusted connection, DB2 obtains the primary authorization ID and runs the sign-on exit routine.

About this task

DB2 searches to determine if the primary authorization ID is allowed to use the trusted connection without authentication. If the primary authorization ID is allowed, DB2 determines if SECURITY LABEL is explicitly or implicitly defined in the trusted context for the user. If SECURITY LABEL is defined, DB2 verifies the SECURITY LABEL with RACF by using the RACROUTE VERIFY request. If the SECURITY LABEL verification is successful, the trusted connection is used by the new user.

If the primary authorization ID is not allowed to use the trusted connection without authentication, DB2 returns the connection to an unconnected state. The only action that you can take is to try running the sign-on exit routine again. Until

a valid authorization is established, any SQL statement that you issue causes DB2 to return an error.

Reusing a local trusted connection through the SQL CONNECT statement

You can switch users on a trusted connection by using the SQL CONNECT statement with the USER and USING clauses.

About this task

DB2, on successful authorization, invokes the connection exit routine if it is defined. The connection then has a primary authorization ID, zero or more secondary IDs, and an SQL ID.

DB2 searches to determine if the primary authorization ID is allowed to use the trusted connection. If the primary authorization ID is allowed, DB2 determines if the SECURITY LABEL attribute is defined in the trusted context for the user either explicitly or implicitly. If the SECURITY LABEL attribute is defined with a security label, DB2 verifies the security label with RACF. If the security label verification is successful, DB2 switches the user on the trusted connection. DB2 uses the security label for multilevel security verification for the user.

If the primary authorization ID is not allowed to use the trusted connection or if the security label verification is not successful, DB2 returns the connection to an unconnected state. The only action you can take is to establish a valid authorization ID to be associated with the trusted connection. Until a valid authorization is established, any SQL statement that you issue causes DB2 to return an error.

Defining external security profiles

You can control the users who can be switched in a trusted connection by defining an external security profile in RACF and authorizing users to use the profile.

Procedure

To define an external security profile in RACF:

1. Create a general resource profile in RACF for the DSNR class by issuing the following command:
   ```
   RDEFINE DSNR (TRUSTEDCTX.PROFILE1) UACC(NONE)
   ```
2. Add users to the TRUSTEDCTX.PROFILE1 profile and define their level of access authority by issuing the following command:
   ```
   PERMIT TRUSTEDCTX.PROFILE1 CLASS(DSNR) ID(USER1 USER2) ACCESS(READ)
   ```
3. Associate the profile with the trusted context definition by using the EXTERNAL SECURITY PROFILE keyword in the trusted context user clause definition.

Results

You can remove users who can be switched in a trusted connection individually from the TRUSTEDCTX.PROFILE1 profile in RACF. You can also remove all users by simply dissociating the profile from the trusted context definition.

Enabling users to perform actions on behalf of others

Within a trusted context, you can allow users to perform actions on objects on behalf of others.

About this task

You can specify the DSN ASUSER option with the authorization ID of the object owner. During the connection processing, the authorization ID is used to determine if a trusted context exists for this authorization ID. If a trusted context exists, a trusted connection is established. The primary authorization ID that is associated with the user ID and specified in the ASUSER option is used to determine if the user can be switched on the trusted connection.

If the user ID that is specified in the ASUSER option is allowed to use the trusted connection, the user runs under the authorization ID of the object owner and can perform actions on behalf of the object owner. The authorization ID of the original user is traced for audit purposes.

Related concepts:

"Switching users of a trusted connection" on page 224

Performing tasks on objects for other users

If you have DBADM authority, you can assume the identity of other users within a trusted context and perform tasks on their behalf.

About this task

After you successfully assume the identity of a view owner, you inherit all the privileges from the ID that owns the view and can therefore perform the CREATE, DROP, and GRANT actions on the view.

Procedure

To perform tasks on behalf of another user:

1. Define a trusted context. Make sure that the SYSTEM AUTH ID is the primary authorization ID that you use in SPUFI.
2. Specify the primary authorization ID as the JOBNAME for the trusted connection.
3. Specify the primary authorization ID of the user whose identity you want to assume.
4. Log onto TSO with your primary authorization ID.
5. Set the ASUSER option on the DB2I DEFAULTS panel to the primary authorization ID of the user whose identity you want to assume.
6. Perform the actions that you want by using the privileges of the specified user.

Example

For example, assume that you have DBADM authority, your primary authorization ID is BOB, and you want to drop a view that is owned by user SALLY. You can issue the following statement to create and enable a trusted context called CTXLOCAL in which BOB can drop the selected view on SALLY's behalf:

```
CREATE TRUSTED CONTEXT CTXLOCAL
 BASED UPON CONNECTION USING SYSTEM AUTHID BOB
 ATTRIBUTES (JOBNAME 'BOB')
 ENABLE
 ALLOW USE FOR SALLY;
```

After logging onto TSO, you can set the ASUSER option to SALLY in the DB2I DEFAULTS panel and invoke SPUFI to process SQL statements. DB2 obtains the primary authorization ID BOB and JOBNAME BOB from the TSO logon session, authenticates BOB, searches for the matching trusted context (CTXLOCAL), and establishes a trusted connection. DB2 then authenticates the primary authorization ID SALLY and validates all privileges that are assigned to SALLY. After successful authentication and validation, you, BOB, can drop the view that is owned by SALLY.

Related concepts:

"Switching users of a trusted connection" on page 224

Chapter 6. Managing access through data definition control

Data definition control is a DB2 security measure that provides additional constraints to existing authorization checks. You can use data definition control to manage access to your DB2 data.

Data definition statements

Data definition control support can control data definition statements.

The following data definition statements are controlled through the DB2 data definition control support.

Table 53. Data definition Statements

Object	CREATE statement	ALTER statement	DROP statement
Alias	CREATE ALIAS		DROP ALIAS
Database	CREATE DATABASE	ALTER DATABASE	DROP DATABASE
Index	CREATE INDEX	ALTER INDEX	DROP INDEX
Storage group	CREATE STOGROUP	ALTER STOGROUP	DROP STOGROUP
Synonym	CREATE SYNONYM		DROP SYNONYM
Table	CREATE TABLE	ALTER TABLE	DROP TABLE
Table space	CREATE TABLESPACE	ALTER TABLESPACE	DROP TABLESPACE
View	CREATE VIEW		DROP VIEW

The data definition control support also controls the COMMENT and LABEL statements.

Related concepts:

"Registration tables" on page 232

Related reference:

"Data definition control support"

Data definition control support

If you want to use data definition statements for your plans and packages, you must install *data definition control support* on the DB2 DSNTIPZ installation panel.

As shown in the following example, you can specify appropriate values for several installation options to install the data definition control support and to control data definition behaviors.

```
DSNTIPZ      INSTALL DB2 - DATA DEFINITION CONTROL SUPPORT
===>

Enter data below:

 1 INSTALL DD CONTROL SUPT. ===> NO        YES - activate the support
                                           NO  - omit DD control support
 2 CONTROL ALL APPLICATIONS ===> NO        YES or NO
 3 REQUIRE FULL NAMES       ===> YES       YES or NO
 4 UNREGISTERED DDL DEFAULT ===> ACCEPT    Action for unregistered DDL:
                                           ACCEPT - allow it
                                           REJECT - prohibit it
                                           APPL   - consult ART
 5 ART/ORT ESCAPE CHARACTER ===>           Used in ART/ORT Searches
 6 REGISTRATION OWNER       ===> DSNRGCOL          Qualifier for ART and ORT
 7 REGISTRATION DATABASE    ===> DSNRGFDB          Database name
 8 APPL REGISTRATION TABLE  ===> DSN_REGISTER_APPL Table name
 9 OBJT REGISTRATION TABLE  ===> DSN_REGISTER_OBJT Table name

Note: ART = Application Registration Table
      ORT = Object      Registration Table

PRESS:  ENTER to continue   RETURN to exit   HELP for more information
```

Figure 12. DSNTIPZ installation panel with default values

Related concepts:

"Registration tables"

Related reference:

"Data definition statements" on page 231

"Data definition control support" on page 231

Registration tables

If you use data definition control support, you must create and maintain an application registration table (ART) and an object registration table (ORT). You can register plans and package collections in the ART and objects that are associated with the plans and collections in the ORT.

DB2 consults these two registration tables before accepting a data definition statement from a process. It denies a request to create, alter, or drop a particular object if the registration tables indicate that the process is not allowed to do so.

Both ART and ORT contain the CREATOR and CHANGER columns. The CREATOR and CHANGER columns are CHAR(26) and large enough for a three-part authorization ID. You need to separate each 8-byte part of the ID with a period in byte 9 and in byte 18. If you enter only the primary authorization ID, consider entering it right-justified in the field (that is, preceded by 18 blanks).

In addition to the CREATOR and CHANGER columns, an ART also contains the following columns, some of which are optional and reserved for administrator use; DB2 does not use these columns.

Table 54. Columns of the ART

Column name	Description
APPLIDENT	Indicates the collection-ID of the package that executes the data definition language. If no package exists, it indicates the name of the plan that executes the data definition language.
APPLIDENTTYPE	Indicates the type of application identifier.

Table 54. Columns of the ART (continued)

Column name	Description
APPLICATIONDESC[1]	Optional data. Provides a more meaningful description of each application than the eight-byte APPLIDENT column can contain.
DEFAULTAPPL	Indicates whether all data definition language should be accepted from this application.
QUALIFIEROK	Indicates whether the application can supply a missing name part for objects that are named in the ORT. Applies only if REQUIRE FULL NAMES = NO.
CREATOR[1, 2]	Optional data. Indicates the authorization ID that created the row.
CREATETIMESTAMP[1]	Optional data. Indicates when a row was created. If you use CURRENT TIMESTAMP, DB2 automatically enters the value of CURRENT TIMESTAMP When you load or insert a row.
CHANGER[1, 2]	Optional data. Indicates the authorization ID that last changed the row.
CHANGETIMESTAMP[1]	Optional data. Indicates when a row was changed. If you use CURRENT TIMESTAMP, DB2 automatically enters the value of CURRENT TIMESTAMP When you update a row.

An ORT also contains the following columns, some of which are optional and reserved for administrator use; DB2 does not use these columns.

Table 55. Columns of the ORT

Column name	Description
QUALIFIER	Indicates the object name qualifier.
NAME	Indicates the unqualified object name.
TYPE	Indicates the type of object.
APPLMATCHREQ	Indicates whether an application that names this object must match the one that is named in the APPLIDENT column.
APPLIDENT	Collection-ID of the plan or package that executes the data definition language.
APPLIDENTTYPE	Indicates the type of application identifier.
APPLICATIONDESC[1]	Optional data. Provides a more meaningful description of each application than the eight-byte APPLIDENT column can contain.
CREATOR[1, 2]	Optional data. Indicates the authorization ID that created the row.
CREATETIMESTAMP[1]	Optional data. Indicates when a row was created. If you use CURRENT TIMESTAMP, DB2 automatically enters the value of CURRENT TIMESTAMP When you load or insert a row.
CHANGER[1, 2]	Optional data. Indicates the authorization ID that last changed the row.
CHANGETIMESTAMP[1]	Optional data. Indicates when a row was changed. If you use CURRENT TIMESTAMP, DB2 automatically enters the value of CURRENT TIMESTAMP When you update a row.

Related reference:

"Data definition statements" on page 231

"Data definition control support" on page 231

Installing data definition control support

You can install data definition control support that is available through the DB2 DSNTIPZ installation panel.

Procedure

To install data definition control support:

1. Enter YES for option 1 on the DSNTIPZ installation panel, as shown in the following example.

   ```
   1 INSTALL DD CONTROL SUPT. ===> YES
   ```

2. Enter the names and owners of the registration tables in your DB2 subsystem and the databases in which these tables reside for options 6, 7, 8, and 9 on the DSNTIPZ installation panel.

   The default values for these options are as follows:

   ```
   6 REGISTRATION OWNER       ===> DSNRGCOL
   7 REGISTRATION DATABASE    ===> DSNRGFDB
   8 APPL REGISTRATION TABLE  ===> DSN_REGISTER_APPL
   9 OBJT REGISTRATION TABLE  ===> DSN_REGISTER_OBJT
   ```

   You can accept the default names or assign names of your own. If you specify your own table names, each name can have a maximum of 17 characters.

3. Enter an escape character for option 5 on the DSNTIPZ installation panel if you want to use the percent character (%) or the underscore character (_) as a regular character in the ART or ORT.

   You can use any special character other than underscore or percent as the escape character. For example, you can use the pound sign (#) as an escape character. If you do, the value for option looks like this:

   ```
   5 ART/ORT ESCAPE CHARACTER ===> #
   ```

   After you specify the pound sign as an escape character, the pound sign can be used in names in the same way that an escape character is used in an SQL LIKE predicate.

4. Register plans, packages, and objects in the ART and ORT.

   Choose the plans, packages, and objects to register based on whether you want to control data definition by application name or object name.

5. Enter the values for the three other options on the DSNTIPZ installation panel as follows:

   ```
   2 CONTROL ALL APPLICATIONS ===>
   3 REQUIRE FULL NAMES       ===>
   4 UNREGISTERED DDL DEFAULT ===>
   ```

Related reference:

"Data definition control support" on page 231

Enabling data definition control

You can use data definition control after you install the DB2 data definition control support and create the application registration table (ART) and the object registration table (ORT).

Procedure

You can use data definition control in the following four ways:

- Controlling data definition by application name
- Controlling data definition by application name with exceptions
- Controlling data definition by object name
- Controlling data definition by object name with exceptions

Related tasks:

"Disabling data definition control" on page 241

Controlling data definition by application name

The simplest way to implement data definition control is to give one or more applications total control over the use of data definition statements in the subsystem.

Procedure

To control data definition by application name:

1. Enter YES for the first option on the DSNTIPZ installation panel, as shown:

   ```
   2 CONTROL ALL APPLICATIONS ===> YES
   ```

   When you specify YES, only package collections or plans that are registered in the ART are allowed to use data definition statements.
2. In the ART, register all package collections and plans that you will allow to issue DDL statements, and enter the value Y in the DEFAULTAPPL column for these package collections. You must supply values for the APPLIDENT, APPLIDENTTYPE, and DEFAULTAPPL columns of the ART. You can enter information in other columns for your own use.

Example

Suppose that you want all data definition language in your subsystem to be issued only through certain applications. The applications are identified by the following application plan names, collection-IDs, and patterns:

PLANA
The name of an application plan

PACKB
The collection-ID of a package

TRULY%
A pattern name for any plan name beginning with TRULY

TR% A pattern name for any plan name beginning with TR

The following table shows the entries that you need in your ART.

Table 56. Table DSN_REGISTER_APPL for total subsystem control

APPLIDENT	APPLIDENTTYPE	DEFAULTAPPL
PLANA	P	Y
PACKB	C	Y
TRULY%	P	Y
TR%	P	Y

If the row with TR% for APPLIDENT contains the value Y for DEFAULTAPPL, any plan with a name beginning with TR can execute data definition language. If DEFAULTAPPL is later changed to N to disallow that use, the changed row does not prevent plans beginning with TR from using data definition language; the row merely fails to allow that specific use. In this case, the plan TRXYZ is not allowed to use data definition language. However, the plan TRULYXYZ is allowed to use data definition language, by the row with TRULY% specified for APPLIDENT.

Controlling data definition by application name with exceptions

You can register an application name with exceptions in the application registration table (ART) as a way to control data definition.

Procedure

To control data definition by application name with exceptions:

1. Choose not to control all applications. On the DSNTIPZ installation panel, specify the following value for option 2:

   ```
   2 CONTROL ALL APPLICATIONS ===> NO
   ```

   When you specify NO, you allow unregistered applications to use data definition statements on some objects.
2. On the DSNTIPZ installation panel, specify the following for option 4:

   ```
   4 UNREGISTERED DDL DEFAULT ===> APPL
   ```

   When you specify APPL, you restrict the use of data definition statements for objects that are **not** registered in the ORT. If an object is registered in the ORT, any applications that are not registered in the ART can use data definition language on the object. However, if an object is not registered in the ORT, only applications that are registered in the ART can use data definition language on the object.
3. In the ART, register package collections and plans that you will allow to issue data definition statements on any object. Enter the value Y in the DEFAULTAPPL column for these package collections. Applications that are registered in the ART retain almost total control over data definition. Objects that are registered in the ORT are the only exceptions.
4. In the ORT, register all objects that are exceptions to the subsystem data definition control that you defined in the ART. You must supply values for the QUALIFIER, NAME, TYPE, APPLMATCHREQ, APPLIDENT, and APPLIDENTTYPE columns of the ORT. You can enter information in other columns of the ORT for your own use.

Example

Suppose that you want almost all of the data definition language in your subsystem to be issued only through an application plan (PLANA) and a package collection (PACKB).

Table 57. Table DSN_REGISTER_APPL for total subsystem control with exceptions

APPLIDENT	APPLIDENTTYPE	DEFAULTAPPL
PLANA	P	Y

Table 57. Table DSN_REGISTER_APPL for total subsystem control with exceptions (continued)

APPLIDENT	APPLIDENTTYPE	DEFAULTAPPL
PACKB	C	Y

However, suppose that you also want the following specific exceptions:

- Object KIM.VIEW1 can be created, altered, or dropped by the application plan PLANC.
- Object BOB.ALIAS can be created, altered, or dropped only by the package collection PACKD.
- Object FENG.TABLE2 can be created, altered, or dropped by **any** plan or package collection.
- Objects with names that begin with SPIFFY.MSTR and exactly one following character can be created, altered, or dropped by any plan that matches the name pattern TRULY%. For example, the plan TRULYJKL can create, alter, or drop the object SPIFFY.MSTRA.

The following table shows the entries that are needed to register these exceptions in the ORT.

Table 58. Table DSN_REGISTER_OBJT for subsystem control with exceptions

QUALIFIER	NAME	TYPE	APPLMATCHREQ	APPLIDENT	APPLIDENTTYPE
KIM	VIEW1	C	Y	PLANC	P
BOB	ALIAS	C	Y	PACKD	C
FENG	TABLE2	C	N		
SPIFFY	MSTR_	C	Y	TRULY%	P

You can register objects in the ORT individually, or you can register sets of objects.

Controlling data definition by object name

You can register object names in the object registration table (ORT) as a way to control data definition. You need to control data definition by object names if you want all objects in the subsystem to be registered and if you want some applications to control specific sets of objects.

About this task

When you control data definition by object name, all objects are registered regardless of whether they are controlled by specific applications.

Procedure

To control data definition by object name:

1. Choose not to control all applications. On the DSNTIPZ installation panel, specify the following value for option 2:

   ```
   2 CONTROL ALL APPLICATIONS ===> NO
   ```

   When you specify NO, you allow unregistered applications to use data definition statements on some objects.
2. On the DSNTIPZ installation panel, complete option 4 as follows:

```
4 UNREGISTERED DDL DEFAULT ===> REJECT
```

When you specify REJECT for option 4, you totally restrict the use of data definition statements for objects that are not registered in the ORT. Therefore, no application can use data definition statements for any unregistered object.

3. In the ORT, register all of the objects in the subsystem, and enter Y in the APPLMATCHREQ column. You must supply values for the QUALIFIER, NAME, TYPE, APPLMATCHREQ, APPLIDENT, and APPLIDENTTYPE columns of the ORT. You can enter information in other columns of the ORT for your own use.
4. In the ART, register any plan or package collection that can use a set of objects that you register in the ORT with an incomplete name. Enter the value Y in the QUALIFIEROK column. These plans or package collections can use data definition language on sets of objects regardless of whether a set of objects has a value of Y in the APPLMATCHREQ column.

Example

The following table shows entries in the ORT for a DB2 subsystem that contains the following objects that are controlled by object name:

- Two storage groups (STOG1 and STOG2) and a database (DATB1) that are not controlled by a specific application. These objects can be created, altered, or dropped by a user with the appropriate authority by using any application, such as SPUFI or QMF.
- Two table spaces (TBSP1 and TBSP2) that are not controlled by a specific application. Their names are qualified by the name of the database in which they reside (DATB1).
- Three objects (OBJ1, OBJ2, and OBJ3) whose names are qualified by the authorization IDs of their owners. Those objects might be tables, views, indexes, synonyms, or aliases. Data definition statements for OBJ1 and OBJ2 can be issued only through the application plan named PLANX. Data definition statements for OBJ3 can be issued only through the package collection named PACKX.
- Objects that match the qualifier pattern E%D and the name OBJ4 can be created, altered, or deleted by application plan SPUFI. For example, the objects EDWARD.OBJ4, ED.OBJ4, and EBHARD.OBJ4, can be created, altered, or deleted by application plan SPUFI. Entry E%D in the QUALIFIER column represents all three objects.
- Objects with names that begin with TRULY.MY_, where the underscore character is actually part of the name. Assuming that you specify # as the escape character, all of the objects with this name pattern can be created, altered, or dropped only by plans with names that begin with TRULY.

Table 59. Table DSN_REGISTER_OBJT for total control by object

QUALIFIER	NAME	TYPE	APPLMATCHREQ	APPLIDENT	APPLIDENTTYPE
	STOG1	S	N		
	STOG2	S	N		
	DATB1	D	N		
DATB1	TBSP1	T	N		
DATB1	TBSP2	T	N		
KIM	OBJ1	C	Y	PLANX	P
FENG	OBJ2	C	Y	PLANX	P

Table 59. Table DSN_REGISTER_OBJT for total control by object (continued)

QUALIFIER	NAME	TYPE	APPLMATCHREQ	APPLIDENT	APPLIDENTTYPE
QUENTIN	OBJ3	C	Y	PACKX	C
E%D	OBJ4	C	Y	SPUFI	P
TRULY	MY#_%	C	Y	TRULY%	P

Assume the following installation option:

```
3 REQUIRE FULL NAMES       ===> YES
```

The entries do not specify incomplete names. Hence, objects that are not represented in the table cannot be created in the subsystem, except by an ID with installation SYSADM authority.

Controlling data definition by object name with exceptions

You can register an object name with exceptions in the object registration table (ORT) as a way to control data definition.

About this task

You can allow some applications to control specific sets of registered objects while allowing other applications to use data definition statements for unregistered objects.

Procedure

To control data definition by object name with exceptions:

1. Choose not to control all applications. On the DSNTIPZ installation panel, specify the following value for option 2:

   ```
   2 CONTROL ALL APPLICATIONS ===> NO
   ```

   When you specify NO, you allow unregistered applications to use data definition statements on some objects.
2. On the DSNTIPZ installation panel, complete option 4 as follows:

   ```
   4 UNREGISTERED DDL DEFAULT ===> ACCEPT
   ```

   This option **does not** restrict the use of data definition statements for objects that are not registered in the ORT. Therefore, **any** application can use data definition language for any unregistered object.
3. Register all controlled objects in the ORT. Use a name and qualifier to identify a single object. Use only one part of a two-part name to identify a set of objects that share just that part of the name. For each controlled object, use APPLMATCHREQ = Y. Enter the name of the plan or package collection that controls the object in the APPLIDENT column.
4. For each set of controlled objects (identified by only a simple name in the ORT), register the controlling application in the ART. You must supply values for the APPLIDENT, APPLIDENTTYPE, and QUALIFIEROK columns of the ART.

Example

The following two tables assume that the installation option REQUIRE FULL NAMES is set to NO. The following table shows entries in the ORT for the following controlled objects:

Table 60. Table DSN_REGISTER_OBJT for object control with exceptions

QUALIFIER	NAME	TYPE	APPLMATCHREQ	APPLIDENT	APPLIDENTTYPE
KIM	OBJ1	C	Y	PLANX	P
FENG	OBJ2	C	Y	PLANX	P
QUENTIN	OBJ3	C	Y	PACKX	C
EDWARD	OBJ4	C	Y	PACKX	C
	TABA	C	Y	PLANA	P
	TABB	C	Y	PACKB	C

- The objects KIM.OBJ1, FENG.OBJ2, QUENTIN.OBJ3, and EDWARD.OBJ4, all of which are controlled by PLANX or PACKX. DB2 cannot interpret the object names as incomplete names because the objects that control them, PLANX and PACKX, are registered, with QUALIFIEROK=N, in the corresponding ART as shown in the following table:

Table 61. Table DSN_REGISTER_APPL for object control with exceptions

APPLIDENT	APPLIDENTTYPE	DEFAULTAPPL	QUALIFIEROK
PLANX	P	N	N
PACKX	C	N	N
PLANA	P	N	Y
PACKB	C	N	Y

  In this situation, with the combination of installation options shown previously, any application can use data definition language for objects that are not covered by entries in the ORT. For example, if HOWARD has the CREATETAB privilege, HOWARD can create the table HOWARD.TABLE10 through any application.
- Two sets of objects, *.TABA and *.TABB, are controlled by PLANA and PACKB, respectively.

Registering object sets

Registering object sets enables you to save time and to simplify object registration.

About this task

Registering object sets is not a data definition control method; you must install of the data definition control methods before you can register any object sets.

Because complete two-part names are not required for every object that is registered in the ORT, you can use incomplete names to register sets of objects. To use incomplete names and register sets of objects, enter option 3 on the DSNTIPZ installation panel as follows:

```
3 REQUIRE FULL NAMES       ===> NO
```

The default value YES requires you to use both parts of the name for each registered object. If you specify the value NO, an incomplete name in the ORT

represents a set of objects that all share the same value for one part of a two-part name. Objects that are represented by incomplete names in the ORT require an authorizing entry in the ART.

Example: If you specify NO for option 3, you can include entries with incomplete names in the ORT. The following table shows entries in the ORT for the following objects:

Table 62. Table DSN_REGISTER_OBJT for objects with incomplete names

QUALIFIER	NAME	TYPE	APPLMATCHREQ	APPLIDENT	APPLIDENTTYPE
	TABA	C	Y	PLANX	P
	TABB	C	Y	PACKY	C
SYSADM		C	N		
DBSYSADM		T	N		
USER1	TABLEX	C	N		

- Two sets of objects, *.TABA and *.TABB, which are controlled by PLANX and PACKY, respectively. Only PLANX can create, alter, or drop any object whose name is *.TABA. Only PACKY can create, alter, or drop any object whose name is *.TABB. PLANX and PACKY must also be registered in the ART with QUALIFIEROK set to Y, as shown in the following table: That setting allows the applications to use sets of objects that are registered in the ORT with an incomplete name.

Table 63. Table DSN_REGISTER_APPL for plans that use sets of objects

APPLIDENT	APPLIDENTTYPE	DEFAULTAPPL	QUALIFIEROK
PLANA	P	N	Y
PACKB	C	N	Y

- Tables, views, indexes, or aliases with names like SYSADM.*.
- Table spaces with names like DBSYSADM.*; that is, table spaces in database DBSYSADM.
- Tables with names like USER1.* **and** tables with names like *.TABLEX.

ART entries for objects with incomplete names in the ORT: APPLMATCHREQ=N and objects SYSADM.*, DBSYSADM.*, USER1.*, and *.TABLEX can be created, altered, or dropped by any package collection or application plan. However, the collection or plan that creates, alters, or drops such an object must be registered in the ART with QUALIFIEROK=Y to allow it to use incomplete object names.

Disabling data definition control

When data definition control is active, only IDs with the installation SYSADM or installation SYSOPR authority can stop a database, a table space, or an index space that contains a registration table or index.

About this task

When the object is stopped, only an ID with one of those authorities can start it again.

An ID with the installation SYSADM authority can execute data definition statements regardless of whether data definition control is active and whether the ART or ORT is available.

Procedure

To bypass data definition control, an ID with the installation SYSADM authority can use the following methods:

- If the ID is the owner of the plan or package that contains the statement, the ID can bypass data definition control by using a static SQL statement.
- If the ID is the current SQL ID, the ID can bypass data definition control through a dynamic CREATE statement.
- If the ID is the current SQL ID, the primary ID, or any secondary ID of the executing process, the ID can bypass data definition control through a dynamic ALTER or DROP statement.

Related tasks:

"Enabling data definition control" on page 234

Managing registration tables and indexes

You can create, update, and drop registration tables and indexes. You can also create table spaces for or add columns to registration tables.

Creating registration tables and indexes

When you install data definition control support, you create the application registration table (ART), the object registration table (ORT), and the unique indexes that are required on the tables. You can re-create these objects if you drop any of them.

About this task

You can use the following CREATE statements to re-create ART, the ORT, or the required unique indexes:

CREATE statements for the ART and its index:

GUPI

```
CREATE TABLE DSNRGCOL.DSN_REGISTER_APPL
  (APPLIDENT          VARCHAR(128) NOT NULL WITH DEFAULT,
   APPLIDENTTYPE      CHAR(1)      NOT NULL WITH DEFAULT,
   APPLICATIONDESC    VARCHAR(30)  NOT NULL WITH DEFAULT,
   DEFAULTAPPL        CHAR(1)      NOT NULL WITH DEFAULT,
   QUALIFIEROK        CHAR(1)      NOT NULL WITH DEFAULT,
   CREATOR            CHAR(26)     NOT NULL WITH DEFAULT,
   CREATETIMESTAMP    TIMESTAMP    NOT NULL WITH DEFAULT,
   CHANGER            CHAR(26)     NOT NULL WITH DEFAULT,
   CHANGETIMESTAMP    TIMESTAMP    NOT NULL WITH DEFAULT)
  IN DSNRGFDB.DSNRGFTS;
CREATE UNIQUE INDEX DSNRGCOL.DSN_REGISTER_APPLI
  ON DSNRGCOL.DSN_REGISTER_APPL
  (APPLIDENT, APPLIDENTTYPE, DEFAULTAPPL DESC, QUALIFIEROK DESC)
  CLUSTER;
```

GUPI

CREATE statements for the ORT and its index:

GUPI

```
CREATE TABLE DSNRGCOL.DSN_REGISTER_OBJT
  (QUALIFIER          CHAR(8)      NOT NULL WITH DEFAULT,
   NAME               CHAR(18)     NOT NULL WITH DEFAULT,
   TYPE               CHAR(1)      NOT NULL WITH DEFAULT,
   APPLMATCHREQ       CHAR(1)      NOT NULL WITH DEFAULT,
   APPLIDENT          VARCHAR(128) NOT NULL WITH DEFAULT,
   APPLIDENTTYPE      CHAR(1)      NOT NULL WITH DEFAULT,
   APPLICATIONDESC    VARCHAR(30)  NOT NULL WITH DEFAULT,
   CREATOR            CHAR(26)     NOT NULL WITH DEFAULT,
   CREATETIMESTAMP    TIMESTAMP    NOT NULL WITH DEFAULT,
   CHANGER            CHAR(26)     NOT NULL WITH DEFAULT,
   CHANGETIMESTAMP    TIMESTAMP    NOT NULL WITH DEFAULT)
  IN DSNRGFDB.DSNRGFTS;
CREATE UNIQUE INDEX DSNRGCOL.DSN_REGISTER_OBJTI
  ON DSNRGCOL.DSN_REGISTER_OBJT
  (QUALIFIER, NAME, TYPE) CLUSTER;
```

GUPI

You can alter these CREATE statements in the following ways:

- Add columns to the ends of the tables
- Assign an auditing status
- Choose buffer pool or storage options for indexes
- Declare table check constraints to limit the types of entries that are allowed

Naming registration tables and indexes

Every member of a data sharing group must have the same names for the application registration table (ART) and object registration tables (ORT) table. Avoid changing the names of the ART and ORT tables.

About this task

If you change the names, owners, or residing database of your ART and ORT, you must reinstall DB2 in update mode and make the corresponding changes on the DSNTIPZ installation panel.

Name the required index by adding the letter I to the corresponding table name. For example, suppose that you are naming a required index for the ART named ABC. You should name the required index ABCI.

Dropping registration tables and indexes

If you drop any of the registration tables or their indexes, most data definition statements are rejected until the dropped objects are re-created.

About this task

The only data definition statements that are allowed under such circumstances are those that create the following objects:

- Registration tables that are defined during installation
- Indexes of the registration tables that are defined during installation
- Table spaces that contain the registration tables that are defined during installation

- The database that contains the registration tables that are defined during installation

Creating table spaces for registration tables

The DSNTIJSG installation job creates a segmented table space that holds the application registration table (ART) and the object registration table (ORT):

About this task

You can issue the following statement to create the table space:

```
CREATE TABLESPACE DSNRGFTS IN DSNRGFDB SEGSIZE 4 CLOSE NO;
```

If you want to use a table space with a different name or different attributes, you can modify the DSNTIJSG job before installing DB2. Alternatively, you can drop the table space and re-create it, the ART and ORT tables, and their indexes.

Adding columns to registration tables

You can use the ALTER TABLE statement to add columns to the application registration table (ART) or the object registration table (ORT) for your own use. If you add columns, the additional columns must come at the end of the table, after existing columns.

About this task

Use a special character, such as the plus sign (+), in your column names to avoid possible conflict. If IBM adds columns to the ART or the ORT in future releases, the column names will contain only letters and numbers.

Updating registration tables

You can use the LOAD utility or the INSERT, UPDATE, or DELETE statements to update the application registration table (ART) and the object registration table (ORT).

About this task

Because security provisions are important, allow only a restricted set of authorization IDs, or perhaps only those with the SYSADM authority, to update the ART. Consider assigning a validation exit routine to the ORT, to allow applications to change only those rows that have the same application identifier in the APPLIDENT column.

A registration table cannot be updated until all jobs whose data definition statements are controlled by the table have completed.

Chapter 7. Managing access through exit routines

You can control access to DB2 by using a DB2-supplied exit routine or an exit routine that you write. DB2 provides installation-wide exit points to the connection, sign-on, and access control authorization routines.

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

Related information:

Exit routines (DB2 Administration Guide)

Connection routines and sign-on routines

Your DB2 subsystem has two exit points for authorization routines, one in connection processing and one in sign-on processing. Both exit points perform crucial steps in the assignment of values to primary IDs, secondary IDs, and SQL IDs.

PSPI You must have a routine for each exit. Default routines are provided for both. DSN3@ATH is the default exit routine for connections, and DSN3@SGN is the default exit routine for sign-ons.

If your installation has a connection exit routine and you plan to use CONNECT with the USER/USING clause, you should examine your exit routine. DB2 does not update the following information to reflect the user ID and password that are specified in the USER/USING clause of the CONNECT statement:

- The security-related control blocks that are normally associated with the thread
- The address space that your exit routine can access

If you want to use secondary authorization IDs, you must replace the default routines with the sample routines, or with routines of your own. PSPI

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

Related tasks:

"Using sample connection and sign-on exit routines for CICS transactions" on page 165

"Specifying connection and sign-on routines"

"Debugging connection and sign-on routines" on page 254

Related reference:

"Processing of connection requests" on page 160

"Processing of sign-on requests" on page 163

"Sample connection and sign-on routines" on page 246

"Exit parameter list for connection and sign-on routines" on page 247

Specifying connection and sign-on routines

Your connection routine must have a CSECT name and entry point of DSN3@ATH. The name of the load module for the connection routine can be the same name, or

it can be a different name. Your sign-on routine must have a CSECT name and entry point of DSN3@SGN. The name of the load module for the sign-on routine can be the same, or it can be a different name.

About this task

PSPI You can use an ALIAS statement of the linkage editor to provide the entry-point name.

Default routines exist in library *prefix*.SDSNLOAD. To use your routines instead, place your routines in library *prefix*.SDSNEXIT. You can use the installation job DSNTIJEX to assemble and link-edit the routines and place them in the new library. If you use any other library, you might need to change the STEPLIB or JOBLIB concatenations in the DB2 start-up procedures.

You can combine both routines into one CSECT and load module, but the module must include both entry points, DSN3@ATH and DSN3@SGN. Use standard assembler and linkage editor control statements to define the entry points. DB2 loads the module twice at startup, by issuing the z/OS LOAD macro first for entry point DSN3@ATH and then for entry point DSN3@SGN. However, because the routines are reentrant, only one copy of each remains in virtual storage. PSPI

Related concepts:

"Connection routines and sign-on routines" on page 245

Related reference:

"Processing of connection requests" on page 160

"Processing of sign-on requests" on page 163

"Sample connection and sign-on routines"

"Exit parameter list for connection and sign-on routines" on page 247

Sample connection and sign-on routines

The sample DB2 exit routines are provided in the source code as members of *prefix*.SDSNSAMP.

PSPI To examine the sample connection routine, list or assemble member DSN3SATH. To examine the sample sign-on routine, list or assemble member DSN3SSGN. You must use the High Level Assembler to assemble them.

Change required for some CICS users: You must change the sample sign-on exit routine (DSN3SSGN) before assembling and using it, if the following conditions are true:

- You attach to DB2 with an AUTH parameter other than AUTH=GROUP.
- You have the RACF list-of-groups option active.
- You have transactions whose initial primary authorization ID is not defined to RACF

To change the sample sign-on exit routine (DSN3SSGN), perform the following steps:

1. Locate the following statement in DSN3SSGN as a reference point:

```
SSGN035   DS     OH         BLANK BACKSCAN LOOP REENTRY
```

2. Locate the following statement, which comes after the reference point:

```
          B      SSGN037    ENTIRE NAME IS BLANK, LEAVE
```

3. Replace the statement with the following statement:

```
B      SSGN090    NO GROUP NAME...  BYPASS RACF CHECK
```

By changing the statement, you avoid an abend with SQLCODE -922. The routine with the new statement provides no secondary IDs unless you use AUTH=GROUP.

PSPI

Related concepts:

"Connection routines and sign-on routines" on page 245

Related tasks:

"Using sample connection and sign-on exit routines for CICS transactions" on page 165

"Specifying connection and sign-on routines" on page 245

"Debugging connection and sign-on routines" on page 254

Related reference:

"Processing of sign-on requests" on page 163

When connection and sign-on routines are taken

Different local processes enter the access control procedure at different points, depending on the environment from which they originate. Different criteria apply to remote requests.

PSPI The following processes go through connection processing only:

- Requests that originate in TSO foreground and background (including online utilities and requests through the call attachment facility)
- JES-initiated batch jobs
- Requests through started task control address spaces (from the MVS START command)

The following processes go through connection processing, and can later go through the sign-on exit:

- The IMS control region
- The CICS recovery coordination task
- DL/I batch
- Requests through the Resource Recovery Services attachment facility (RRSAF)

The following processes go through sign-on processing:

- Requests from IMS-dependent regions (including MPP, BMP, and Fast Path)
- CICS transaction subtasks
- Scheduled tasks that are executed by the DB2 administrative task scheduler

PSPI

Exit parameter list for connection and sign-on routines

The parameter list of connection and sign-on routines contains pointers to other information, such as the authorization ID list.

PSPI The following diagram shows how the parameter list points to other information.

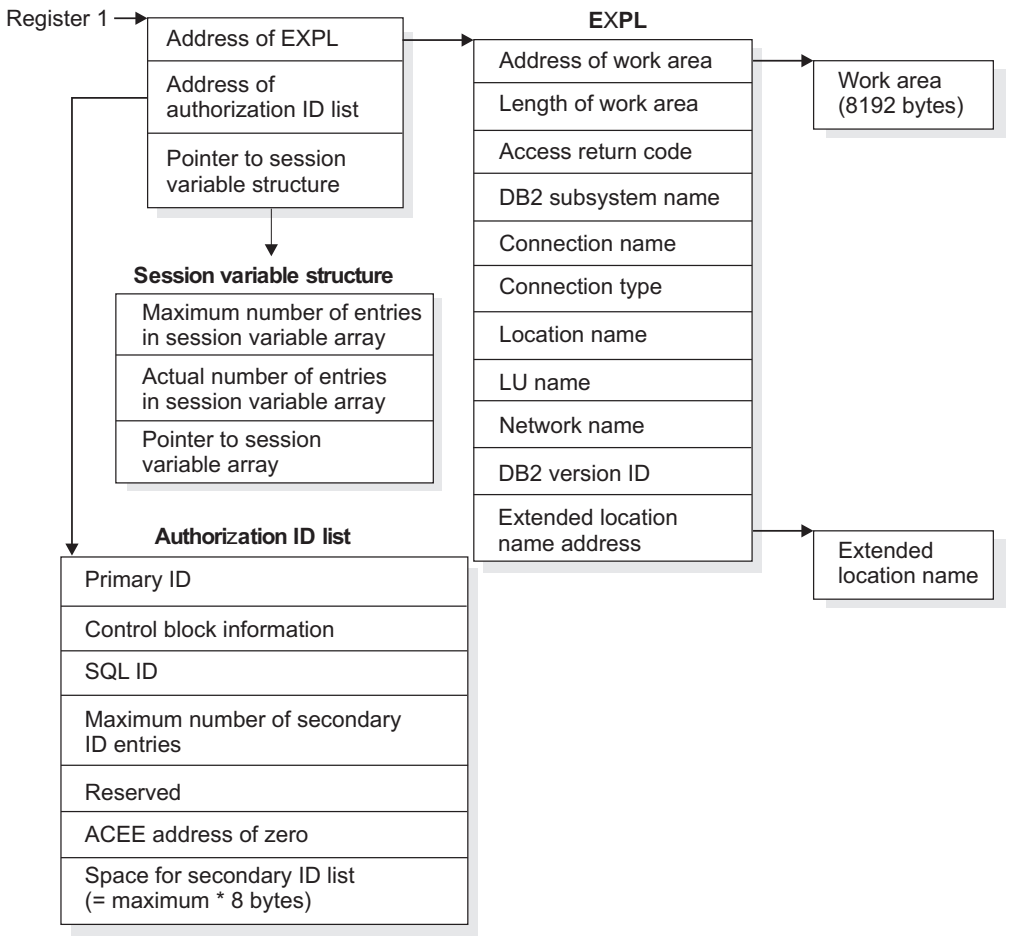


Figure 13. How a connection or sign-on parameter list points to other information

Connection routines and sign-on routines use 28 more bytes of the exit parameter list EXPL than other routines. The following table shows the entire list of connection routines and sign-on routines. The exit parameter list is described by macro DSNDEXPL.

Table 64. Exit parameter list for connection routines and sign-on routines

Name	Hex offset	Data type	Description
EXPLWA	0	Address	Address of a 8192-byte work area to be used by the routine.
EXPLWL	4	Signed 4-byte integer	Length of the work area, in bytes; value is 8192.
EXPLRSV1	8	Signed 2-byte integer	Reserved.
EXPLRC1	A	Signed 2-byte integer	Not used.
EXPLRC2	C	Signed 4-byte integer	Not used.

Table 64. Exit parameter list for connection routines and sign-on routines (continued)

Name	Hex offset	Data type	Description
EXPLARC	10	Signed 4-byte integer	Access return code. Values can be: **0** Access allowed; DB2 continues processing. **12** Access denied; DB2 terminates processing with an error.
EXPLSSNM	14	Character, 8 bytes	DB2 subsystem name, left justified; for example, 'DSN '.
EXPLCONN	1C	Character, 8 bytes	Connection name for requesting location.
EXPLTYPE	24	Character, 8 bytes	Connection type for requesting location. For DDF threads, the connection type is 'DIST '.
EXPLSITE	2C	Character, 16 bytes	For SNA protocols, this is the location name of the requesting location or <*luname*>. For TCP/IP protocols, this is the dotted decimal IP address of the requester. If the value of EXPLSITE_OFF is not 0, EXPLSITE is not used.
EXPLLUNM	3C	Character, 8 bytes	For SNA protocols, this is the locally known LU name of the requesting location. For TCP/IP protocols, this is the character string 'TCPIP'.
EXPLNTID	44	Character, 17 bytes	For SNA protocols, the fully qualified network name of the requesting location. For TCP/IP protocols, this field is reserved.
EXPLVIDS	55	Character, 1 byte	DB2 version identifier
EXPLSITE_OFF	56	Signed 2-byte integer	Offset from the beginning of the work area to the extended location name of the DB2 site that originated the work request. Use this value if the location name is greater than 16 bytes. The extended location name has the following format: • Signed, 2-byte integer: Length of the extended location name • Character, 128 bytes: Extended location name

PSPI

Related concepts:

"Connection routines and sign-on routines" on page 245

Related tasks:

"Using sample connection and sign-on exit routines for CICS transactions" on page 165

"Specifying connection and sign-on routines" on page 245

"Debugging connection and sign-on routines" on page 254

Related reference:

"Processing of sign-on requests" on page 163

Authorization ID parameter list for connection and sign-on routines

An authorization ID list contains information that is specific to connection routines and sign-on routines.

The following table includes the authorization ID list for a connection or sign-on exit routine.

PSPI

Table 65. Authorization ID list for a connection or sign-on exit routine

Name	Hex offset	Data type	Description
AIDLPRIM	0	Character, 8 bytes	Primary authorization ID for input and output; see descriptions in the text.
AIDLCODE	8	Character, 2 bytes	Control block identifier.
AIDLTLEN	A	Signed 2-byte integer	Total length of control block.
AIDLEYE	C	Character, 4 bytes	Eyecatcher for block, "AIDL".
AIDLSQL	10	Character, 8 bytes	On output, the current SQL ID.
AIDLSCNT	18	Signed 4-byte integer	Number of entries allocated to secondary authorization ID list. Always equal to 1012.
AIDLSAPM	1C	Address	For a sign-on routine only, the address of an 8-character additional authorization ID. If RACF is active, the ID is the user ID's connected group name. If the address was not provided, the field contains zero.
AIDLCKEY	20	Character, 1 byte	Storage key of the ID pointed to by AIDLSAPM. To move that ID, use the "move with key" (MVCK) instruction, specifying this key.
AIDLRSV1	21	Character, 3 bytes	Reserved
AIDLRSV2	24	Signed 4-byte integer	Reserved
AIDLACEE	28	Signed 4-byte integer	The address of the ACEE structure, if known; otherwise, zero

Table 65. Authorization ID list for a connection or sign-on exit routine (continued)

Name	Hex offset	Data type	Description
AIDLRACL	2C	Signed 4-byte integer	Length of data area returned by RACF, plus 4 bytes
AIDLRACR	30	26 bytes	Reserved
AIDLSEC	4A	Character, maximum x 8 bytes	List of the secondary authorization IDs, 8 bytes each

PSPI

Input values for connection routines

A connection routine can have different input values.

The input values for a connection routine include the following:

- PSPI The initial primary authorization ID for a local request can be obtained from the z/OS address space extension block (ASXB).

  The ASXB contains at most only a seven-character value. That is always sufficient for a TSO user ID or a user ID from an z/OS JOB statement, and the ASXB is always used for those cases.

  For CICS, IMS, or other started tasks, z/OS can also pass an eight-character ID. If an eight-character ID is available, and if its first seven characters agree with the ASXB value, then DB2 uses the eight-character ID. Otherwise it uses the ASXB value.

  If RACF is active, the field used contains a verified RACF user ID; otherwise, it contains blanks.
- The primary ID for a remote request is the ID passed in the conversation attach request header (SNA FMH5) or in the DRDA SECCHK command.
- The SQL ID contains blanks.
- The list of secondary IDs contains blanks. PSPI

Input values for sign-on routines

A sign-on routine can have different input values.

The input values for a sign-on routine are as follows:

- PSPI The initial primary ID depends on the sign-on method.
- The SQL ID and all secondary IDs contain blanks.
- Field AIDLSAPM in the authorization ID list can contain the address of an 8-character additional authorization ID, obtained by the CICS attachment facility using the RACROUTE REQUEST=EXTRACT service with the requester's user ID. If RACF is active, this ID is the RACF-connected group name from the ACEE corresponding to the requester's user ID. Otherwise, this field contains blanks. IMS does not pass this parameter.
- Field AIDLCKEY contains the storage key of the identifier pointed to by AIDLSAPM. To move that ID, use the “move with key” (MVCK) instruction, specifying this key.

- Field AIDLACEE contains the ACEE address only for a sign-on through the CICS attachment facility and only when the CICS RCT uses AUTH=GROUP.

PSPI

Expected output for connection and sign-on routines

DB2 uses the output values of the primary ID, the SQL ID, and the secondary IDs. Your routines can set these IDs to any value that is an SQL short identifier.

PSPI If your identifier does not meet the 8-character criteria, the request fails. Therefore, when necessary, add blanks to the end of short identifiers to ensure that they meet the criteria.

If the values that are returned are not blank, DB2 interprets them in the following ways:

- The primary ID becomes the primary authorization ID.
- The list of secondary IDs, down to the first blank entry or to a maximum of 1012 entries, becomes the list of secondary authorization IDs. The space allocated for the secondary ID list is only large enough to contain the maximum number of authorization IDs. This number is in field AIDLSCNT.

  Important: If you allow more than 1012 secondary authorization IDs, abends and storage overlays can occur.
- The SQL ID is checked to see if it is the same as the primary or one of the secondary IDs. If it is not, the connection or sign-on process fails. Otherwise, the validated ID becomes the current SQL ID.

If the returned value of the primary ID is blank, DB2 takes the following steps:

- In connection processing, the default ID that is defined when DB2 is installed (UNKNOWN AUTHID on panel DSNTIPP) is substituted as the primary authorization ID and the current SQL ID. The list of secondary IDs is set to blanks.
- Sign-on processing abends. No default value exists for the primary ID.

If the returned value of the SQL ID is blank, DB2 makes it equal to the value of the primary ID. If the list of secondary IDs is blank, it remains blank. No default secondary IDs exist.

Your routine must also set a return code in word 5 of the exit parameter list to allow or deny access (field EXPLARC). By those means you can deny the connection altogether. The code must have one of the values that are shown in Table 66.

Table 66. Required return code in EXPLARC

Value	Meaning
0	Access allowed; continue processing.
12	Access denied; terminate.

Any other value will cause an abend. PSPI

Processing in sample connection and sign-on routines

The sample routines that are provided by IBM can serve as models for the processing that is required in connection routines and sign-on routines.

PSPI **Recommendation:** Consider using the sample routines as a starting point when you write your own routines.

Both the sample connection routine (DSN3SATH) and the sample sign-on routine have similar sections for setup, constants, and storage areas. Both routines set values of the primary ID, the SQL ID, and the secondary IDs in three numbered sections.

In the sample connection routine (DSN3SATH): The three sections of the sample connection routine perform the following functions:

Section 1

Section 1 provides the same function as in the default connection routine. It determines whether the first character of the input primary ID has a value that is greater than blank (hex 40), and performs the following operations:

- If the first character is greater than hex 40, the value is not changed.
- If the first character is not greater than hex 40, the value is set according to the following rules:
  - If the request is from a TSO foreground address space, the primary ID is set to the logon ID.
  - If the request is not from a TSO foreground address space, the primary ID is set to the job user ID from the JES job control table.
  - If no primary ID is located, Section 2 is bypassed.

Section 2

At the beginning of Section 2, you can restore one commented-out instruction, which then truncates the primary authorization ID to 7 characters. (The instruction is identified by comments in the code.)

Section 2 next tests RACF options and makes the following changes in the list of secondary IDs, which is initially blank:

- If RACF is not active, the list remains blank.
- If the list of groups option is not active, but an ACEE exists, the connected group name is copied as the only secondary ID. The source of the ACEE is one of the following:
  - An ACEE that is passed by the caller
  - The address-space-level ACEE
  - The task-level ACEE if the connection is for batch utilities.
- If the list of groups option is active, the list of group names from the ICHPCGRP block is copied into AIDLSEC in the authorization ID list.

Section 3

Section 3 performs the following steps:

1. The SQL ID is set equal to the primary ID.
2. If the TSO data set name prefix is a valid primary or secondary ID, the SQL ID is replaced with the TSO data set name prefix. Otherwise, the SQL ID remains set to the primary ID.

In the sample sign-on routine (DSN3SSGN): The three sections of the sample sign-on routine perform the following functions:

Section 1

Section 1 does not change the primary ID.

Section 2

Section 2 sets the SQL ID to the value of the primary ID.

Section 3

Section 3 tests RACF options and makes the following changes in the list of secondary IDs, which is initially blank:

- If RACF is not active, the list remains blank.
- If the list of groups option is active, section 3 attempts to find an existing ACEE from which to copy the authorization ID list.
  - If AIDLACEE contains a valid ACEE, it is used.

    Otherwise, look for a valid ACEE chained from the TCB or from the ASXB or, if no usable ACEE exists, issue RACROUTE to have RACF build an ACEE structure for the primary ID.

    Copy the list of group names from the ACEE structure into the secondary authorization list.
  - If the exit issued RACROUTE to build an ACEE, another RACROUTE macro is issued and the structure is deleted.
- If a list of secondary authorization IDs has not been built, and AIDLSAPM is not zero, the data that is pointed to by AIDLSAPM is copied into AIDLSEC. PSPI

Performance considerations for connection and sign-on routines

Your sign-on exit routine is part of the critical path for transaction processing in IMS and CICS. Therefore, try to execute as quickly as possible.

About this task

PSPI Avoid writing SVC calls like GETMAIN, FREEMAIN, and ATTACH. Also avoid I/O operations to any data set or database. To improve performance, you might be able to delete the list of groups that process in Section 3 of the sample sign-on exit routine.

The sample sign-on exit routine can issue the RACF RACROUTE macro with the default option SMC=YES. If another product issues RACROUTE with SMC=NO, a deadlock might occur.

Your routine can also enhance the performance of later authorization checking. Authorization for dynamic SQL statements is checked first for the CURRENT SQLID, then for the primary authorization ID, and then for the secondary authorization IDs. If you know that a user's privilege most often comes from a secondary authorization ID, then set the CURRENT SQLID to this secondary ID within your exit routine. PSPI

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

Debugging connection and sign-on routines

The diagnostic aids can assist you in debugging connection exit routines and sign-on exit routines.

About this task

PSPI ***Subsystem support identify recovery:*** The identify ESTAE recovery routine, DSN3IDES, generates the following VRADATA entries. The last entry, key VRAIMO, is generated only if the abend occurred within the connection exit routine.

Table 67. VRADATA entries that are generated by DSN3IDES

VRA keyname	Key hex value	Data length	Content
VRAFPI	22	8	Constant 'IDESTRAK'
VRAFP	23	24	• 32-bit recovery tracking flags • 32-bit integer AGNT block unique identifier • AGNT block address • AIDL block address • Initial primary authorization ID as copied from ASXBUSER
VRAIMO	7C	10	• Connection exit load module load point address • Connection exit entry point address • Offset of failing address in the PSW from the connection exit entry point address

Subsystem support sign-on recovery: The sign-on ESTAE recovery routine DSN3SIES generates the following VRADATA entries. The last entry, key VRAIMO, is generated only if the abend occurred within the sign-on exit routine.

Table 68. VRADATA entries that are generated by DSN3SIES

VRA keyname	Key hex value	Data length	Content
VRAFPI	22	8	Constant 'SIESTRAK'
VRAFP	23	20	• Primary authorization ID (CCBUSER) • AGNT block address • Identify-level CCB block address • Sign-on-level CCB block address
VRAIMO	7C	10	• Sign-on exit load module load point address • Sign-on exit entry point address • Offset of failing address in the PSW from the sign-on exit entry point address

Diagnostics for connection exit routines and sign-on exit routines: The connection (identify) recovery routine and the sign-on recovery routine provide diagnostics for the corresponding exit routines. The diagnostics are produced only when the abend occurs in the exit routine. The following diagnostics are available:

Dump title
The component failing module name is "DSN3@ATH" for a connection exit or "DSN3@SGN" for a sign-on exit.

z/OS and RETAIN® symptom data
SDWA symptom data fields SDWACSCT (CSECT/) and SDWAMODN (MOD/) are set to "DSN3@ATH" or "DSN3@SGN", as appropriate.

Summary dump additions

The AIDL, if addressable, and the SADL, if present, are included in the summary dump for the failing allied agent. If the failure occurred in connection or sign-on processing, the exit parameter list (EXPL) is also included. If the failure occurred in the system services address space, the entire SADL storage pool is included in the summary dump. PSPI

Related concepts:

"Connection routines and sign-on routines" on page 245

Related reference:

"Processing of connection requests" on page 160

"Processing of sign-on requests" on page 163

"Sample connection and sign-on routines" on page 246

"Exit parameter list for connection and sign-on routines" on page 247

Session variables in connection and sign-on routines

DB2 supplies default session variables. In addition, the connection exit routine and the sign-on exit routine support up to 10 more session variables. You can define these additional session variables and use them to provide information to applications by using the GETVARIABLE function.

PSPI ***The session variable structure:*** The connection exit routine and the sign-on exit routine point to the session variable structure (DSNDSVS). DSNDSVS specifies the maximum number of entries in the session array, the actual number of entries in the session array, and a pointer to the session variable array. The default value for the actual number of session variables is zero.

Defining session variables: To define session variables, use the session variable array (DSNDSVA) to list up to 10 session variables as name and value pairs. The session variables that you establish in the connection exit routine and the sign-on exit routine are defined in the SESSION schema. The values that the exit routine supplies in the session variable array replace the previous values.

Example: The following session variable array lists six session variables.

Table 69. Sample session variable array

Name	Value
default_database	DATAXM
default_driver	PZN4Y7
location	Kyoto
member_of	GROUP_42
filename	report.txt
account_number	A1-X142783

The unqualified names are defined as VARCHAR(128), and the values are defined as VARCHAR(255). The exit routines must provide these values in Unicode CCSID 1208. PSPI

Access control authorization exit routine

You can provide your own access control authorization exit routine by using an exit point that DB2 provides. Alternatively, after you carefully consider several important factors, you might choose to let RACF perform DB2 authorization checking for you.

PSPI

Is the access control authorization exit routine right for you?

Using the RACF (Security Server for z/OS) to perform access control is not the best choice for every customer. Consider the following points before choosing RACF to perform access control:

- If you want the database administrators to manage security, integration with DB2 is very important. Using RACF access control provides less integration with DB2. In most of these cases, DB2 authorization provides advantages.
- If you want security administrators to manage security, integration with the security server is more important. In most of these cases, using RACF for access control provides advantages. Furthermore, if you want a security group to define authorization and a centralized security control point, RACF access control is an excellent match.

If you change from DB2 authorization to RACF access control, you must change to RACF methods for some authorization techniques, and you must understand how DB2 and RACF work together. Expect to make the following changes when you implement RACF access control:

- Plan to use RACF facilities (such as groups and patterns) more.
- Plan to use patterns instead of individual item access profiles and permissions.
- Plan to use DB2 roles, RACF groups, or both, instead of secondary authorization IDs, which are not implemented in RACF. OWNER generally must be a valid group or a DB2 role.
- Plan to use DB2 roles for BINDAGENT processing. BINDAGENT based on secondary authorizations IDs is not implemented in RACF.
- Understand how SET CURRENT SQLID works with RACF. SET CURRENT SQLID can set a qualifier, but does not change authorization.
- Know that authorizations are not dropped when objects are dropped or renamed.
- Be aware of the relationship between objects and revoked privileges. Packages are not invalidated when authorizations are revoked. Views are not dropped when authorizations are revoked.

If the AUTHEXIT_CHECK system parameter is set to DB2, DB2 provides the ACEE of the package owner to perform authorization checking when processing the autobind, BIND and REBIND commands. DB2 provides the ACEE of the authorization ID as determined by the DYNAMICRULES option to perform dynamic SQL authorization checking. The access control authorization exit uses the ACEE for XAPLUCHK for authorization checking. The XAPLUCHK authorization ID can be a user or a group in RACF. To ensure successful authorization checks with the owner ACEE, the owner authorization ID in XAPLUCHK must be permitted access to the resources in RACF.

How the access control authorization routine works

Your routine specifies whether the authorization checking should all be done by RACF only, or by both RACF and DB2. (Also, the routine can be called and still let all checking be performed by DB2.)

When DB2 invokes the routine, it passes three possible functions to the routine:
- Initialization (DB2 startup)
- Authorization check
- Termination (DB2 shutdown)

The bulk of the work in the routine is for authorization checking. When DB2 must determine the authorization for a privilege, it invokes your routine. The routine determines the authorization for the privilege and then indicates to DB2 whether the privilege is authorized or not authorized, or whether DB2 should do its own authorization check, instead.

When you write an access control authorization routine, use the general guidelines for writing exit routines, with the following exceptions to the environment description:
- The routine executes in non-cross-memory mode during initialization and termination (XAPLFUNC of 1 or 3).
- During authorization checking, the routine can execute under a TCB or SRB in cross-memory or non-cross-memory mode.

Bypass of the access control authorization routine

In the following situations, the access control authorization routine is not called to check authorization:
- The authorization ID that DB2 uses to determine access has installation SYSADM or installation SYSOPR authority (where installation SYSOPR authority is sufficient to authorize the request). This authorization check is made strictly within DB2. For example, if the execute privilege is being checked on a package, DB2 performs the check on the plan owner that this package is in. If the plan owner has installation SYSADM, the routine is not called.
- DB2 security has been disabled. (You can disable DB2 security by specifying NO on the USE PROTECTION field of installation panel DSNTIPP).
- Authorization has been cached from a prior check.
- In a prior invocation of the exit routine, the routine indicated that it should not be called again.
- GRANT statements.

The routine executes in the *ssnm*DBM1 address space of DB2.

PSPI

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

"Access control external to DB2" on page 4

Introduction to the RACF access control module (RACF Access Control Module Guide)

Related reference:

"Parameter list for access control authorization routines" on page 268

Specifying the access control authorization routine

Your access control authorization routine must have a CSECT name and an entry point of DSNX@XAC. The load module name or alias name must also be DSNX@XAC. A default routine with this name and entry point exists in library *prefix*.SDSNLOAD.

About this task

PSPI To use your routine instead of the default routine, place it in the *prefix*.SDSNEXIT library. Use installation job DSNTIJEX to assemble and link-edit the routine and to place it in the *prefix*.SDSNEXIT library. If you use any other library, you might need to change the STEPLIB or JOBLIB concatenations in the DB2 start-up procedures.

The source code for the default routine is in *prefix*.SDSNSAMP as DSNXSXAC. You can use it to write your own exit routine. To assemble it, you must use the High Level Assembler.

RACF provides a sample exit routine DSNXRXAC, which is shipped with DB2. It can be found in *prefix*.SDSNSAMP. PSPI

The default access control authorization routine

The default exit routine returns a code to the DB2 authorization module. The code indicates that a user-defined access control authorization exit routine is not available. DB2 then performs normal authorization checking and does not attempt to invoke this exit routine again.

When access control authorization routine is taken

DB2 can take the access control authorization routine when it starts up, shuts down, or performs an authorization check on a privilege.

PSPI The access control authorization routine is taken in the following three instances:

At DB2 startup
This exit routine is taken when DB2 starts to allow the external authorization checking application to perform any required setup prior to authorization checking. For example, loading authorization profiles into storage is a required setup task. DB2 uses the reason code that the exit routine sets during startup to determine how to handle exception situations.

When an authorization check is to be performed on a privilege
This exit routine is taken when DB2 accesses security tables in the catalog

to check authorization on a privilege. The exit routine is taken only if none of the prior invocations have indicated that the exit routine must not be called again.

At DB2 shutdown
This exit routine is taken when DB2 is stopping, to let the external authorization checking application perform its cleanup before DB2 stops.

PSPI

Considerations for the access control authorization routine

You need to take additional factors into consideration when you use the access control authorization exit routine.

After a privilege is granted, the authorization information is cached for faster re-checking. If the AUTHEXIT_CACHEREFRESH system parameter is specified and RACF commands are issued with generic character ** or * in the resource names, the entire authorization cache for the corresponding class being revoked might be refreshed. In this case, the performance of authorization checking might be impacted until the cache is successfully rebuilt.

When DB2 cannot provide an ACEE

Sometimes DB2 cannot provide an ACEE. This happens, for example, when you do not use external security in CICS and CICS does not pass an ACEE to the CICS attachment facility.

PSPI When DB2 does not have an ACEE, it passes zeros in the XAPLACEE field. If this happens, your routine can return a 4 in the EXPLRC1 field, and let DB2 handle the authorization check.

DB2 does not pass the ACEE address for IMS transactions. The ACEE address is passed for CICS transactions, if available.

DB2 does pass the ACEE address when it is available for DB2 commands that are issued from a logged on z/OS console. DB2 does not pass the ACEE address for DB2 commands that are issued from a console that is not logged on, or for the START DB2 command, or commands issued automatically during DB2 startup.

An ACEE is available to DB2 for an IMS transaction if IMS is configured to use either APPC/OTMA security full or the IMS Build Security Environment exit (DFSBSEX0). You need to code DFSBSEX0 to return RC4 in register 15, which will instruct IMS to create the ACEE in the dependent region. PSPI

Authorization IDs and ACEEs

XAPL has two authorization ID fields, XAPLUPRM (the primary authorization ID) and XAPLUCHK (the authorization ID that DB2 uses to perform the authorization). These two fields might have different values.

PSPI The ACEE passed in XAPLACEE is that of the primary authorization ID, XAPLUPRM. If XAPLOWAC is on, the ACEE passed in XAPLACEE is that of the authorization ID that DB2 uses to perform the authorization, XAPLUCHK.

The implications of the XAPLUPRM and XAPLUCHK relationship need to be clearly understood. XAPLUCHK, the authorization ID that DB2 uses to perform

authorization may be the primary authorization ID (XAPLUPRM), a secondary authorization ID, or another authorization ID such as a package owner.

If the RACF access control module is used, the following rules apply:

- RACF uses the ACEE of the primary authorization ID (XAPLUPRM) or the owner ID (XAPLUCHK) to perform authorization. The ACEE of the XAPLUCHK ID is used when the AUTHEXIT_CHECK system parameter is set to DB2.

  To ensure successful authorization checks with the owner ACEE, the owner authorization ID in XAPLUCHK must be permitted access to the resources in RACF. If the owner is a group in RACF, you need to permit the group access to the resource associated with the connection in the RACF DSNR class. For example, if the group access is from a batch application, you can issue the following PERMIT command to grant a group access to subsystem.BATCH or subsystem.* in the DSNR class:

  ```
  PERMIT DSN.BATCH CLASS(DSNR) ID(DB2GRP) ACCESS(READ)
  PERMIT DSN.* CLASS(DSNR) ID(DB2GRP) ACCESS(READ)
  ```

- Secondary authorization IDs are not implemented in RACF. DB2 roles or RACF groups should be used instead.

Examples: The following examples show how the rules apply:

- A package may be bound successfully by using the privileges of the binder (XAPLUPRM). Then only the EXECUTE privilege on the package is needed to execute it. If at some point this package is marked invalid (for instance, if a table it depends upon is dropped and re-created), the next execution of it will cause an autobind, which will usually fail. In this case, autobind checks the runner for the necessary authorization, but the runner does not have the required privileges for a successful rebind. However, if the owner of the package is a DB2 role, and the role has the necessary authorization, autobind will succeed. Or, if the AUTHEXIT_CHECK system parameter is set to DB2, RACF checks the owner of the package (XAPLUCHK) for the necessary privileges, and autobind will succeed.
- If the OWNER on the BIND command is based on secondary authorization IDs, which are not supported by RACF. RACF groups should be used instead.
- SET CURRENT SQLID can set a qualifier, but it cannot change authorization.
- The DYNAMICRULES settings have a limited effect on which authorization ID is checked. Only the primary authorization ID and secondary IDs that are valid RACF groups for this user are considered. For dynamic statements with the DYNAMICRULES(BIND) option to work, for example, the package owner must be the primary authorization ID or one of the RACF groups of the user who executes the statements.

  However, the DYNAMICRULES settings will have the effect that you want on which authorization is checked if the authorization is based on a DB2 role or if the AUTHEXIT_CHECK system parameter is set to DB2. For example, using a DB2 role, the dynamic statements with the DYNAMICRULES(BIND) option will work if a DB2 role is the owner of a plan or package or the definer of a stored procedure. If the AUTHEXIT_CHECK system parameter is set to DB2, the dynamic statements with the DYNAMICRULES(BIND) option will work.
- User-defined function and stored procedure authorizations involve several authorization IDs, such as implementer, definer, invoker, and so forth. Only the primary authorization ID and secondary IDs that are DB2 roles or RACF groups are considered. If the AUTHEXIT_CHECK system parameter is set to DB2, the user-defined function and stored procedure authorizations that involve various authorization IDs will work. PSPI

DB2 processing of ENF signals

When the AUTHEXIT_CACHEREFRESH system parameter is set to ALL and when DB2 and the access control authorization exit are active, DB2 listens to type 62, type 71, and type 79 ENF signals from RACF for any user profile or resource access changes. If DB2 receives ENF 62, 71, and 79 signals, it refreshes the cache entries of the package authorization, the routine authorization, the DDF user authentication, and the dynamic statement.

PSPI RACF issues the ENF 71 signal for any change to a RACF user or group profile. DB2 listens to the ENF 71 signal when you use the following RACF commands:

- ALTUSER with the REVOKE option
- CONNECT with the REVOKE option
- DELUSER (to delete a user from RACF)
- DELGROUP (to delete a group and its relationship with its parent group from RACF)
- REMOVE (to remove a user from a group)

RACF issues the ENF 79 signal for any change to a RACF user's or group's authorization to resources. DB2 listens to the ENF 79 signal when you use the following RACF commands:

- PERMIT with the DELETE, ACCESS(NONE), RESET, or WHEN(CRITERIA(SQLROLE ...)) option
- RALTER with the UACC(NONE) or DELMEM option
- RDELETE

When the ENF 79 signal is issued, DB2 caches the resource changes first and refreshes the cache entries only after the SETROPTS RACLIST REFRESH command is issued. RACF issues the ENF 62 signal when the SETROPTS RACLIST REFRESH command is used. Upon receiving the ENF 62 signal, DB2 refreshes the cache entries for the resources that are cached during ENF 79 notification. However, DB2 does not refresh the cache entries when the RDELETE command is used to delete general resource profiles for DSNADM and MDSNSM/GDSNSM classes without a profile name.

The ENF 79 signal is issued only for resource classes that are defined in the RACF Class Descriptor Table with the SIGNAL=YES option. The SIGNAL=YES option is enabled, by default, for the following IBM-supplied RACF resource classes for DB2:

- MDSNPK / GDSNPK
- MDSNTB / GDSNTB
- MDSNSP / GDSNSP
- MDSNSQ / GDSNSQ
- DSNADM and MDSNSM / GDSNSM
- MDSNUF / GDSNUF
- MDSNGV / GDSNGV

If you define RACF classes for DB2 objects and administrative authorities without using IBM-supplied RACF resource classes, you need to enable the SIGNAL=YES option for these classes in the RACF Class Descriptor Table. Class names for DB2 objects in both single-subsystem scope and multiple-subsystem scope are supported.

Profile names with discrete and generic resource characters are supported with the following restrictions:

- Generic character ampersand (&) indicates that RACF uses a profile in the RACFVARS class to determine the actual values for that part of the profile name. DB2 ignores a RACF profile that contains the & character and does not perform cache refresh for the profile.
- Generic character % is not supported in the privilege part of the profile name for cache refresh. DB2 ignores a RACF profile that contains the % character in the privilege part and does not perform cache refresh for the profile.
- If a profile name for classes other than DSNADM contains generic character * or ** and has parts few than what the CLASS parameter supports, all objects or all privileges or both for the specified CLASS parameter may be considered for cache refresh. For example, if you issue the PERMIT SYS1.** ID(USER01) DELETE CLASS(MDSNPK) command, DB2 deletes the entries in the package authorization cache for user USER01. If you issue the PERMIT SYS1.**.GV* ID(*) DELETE CLASS(MDSNGV) command, DB2 deletes the entries in the dynamic statement cache for object type global variables where the schema name starts with GV. If you issue the PERMIT SYS1.TSCH.**.VNAM.* ID(USER03) DELETE CLASS(MDSNTB) command, DB2 deletes the entries in the dynamic statement cache for object type table where the schema is TSCH for user USER03. It also deletes the entries where the schema is VNAM for user USER03.
- Generic character * is not supported when it is specified as an authid in ID(*) for revoking the DSNADM class authority or the MDSNSM class for the SQLADM authority. DB2 ignores the authid and does not perform cache refresh for the authid. When ID(authid) is specified, DB2 deletes all the entries in the caches for the specified authid.

  DB2 may cache the entries for the users who are associated with a group that has the required authorization. If the privilege is revoked from the group, DB2 may not delete the cache entries for all users associated with the group. You need to explicitly permit the users associated with the group the required privilege and then delete the permissions in RACF. PSPI

Related reference:

"Invalid and inoperative packages"

AUTH EXIT CACHE REFR (AUTHEXIT_CACHEREFRESH subsystem parameter) (DB2 Installation and Migration)

Invalid and inoperative packages

In DB2, when a privilege that is required by a package is revoked, the package is invalidated. DB2 can automatically rebind an invalidated package if proper privileges are granted.

PSPI If the revoked privilege is the EXECUTE privilege on a user-defined function, DB2 marks the package inoperative, instead of invalid; you will need to manually rebind the inoperative package.

If a privilege that the package depends on is revoked, and if you want to invalidate the package or make it inoperative, you must use the SQL GRANT statement to grant the revoked privilege and then use the SQL REVOKE statement to revoke it.

If you use an authorization access control routine, the exit routine does not have the ability to tell DB2 that a privilege is revoked. In this case, DB2 does not know that it needs to invalidate the package.

If you set the AUTHEXIT_CACHEREFRESH system parameter to ALL and when the user profile or resource access is changed in RACF, DB2 refreshes the cache entries of the package authorization, the routine authorization, and the dynamic statement. DB2 also checks for static package dependency and invalidates the package when one of the following resource class permissions is removed from the user:

- INSERT, UPDATE, DELETE, SELECT on a table
- USAGE on a sequence
- EXECUTE on a stored procedure
- EXECUTE on an UDF (Dependent packages are marked inoperative.)
- READ, WRITE on a global variable.

If EXECUTE on a package is revoked from the user, DB2 will check for plan dependency and invalidates the plan.

A package can be invalidated only when DB2 is active during ENF notification and if the name of the affected RACF profile contains discrete characters. ENF notification ignores a profile if it is associated with the DSNADM class or if its name contains any generic characters (*, **, &, %). If the package owner is a user (not a RACF group) and if the user is associated with a group that had the required privileges when the package was bound, you need to explicitly permit the user all the privileges required for invalidating the package and then delete the permissions in RACF.

PSPI

Related concepts:

Changes that invalidate packages (DB2 Application programming and SQL)

Related tasks:

Checking for invalid packages (DB2 Performance)

Related reference:

"Explicit package privileges" on page 23

GRANT (DB2 SQL)

REVOKE (DB2 SQL)

Related information:

00E30305 (DB2 Codes)

Automatic rebind with DB2 roles

If you execute a package that is marked invalid, DB2 will attempt to rebind it.

PSPI If the package contains static SQL statements, DB2 will check the owner for the required authorization for a successful rebind. If RACF access control is used and if the owner of the plan or package is a DB2 role, DB2 will be able to complete the rebind.

If the AUTHEXIT_CHECK system parameter is set to DB2, DB2 provides the ACEE of the package owner to perform authorization checking when processing the autobind, BIND and REBIND commands. DB2 provides the ACEE of the authorization ID as determined by the DYNAMICRULES option to perform dynamic SQL authorization checking. The access control authorization exit uses the ACEE for XAPLUCHK for authorization checking. The XAPLUCHK authorization

ID can be a user or a group in RACF. To ensure successful authorization checks with the owner ACEE, the owner authorization ID in XAPLUCHK must be permitted access to the resources in RACF. PSPI

DB2 roles for the DYNAMICRULES(BIND) Option

The DYNAMICRULES(BIND) option provides the flexibility for you to specify the owner of a plan or a package that DB2 checks for the required authorization for dynamic SQL statements. Because RACF does not support secondary IDs, you can use DB2 roles to exploit this flexibility.

PSPI To use DB2 roles with the DYNAMICRULES(BIND) option, the owner of the plan or package must be a DB2 role. Similarly, for the define and invoke behavior of the DYNAMICRULES BIND options, the definer or invoker must be a DB2 role. In order to make the owner of the plan, package, or stored procedure a DB2 role, you need to create the plan, package, or stored procedure in a trusted context that is defined with the ROLE AS OBJECT OWNER AND QUALIFIER clause.

If the AUTHEXIT_CHECK system parameter is set to DB2, DB2 provides the ACEE of the package owner to perform authorization checking when processing the autobind, BIND and REBIND commands. DB2 provides the ACEE of the authorization ID as determined by the DYNAMICRULES option to perform dynamic SQL authorization checking. The access control authorization exit uses the ACEE for XAPLUCHK for authorization checking. The XAPLUCHK authorization ID can be a user or a group in RACF. To ensure successful authorization checks with the owner ACEE, the owner authorization ID in XAPLUCHK must be permitted access to the resources in RACF. PSPI

Using DB2 roles for BINDAGENT

You can bind plans and packages on the behalf of the owner by using the RACF BINDAGENT privilege through a DB2 role.

About this task

PSPI RACF provides support for BINDAGENT through DB2 roles. To use BINDAGENT, you must specify a role, instead of a secondary ID, as the owner of a plan or package and perform the BIND task within a trusted context. To use trusted connections, you cannot set the ALL subsystem parameter to ALL and set the RESTART subsystem parameter to DEFER on installation panel DSNTIPS.

For this task, suppose you want role ROLEOWNER to own package COLLECTION01.PACKAGE01, but will have role ROLEBINDAGENT perform the BIND on behalf of role ROLEOWNER.

Procedure

To have ROLEBINDAGENT perform the BIND on behalf of ROLEOWNER:

1. Create role ROLEOWNER and role ROLEBINDAGENT. Make sure that the ROLEOWNER role is the owner of the package and that the binder is associated with the ROLEBINDAGENT role and will bind the package.
2. Create trusted context CTX1 with the WITH ROLE AS OBJECT OWNER AND QUALIFIER clause. Specify ROLEBINDAGENT as the default role and set JOB=BINDPKG (which is the bind job name) and SYSTEM AUTHID=UBINDER (which is the binder's userid).

3. Create a RACF profile V91A.ROLEOWNER.BINDAGENT to control BINDAGENT access
4. Permit role ROLEBINDAGENT access to profile V91A.ROLEOWNER.BINDAGENT by issuing a RACF **PERMIT** command:

```
PERMIT  V91A.ROLEOWNER.BINDAGENT ID(*) +
  WHEN(CRITERIA(SQLROLE('ROLEBINDAGENT'))) CL(MDSNSM)
```

5. Set up appropriate RACF profiles and give role ROLEOWNER the BINDADD and CREATE IN privileges on the package collection:

```
PERMIT V91A.BINDADD ID(*) CL(MDSNSM) +
  WHEN(CRITERIA(SQLROLE('ROLEOWNER')))
PERMIT V91A.COLLECTION01.CREATEIN ID(*) CL(MDSNCL) +
  WHEN(CRITERIA(SQLROLE('ROLEOWNER')))
```

6. Permit role ROLEOWNER all the required privileges for executing SQL statements in the application as shown in the following example:

```
PERMIT V91A.USRT007.TABL01.SELECT ID(*) CL(MDSNTB) +
  WHEN(CRITERIA(SQLROLE('ROLEOWNER')))
```

7. Have UBINDER submit bind job BINDPKG that will run in trusted context CTX1 with role ROLEBINDAGENT and perform the BIND on behalf of role ROLEOWNER:

```
BIND PACKAGE(COLLECTION01) MEMBER(PACKAGE01) ACTION(REP) OWNER(ROLEOWNER)
```

   RACF performs the BINDAGENT check on binder UBINDER, its role ROLEBINDAGENT, and its RACF groups. It then perform all the remaining checks on role ROLEOWNER and allows the BIND command to complete.

   PSPI

View authorization

DB2 passes specific base table information to an access control authorization exit (ACAE) routine. This information helps the routine to effectively control data access through views.

PSPI For the DELETE and INSERT privileges, DB2 passes the schema and name of the base table in the XAPLBSCM and XAPLBSNAM fields, along with the information about the view itself. For the UPDATE privilege, DB2 additionally passes the name of the base table column in the XAPLBCOL field that is being updated.

For any view in a nested stack, DB2 passes the base table information in addition to that of the view itself. All the intermediate views between the base table and the view that is being processed are ignored.

In the cases when the view is not updatable, the view information will be repeated in the XAPLBSCM, XAPLBSNAM, and XAPLBCOL fields. For example, if the view is specified with the Instead of Trigger, the base table of the view is not being updated using the view because all processing is based on the content of the trigger package. The view information is repeated in the base table fields to facilitate any view authorization check.

When a view is created, DB2 checks whether the owner of the view has the INSERT, UPDATE and DELETE privileges on the underlying base table. DB2 performs this check to determine what privileges should be granted to the view owner. This processing occurs whether or not an ACAE routine, like the RACF access control module, is in effect. If an ACAE routine is in effect, the result of the DB2 authorization check does not impact the creation of the view or the privileges that the view owner gets on the view. In the case when the view is created based

on another view, the base view information will be repeated in the XAPLBSCM, XAPLBSNAM, and XAPLBCOL fields. PSPI

Behavior of EXPLAIN STMTCACHE with the access control authorization routine

The behavior of EXPLAIN STMTCACHE changes because in some instances the primary authorization ID replaces the statement authorization ID.

PSPI Dynamic statements are cached by using the primary authorization ID that runs the plan or package regardless of the DYNAMICRULES value. Therefore, if the access control authorization routine is used for security, the EXPLAIN STMTCACHE statement must be issued with the same primary authorization ID as that for inserting the dynamic statements into the cache. PSPI

Dropping views

A view is dropped when the privilege that is required to create it is revoked.

PSPI Revoking the privilege on a view is not communicated to DB2 by the authorization checking routine. If you want DB2 to drop the view when the privilege is revoked, you must issue the SQL REVOKE statement. PSPI

Caching of EXECUTE on plans, packages, and routines

The results of authorization checks on the EXECUTE privilege for plans are not cached when those checks are performed by the authorization access control exit routine. The results of authorization checks on the EXECUTE privilege for packages and routines are cached if package and routine authorization caching is enabled on your system.

PSPI If authorization checks on the EXECUTE privilege for packages and routines are performed by the authorization access control exit routine, the role in effect or the primary authorization ID is cached. DB2 authorization can cache roles or primary authorization IDs for handling packages and routines. DB2 checks and caches a role if it is in effect and authorized. If a role is not in effect or authorized, DB2 checks and caches the primary authorization ID.

If this privilege is revoked in the exit routine, the cached information is not updated to reflect the revoke. You must use the GRANT statement and the REVOKE statement to update the cached information.

If the AUTHEXIT_CACHEREFRESH system parameter is set to DB2, DB2 refreshes the cache entries of the package authorization, the routine authorization, the DDF user authorization, and the dynamic statement when a user profile or resource access is changed in RACF and the access control authorization exit is active. PSPI

Caching of dynamic SQL statements

Dynamic statements can be cached when they have passed the authorization checks if the dynamic statement caching is enabled on your system.

PSPI If authorization checks for dynamic statements are performed by the authorization access control exit routine, the role in effect or the primary authorization ID is cached. DB2 authorization can cache roles or primary

authorization IDs for handling dynamic statements. DB2 checks and caches a role if it is in effect and authorized. If a role is not in effect or authorized, DB2 checks and caches the primary authorization ID.

If the privileges that this statement requires are revoked from the authorization ID that is cached with the statement, this cached statement must be invalidated. If the privilege is revoked in the exit routine this does not happen, and you must use the SQL statements GRANT and REVOKE to refresh the cache. PSPI

Resolution of user-defined functions

The create timestamp for a user-defined function must be older than the bind timestamp for the package or plan in which the user-defined function is invoked. If DB2 authorization checking is in effect, and DB2 performs an automatic rebind on a plan or package that invokes a user-defined function, any user-defined functions that are created after the original BIND or REBIND of the invoking plan or package are not candidates for execution.

PSPI If you use an access control authorization exit routine, some user-defined functions that were not candidates for execution before the original BIND or REBIND of the invoking plan or package might become candidates for execution during the automatic rebind of the invoking plan or package. If a user-defined function is invoked during an automatic rebind, and that user-defined function is invoked from a trigger body and receives a transition table, the form of the invoked function that DB2 uses for function selection includes only the columns of the transition table that existed at the time of the original BIND or REBIND of the package or plan for the invoking program. PSPI

Creating materialized query tables

When a materialized query table is created, a CRTVUAUTT authorization check is performed. The CRTVUAUTT check is used to determine whether the creator of a materialized query table can provide the required SELECT privileges on base tables to the owner of the materialized query table.

PSPI If the owner of the materialized query table has the required privileges, the CRTVUAUTT authorization check proves redundant. However, the check is performed before the owner of the materialized query table's privileges are determined. Therefore, if the materialized query table owner holds the necessary privileges and the creator of the materialized query table does not, the CRTVUAUTT check can produce unwanted error messages.

For an ACA exit routine to suppress unwanted error messages during the creation of materialized query tables, XAPLFSUP is turned on. PSPI

Parameter list for access control authorization routines

The parameter list of access control authorization routines contains pointers to other information, such as the work area and the authorization ID list.

PSPI The following diagram shows how the parameter list points to other information.

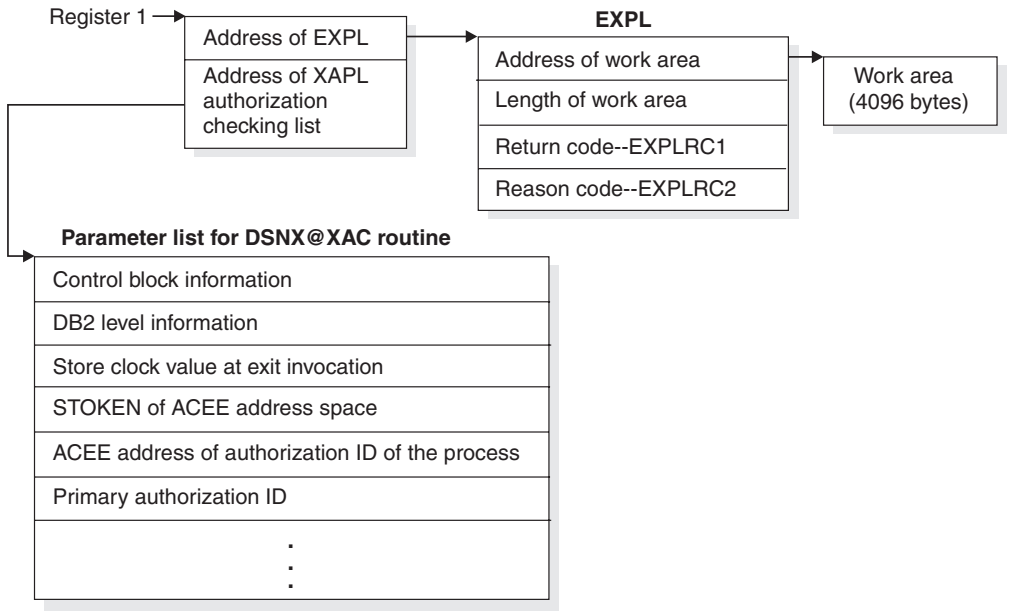


Figure 14. How an authorization routine's parameter list points to other information

The work area (4096 bytes) is obtained once during the startup of DB2 and only released when DB2 is shut down. The work area is shared by all invocations to the exit routine.

At invocation, registers are set, and the authorization checking routine uses the standard exit parameter list (EXPL). The following is a list of the exit-specific parameters, described by macro DSNDXAPL. Field names indicated by an asterisk (*) apply to initialization, termination, and authorization checking. Field names indicated by double asterisks (**) apply to initialization only. Other fields apply to authorization checking only.

Table 70. Parameter list for access control authorization routines

Name	Hex offset	Data type	Input or output	Description
XAPLCBID*	0	Character, 2 bytes	Input	Control block identifier; value X'216A'.
XAPLLEN *	2	Signed, 2-byte integer	Input	Length of XAPL; value X'100' (decimal 256).
XAPLEYE *	4	Character, 4 bytes	Input	Control block eye catcher; value “XAPL”.
XAPLLVL *	8	Character, 8 bytes	Input	DB2 version and level; for example, “VxRxMx ”.
XAPLSTCK *	10	Character, 8 bytes	Input	The store clock value when the exit is invoked. Use this to correlate information to this specific invocation.
XAPLSTKN *	18	Character, 8 bytes	Input	STOKEN of the address space in which XAPLACEE resides. Binary zeroes indicate that XAPLACEE is in the home address space.

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLACEE *	20	Address, 4 bytes	Input	• ACEE address – Of the DB2 address space (*ssnm*DBM1) when XAPLFUNC is 1 or 3. – Of the primary authorization ID associated with this agent or XAPLUCHK ID when XAPLFUNC is 2. There might be cases where an ACEE address is not available for an agent. In such cases this field contains binary zeroes.
XAPLUPRM *	24	Character, 8 bytes	Input	One of the following IDs: • When XAPLFUNC is 1 or 3, it contains the User ID of the DB2 address space (*ssnm*DBM1) • When XAPLFUNC is 2, it contains the primary authorization ID associated with the agent. The primary authorization ID is set to XAPLUCHK ID when XAPLOWAC is on.
XAPLFUNC *	2C	Signed, 2-byte integer	Input	Function to be performed by exit routine: **1** Initialization **2** Authorization Check **3** Termination
XAPLGPAT *	2E	Character, 4 bytes	Input	DB2 group attachment name for data sharing. The DB2 subsystem name if not data sharing.
XAPLUCKT	32	Character, 1 byte	Input	Type of the authorization ID on which DB2 performs the check: **' '** An authorization ID **L** A role
XAPLONRT	33	Character, 1 byte	Input	Type of the authorization ID that owns the object in XAPLOWNR: **' '** An authorization ID **L** A role
XAPLSDEF	34	Character, 1 byte	Input	System-defined object: **S** A system-defined routine or package **' '** Not a system-defined object
XAPLRSV1	35	Character, 3 bytes		Reserved
XAPLPRIV	38	Signed, 2-byte integer	Input	DB2 privilege being checked. Security administrator (SECADM) authority and secure object creation (CREATE_SECURE_OBJECT) privilege required for row and column access control

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description	
XAPLTYPE	3A	Character, 1	Input	DB2 object type:	
				B	Buffer pool
				C	Collection
				D	Database
				E	Distinct typeDistinct type
				F	User-defined functionUser-defined function
				H	Global variable
				J	JAR
				K	Package
				L	Role
				M	Schema
				N	Trusted context
				O	Stored procedure
				P	Application plan
				Q	Sequence
				R	Table space
				S	Storage group
				T	Table
				U	System privilege
				V	View

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLFLG1	3B	Character, 1 byte	Input	The highest-order bit, bit 8, (XAPLCHKS) is on if the secondary IDs associated with this authorization ID (XAPLUCHK) are included in DB2's authorization check. If it is off, only this authorization ID is checked. Bit 7 (XAPLUTB) is on if this is a table or view privilege (SELECT, INSERT, and so on) and if SYSCTRL, SQLADM, System DBADM, ACCESSCTRL, DATAACCESS, or SECADM is not sufficient authority to perform the specified operation on a table or view. SYSCTRL, SQLADM, System DBADM, ACCESSCTRL, DATAACCESS, or SECADM does not have the privilege of accessing user data unless the privilege is specifically granted to it. Bit 6 (XAPLAUTO) is on if this is an autobind. Bit 5 (XAPLCRVW) is on if the installation parameter DBADM CREATE AUTH is set to YES. Bit 4 (XAPLRDWR) is on if the privilege is a write privilege. If the privilege is a read-only privilege, bit 4 is off. Bit 3 (XAPLFSUP) is on to suppress error messages from the CRTVUAUTT authorization check during the creation of a materialized query table. These error messages are caused by intermediate checks that do not affect the final result. Bit 2 (XAPLRAOO) is on if this operation is in a trusted context that is defined with the ROLE AS OBJECT OWNER clause. Bit 1 (XAPLIMPD) is on if authorization checking involves an implicitly created database.
XAPLUCHK	3C	Address, 4 bytes	Input	Address to the authorization ID on which DB2 performs the check. It could be the primary, secondary, or some other ID. This is a VARCHAR(128) field.

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLOBJN	40	Address, 4 bytes	Input	Address to the unqualified name of the object with which the privilege is associated. This is a VARCHAR(128) field.It is one of the following names: **Name Length** **Application plan** 8 **Buffer pool** 8 **Collection** VARCHAR(128) **Database** 8 **Distinct type** VARCHAR(128) **Variable name** VARCHAR(128) **JAR** VARCHAR(128) **Package** VARCHAR(128) **Role** VARCHAR(128) **Schema** VARCHAR(128) **Sequence** VARCHAR(128) **Storage group** VARCHAR(128) **Table** VARCHAR(128) **Table space** 8 **Trusted context** VARCHAR(128) **User-defined function** VARCHAR(128) **View** VARCHAR(128) For special system privileges (SYSADM, SYSCTRL, and so on) this field might contain binary zeroes.
XAPLOWNQ	44	Address, 4 bytes	Input	Address of the object owner (creator) or object qualifier. The contents of this parameter depends on either the privilege being checked or the object. This is a VARCHAR(128) field. If this field is not applicable, it contains binary zeros.

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLREL1	48	Address, 4 bytes	Input	Address of other related information 1. The contents of this parameter depend on either the privilege being checked or the object. This is a VARCHAR(128) field. If this field is not applicable, it contains binary zeros.
XAPLREL2	4C	Address, 4 bytes	Input	Address of other related information 2. The contents of this parameter depends on the privilege being checked. This is a VARCHAR(128) field. If this field is not applicable, it contains binary zeros.
XAPLDBSP	50	Address, 4 bytes	Input	Address of database information. This information is passed for CREATE VIEW and CREATE ALIAS. If this field is not applicable, it contains binary zeros.
XAPLOWNR	54	Address, 4 bytes	Input	Address of the object owner. This is a VARCHAR(128) field. If this field is not applicable, it contains binary zeros.
XAPLROLE	58	Address, 4 bytes	Input	Address of the user's role when operating in a trusted context. If this field is not applicable, it contains binary zeros.
XAPLOONM	5C	Address, 4 bytes	Input	Address of other object name
XAPLOOON	60	Address, 4 bytes	Input	Address of other object owner
XAPLBSCM	64	Address, 4 bytes	Input	Address of base table qualifier of a view or repeated view qualifier
XAPLBNAM	68	Address, 4 bytes	Input	Address of base table name of a view or repeated view name
XAPLBCOL	6C	Address, 4 bytes	Input	Address of base table column name of a view or repeated view column name
XAPLCLST**	70	Address, 4 bytes	Output	Address to the RACLISTed class list
XAPLCLNM**	74	Signed, 2-byte integer	Output	Number of RACLISTed DB2 classes
XAPLFLG3**	76	Character, 1 byte	Output	Bit 8 (the highest order bit) is on if classes are defined in multi-subsystem scope (XAPLMSSC) The remaining 7 bits are reserved.
XAPLRSV2	77	Character, 42 bytes		Reserved.
XAPLOOTP	A1	Character, 1 byte	Input	Other object type or the owner of the base table of a view
XAPLOOOT	A2	Character, 1 byte	Input	Other object owner type or the owner type of the base table of a view
XAPLRSV3	A3	Character, 1 byte		Reserved
XAPLXBTS	A4	Timestamp, 10 bytes	Input	The function resolution timestamp. Authorizations received prior to this timestamp are valid. Applicable to functions and procedures.

Table 70. Parameter list for access control authorization routines (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLONWT	AE	Character, 1 byte	Output	Information required by DB2 from the exit routine for the UPDATE and REFERENCES table privileges: **Value** **Explanation** ' ' Requester has privilege on the entire table * Requester has privilege on just this column
XAPLFLG2	AF	Character, 1 byte	Input	Bit 8 (the highest-order bit) is on if an object is associated with the row and column access control (XAPLSOBJ) Bit 7 is on if the SEPARATE SECURITY system parameter is set to YES (XAPLSPSC) Bit 6 is on when a catalog table (XAPLSCTB) can be accessed only by the SECADM authority. Bit 5 (XAPLACAC) is on when authorization checking is done for statements that involve the package authorization, routine authorization, or dynamic statement cache. Bit 4 (XAPLOWAC) is on if ACEE FOR XAPLUCHK ID is set IN XAPLACEE Bit 3 is on if class names are defined in multi-subsystem scope (XAPLMSSC) The remaining 2 bits are reserved.
XAPLDIAG	B0	Character, 80 bytes	Output	Information returned by the exit routine to help diagnose problems.

The following table includes database information for determining authorization for creating a view. The address to this parameter list is in XAPLREL2.

Table 71. Parameter list for access control authorization routines—database information

Name	Hex offset	Data type	Input or output	Description
XAPLDBNP	0	Address	Input	Address of information for the next database. X'00000000' indicates no next database exists.
XAPLDBNM	4	Character, 8 bytes	Input	Database name.

Table 71. Parameter list for access control authorization routines—database information (continued)

Name	Hex offset	Data type	Input or output	Description
XAPLDBDA	C	Character, 1 byte	Output	Required by DB2 from the exit routine for CREATE VIEW. A value of **Y** and EXPLRC1=0 indicate that the user ID in field XAPLUCHK has database administrator authority on the database in field XAPLDBNM. When the exit checks if XAPLUCHK can create a view for another authorization ID, it first checks for SYSADM or SYSCTRL authority. If the check is successful, no more checking is necessary because SYSCTRL authority (for non-user tables) or SYSADM authority satisfies the requirement that the view owner has the SELECT privilege for all tables and views that the view might be based on. This is indicated by a blank value and EXPLRC1=0. If the authorization ID does not have SYSADM or SYSCTRL authority, the exit checks if the view creator has DBADM on each database of the tables that the view is based on because the DBADM authority on the database of the base table satisfies the requirement that the view owner has the SELECT privilege for all base tables in that database.
XAPLDBIM	D	Character, 1 bytes	Input	A value of 'Y' indicates that the database is implicitly created.
XAPLRSV5	E	Character, 2 bytes	none	Reserved.

Table 72. Parameter list for access control authorization routines-class list array information

Name	Hex offset	Data type	Input or output	Description
XAPLCMEM**	0	Character, 8 bytes	Output	DB2 class name

XAPLOWNQ, XAPLREL1 and XAPLREL2 might further qualify the object or may provide additional information that can be used in determining authorization for certain privileges. The following is a list of the privileges and the contents of XAPLOWNQ, XAPLREL1 and XAPLREL2.

Table 73. Related information for certain privileges

Privilege	Object type (XAPLTYPE)	XAPLOWNQ	XAPLREL1	XAPLREL2	XAPLOWNR
0263 (USAGE)	E	Address of schema name	Address of distinct type owner	Contains binary zeroes	Address of distinct type owner

Table 73. Related information for certain privileges (continued)

Privilege	Object type (XAPLTYPE)	XAPLOWNQ	XAPLREL1	XAPLREL2	XAPLOWNR
0291 (READ) 0292 (WRITE)	H	Address of schema name	Address of global variable owner	Contains binary zeroes	Address of global variable owner
0064 (EXECUTE) 0265 (START) 0266 (STOP) 0267 (DISPLAY)	F	Address of schema name	Address of user-defined function owner	Contains binary zeroes	Address of user-defined function owner
0263 (USAGE)	J	Address of schema name	Address of JAR owner	Contains binary zeroes	Address of JAR owner
0064 (EXECUTE)	K	Address of collection ID	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0065 (BIND)	K	Address of collection ID	Address of package owner	Contains binary zeroes	Address of package owner
0073 (DROP)	K	Address of collection ID	Contains binary zeroes	Address of version ID	Contains binary zeroes
0097 (COMMENT)	K	Address of collection ID	Address of package owner	Contains binary zeroes	Address of package owner
0225 (COPY ON PKG)	K	Address of collection ID	Address of package owner	Contains binary zeroes	Address of package owner
0228 (ALLPKAUT)	K	Address of collection ID	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0229 (SUBPKAUT)	K	Address of collection ID	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0252 (ALTERIN) 0097 (COMMENT) 0252 (DROPIN)	M	Address of schema name	Address of object owner	Contains binary zeroes	Address of object owner
0064 (EXECUTE) 0265 (START) 0266 (STOP) 0267 (DISPLAY)	O	Address of schema name	Address of procedure owner	Contains binary zeroes	Address of procedure owner
0065 (BIND)	P	Address of plan owner	Contains binary zeroes	Contains binary zeroes	Address of plan owner
0097 (COMMENT)	P	Address of plan owner	Contains binary zeroes	Contains binary zeroes	Address of plan owner
0061 (ALTER) 0263 (USAGE)	Q	Address of schema name	Address of sequence name	Contains binary zeroes	Contains binary zeroes
0061 (ALTER)	R	Address of database name	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0073 (DROP)	R	Address of database name	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0087 (USE)	R	Address of database name	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0053 (UPDATE) 0054 (REFERENCES)	T	Address of table schema	Address of column name, if applicable	Address of database name	Address of table owner

Table 73. Related information for certain privileges (continued)

Privilege	Object type (XAPLTYPE)	XAPLOWNQ	XAPLREL1	XAPLREL2	XAPLOWNR
0022 (CATMAINT CONVERT) 0050 (SELECT) 0051 (INSERT) 0052 (DELETE) 0055 (TRIGGER) 0056 (CREATE INDEX) 0061 (ALTER) 0073 (DROP) 0075 (LOAD) 0076 (CHANGE NAME QUALIFIER) 0097 (COMMENT) 0098 (LOCK) 0233 (ANY TABLE PRIVILEGE) 0251 (RENAME) 0275 (REFRESH)	T	Address of table schema	Contains binary zeroes	Address of database name	Address of table owner
0020 (DROP ALIAS) 0104 (DROP SYNONYM)	T	Address of table schema	Contains binary zeroes	Contains binary zeroes	Contains binary zeroes
0103 (ALTER INDEX) 0105 (DROP INDEX) 0274 (COMMENT ON INDEX) 0283 (RENAME INDEX)	T	Address of table schema	Contains binary zeroes	Address of database name	Address of index owner
0227 (BIND AGENT)	U	Address of package owner	Contains binary zeroes	Contains binary zeroes	Address of package owner
0015 (CREATE ALIAS)	U	Contains binary zeroes	Contains binary zeroes	Address of database name, if the alias is on a table	Contains binary zeroes
0053 (UPDATE)	V	Address of view schema	Address of column name, if applicable	Address of the database name of the view's base table, if applicable	Address of view owner
0051 (INSERT) 0052 (DELETE)	V	Address of view schema	Contains binary zeroes	Address of the database name of the view's base table, if applicable	Address of view owner
0050 (SELECT) 0073 (DROP) 0097 (COMMENT) 0233 (ANY TABLE PRIVILEGE)	V	Address of view schema	Contains binary zeroes	Contains binary zeroes	Address of view owner
0055 (TRIGGER)	V	Address of view schema	Contains binary zeroes	Contains binary zeroes	Address of view owner
0061 (ALTER)	V	Address of view schema	Contains binary zeroes	Contains binary zeroes	Address of view owner

The following is a list of data types and field lengths.

Table 74. Data types and field lengths

Resource name or other	Type	Length
Database name	Character	8
Global variable name	Character	VARCHAR(128)
Table name qualifier	Character	VARCHAR(128)
Object name qualifier	Character	VARCHAR(128)
Column name	Character	VARCHAR(128)
Collection ID	Character	VARCHAR(128)
Plan owner	Character	VARCHAR(128)
Package owner	Character	VARCHAR(128)
Package version ID	Character	VARCHAR(64)
Schema name	Character	VARCHAR(128)
Distinct typeowner	Character	VARCHAR(128)
JAR owner	Character	VARCHAR(128)
User-defined function owner	Character	VARCHAR(128)
Procedure owner	Character	VARCHAR(128)
View name qualifier	Character	VARCHAR(128)
Sequence owner	Character	VARCHAR(128)
Sequence name	Character	VARCHAR(128)

PSPI

Expected output for access control authorization routines

Your authorization exit routine is expected to return certain fields when it is called. If an unexpected value is returned in any of these fields, an abend occurs.

PSPI

The following is a list of output fields for the access control authorization routine. Register 3 points to the field in error, and abend code 00E70009 is issued.

Table 75. Output fields for the access control authorization routine

Field	Required or optional
EXPLRC1	Required
EXPLRC2	Optional
XAPLONWT	Required only for UPDATE and REFERENCES table privileges
XAPLDIAG	Optional

PSPI

Handling return codes

You need to place the return codes from the access control authorization routine in the EXPL field named EXPLRC1. The EXPLRC1 value affects DB2 processing.

About this task

PSPI EXPLRC1 must have one of the following values during initialization.

Table 76. Required values in EXPLRC1 during initialization

Value	Meaning
0	Initialization successful.
12	Unable to service request; don't call exit again.

DB2 does not check EXPLRC1 on return from the exit routine during termination. Make sure that EXPLRC1 has one of the following values during the authorization check.

Table 77. Required values in EXPLRC1 during authorization check

Value	Meaning
0	Access permitted.
4	Unable to determine; perform DB2 authorization checking.
8	Access denied.
12	Unable to service request; don't call exit routine again.

On authorization failures, the return code is included in the IFCID 0140 trace record.

PSPI

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

Related reference:

"Exception processing" on page 281

Handling reason codes

After initialization, the access control authorization routine returns reason code EXPLRC2. EXPLRC2 determines how DB2 processes return code EXPLRC1 that is returned during authorization checking.

About this task

PSPI The following is a list of reason codes during initialization.

Table 78. Reason codes during initialization

Value	Meaning
-1	Identifies the default exit routine shipped with DB2. If you replace or modify the default exit, you should not use this value.
16	Indicates to DB2 that it should terminate if the exit routine returns EXPLRC1=12, an invalid EXPLRC1 or abnormally terminates during initialization or authorization checking. **When the exit routine sets the reason code to 16, DB2 does an immediate shutdown, without waiting for tasks to end.** For long-running tasks, an immediate shutdown can mean that recovery times are long.
Other	Ignored by DB2.

Field EXPLRC2 enables you to put in any code for authorization check. You can use EXPLRC2 to determine why the authorization check in the exit routine failed. On authorization failures, the reason code is included in the IFCID 0140 trace record. PSPI

Related concepts:

General guidelines for writing exit routines (DB2 Administration Guide)

Related reference:

"Exception processing"

Exception processing

During initialization or authorization checking, DB2 issues diagnostic message DSNX210I to the operator's console when an error condition occur.

PSPI DB2 issues diagnostic message DSNX210I if one of the following conditions occur:

- The authorization exit returns a return code of 12 or an invalid return code.
- The authorization exit abnormally terminates.

Additional actions that DB2 performs depend on the reason code that the exit returns during initialization. The following is a list of these actions.

Table 79. How an error condition affects DB2 actions during initialization and authorization checking

Exit result	Reason code of 16 returned by exit routine during initialization	Reason code other than 16 or -1 returned by exit routine during initialization[1]
Return code 12	• The task[2] abnormally terminates with reason code 00E70015 • DB2 terminates	• The task[2] abnormally terminates with reason code 00E70009 • DB2 switches to DB2 authorization checking
Invalid return code	• The task[2] abnormally terminates with reason code 00E70015 • DB2 terminates	• The task[2] abnormally terminates with reason code 00E70009 • DB2 switches to DB2 authorization checking
Abnormal termination during initialization	DB2 terminates	DB2 switches to DB2 authorization checking
Abnormal termination during authorization checking	You can use the subsystem parameter AEXITLIM[3] to control how DB2 and the exit behave. **Example:** If you set AEXITLIM to 10, the exit routine continues to run after the first 10 abnormal terminations. On the eleventh abnormal termination, the exit stops and DB2 terminates.	You can use the subsystem parameter AEXITLIM to control how DB2 and the exit behave. **Example:** If you set AEXITLIM to 10, the exit routine continues to run after the first 10 abnormal terminations. On the eleventh abnormal termination, the exit routine stops and DB2 switches to DB2 authorization checking.

Table 79. How an error condition affects DB2 actions during initialization and authorization checking (continued)

Exit result	Reason code of 16 returned by exit routine during initialization	Reason code other than 16 or -1 returned by exit routine during initialization[1]

Note:

1. During initialization, DB2 sets a value of -1 to identify the default exit. The user exit routine should not set the reason code to -1.
2. During initialization, the task is DB2 startup. During authorization checking, the task is the application.
3. AEXITLIM (authorization exit limit) can be updated online.

PSPI

Debugging access control authorization routines

You can use IFCID 0314 to provide a trace record of the parameter list on return from the exit routine. You can activate the trace record by turning on trace class 22.

Determining whether the access control authorization routine is active

You can determine whether the exit routine or DB2 is performing authorization checks.

Procedure

PSPI To determine whether the exit routine or DB2 is performing authorization checks:

1. Start audit trace class 1.
2. Choose a DB2 table on which to issue a SELECT statement and an authorization ID to perform the SELECT. The authorization ID must not have the DB2 SELECT privilege or the external security system SELECT privilege on the table.
3. Use the authorization ID to issue a SELECT statement on the table. The SELECT statement should fail.
4. Format the trace data and examine the return code (QW0140RC) in the IFCID 0140 trace record.
   - QW0140RC = –1 indicates that DB2 performed the authorization check and denied access.
   - QW0140RC = 8 indicates that the external security system performed the authorization check and denied access. PSPI

RACF access control module

The RACF access control module allows you to use RACF as an alternative to DB2 authorization checking for DB2 objects, authorities, and utilities.

PSPI You can activate the RACF access control module at the DB2 access control authorization exit point (DSNX@XAC), where you can replace the default routine.

The RACF access control module is provided as an assembler source module in the DSNXRXAC member of DB2.SDSNSAMP.

The RACF access control module (DSNXRXAC) does not provide full support of role on z/OS 1.7. PSPI

Related concepts:

Introduction to the RACF access control module (RACF Access Control Module Guide)

Chapter 8. Managing program authorization

Program authorization lets you control whether a DB2 application program is authorized to use a plan.

Before you begin

Table SYSIBM.DSNPROGAUTH and index SYSIBM.DSNPROGAUTH_IDX1 must exist on your DB2 subsystem. They are created by installation job DSNTIJSG.

About this task

Program authorization is a useful technique when you do not know all of the programs and packages that might use a plan. In addition, program authorization lets you determine at the time that a program is loaded whether it has been modified. Program authorization is performed in addition to package authorization.

Restriction:

Programs that run in the following environments do not support program authorization:

- RRSAF applications that issue CREATE THREAD with a collection name, and therefore use the default plan name ?RRSAF
- Multicontext ODBC applications, which use the RRSAF attachment facility and the plan name DSNACLI
- Programs that run in stored procedure address spaces

Procedure

To enable program authorization:

1. Bind or rebind plans for which you want to enable program authorization with the PROGAUTH(ENABLE) option.
2. Add a row in the SYSIBM.DSNPROGAUTH table for each program and plan combination for which the plan is bound with PROGAUTH(ENABLE).

   The program name that you need to insert in the row depends on the attachment facility that the program uses to connect to DB2:

   - If the program uses the TSO attachment facility, the program name is the name that you specify in the DSN RUN subcommand.
   - If the program uses any other attachment facility, the program name is the name of the module that is executed first under the job step TCB.

   Job DSNTIJSG contains a sample INSERT statement for a SYSIBM.DSNPROGAUTH row. You can modify the INSERT statement and execute it to add a row for a program and plan.

Chapter 9. Protecting data through encryption and RACF

You can use the DB2 Secure Socket Layer (SSL) support or built-in data encryption functions to protect your sensitive data. You can also use the security features of RACF, or an equivalent system, to protect your data sets.

Encrypting your data with Secure Socket Layer support

DB2 supports Secure Socket Layer (SSL) protocol by using the z/OS Communications Server IP Application Transparent Transport Layer Security (AT-TLS).

The z/OS Communications Server for TCP/IP (beginning in V1R7 of z/OS) supports the AT-TLS function in the TCP/IP stack for applications that require secure TCP/IP connections. AT-TLS performs TLS on behalf of the application, such as DB2, by invoking the z/OS system SSL in the TCP layer of the TCP/IP stack. The z/OS system SSL supports TLS V1.0, SSL V3.0, and SSL V2.0 protocols.

AT-TLS also uses policies that provide system SSL configurations for connections that use AT-TLS. An application continues to send and receive clear text data over the socket while the transmission is protected by the system SSL.

AT-TLS support is policy-driven and can be deployed transparently underneath many existing sockets applications.

Related concepts:

"Encrypting your data through DB2 built-in functions" on page 296

"Protecting data sets through RACF" on page 293

AT-TLS configuration

You need to complete a set of configurations that are required for DB2 to take advantage of AT-TLS support.

You must complete the following configurations of your DB2 to use the AT-TLS support:

- PROFILE.TCPIP configuration

  You can specify the TTLS or NOTTLS parameter on the TCPCONFIG statement in PROFILE.TCPIP to control whether you want to use the AT-TLS support.
- TCP/IP stack access control configuration

  To protect TCP/IP connections, you can configure the RACF EZB.INITSTACK.sysname.tcpname resource in the SERVAUTH class to block all stack access except for the user IDs that are permitted to use the resource.
- Policy configuration

  The policy agent provides AT-TLS policy rules to the TCP/IP stack. Each rule defines a set of security conditions that the policy agent compares to the conditions at the connection that it is checking. When the policy agent finds a match, it assigns the connection to the actions that are associated with the rule.

SSL authentication level

The Secure Socket Layer (SSL) protocol supports server and client authentication during the handshake phase.

The SSL provides server authentication as the minimum level of security. It uses the Server Authentication mechanism to secure communications between a server and its client and allows the client to validate the authenticity of the server.

The SSL provides client authentication as an additional level of authentication and access control. It enables a server to validates the certificates of a client at the server and thus prevents the client from obtaining a secure connection without an installation-approved certificate.

Client authentication is optional and, if used, can provide the following three levels of authentication:

- Level 1 authentication is performed by system SSL. A client passes a digital certificate to a server as part of the SSL handshake. To successfully pass the required authentication, the Certificate Authority (CA) that signs the client certificate must be trusted by the server. That is, the certificate for the CA must be in the key ring that the server uses and designates as trusted.
- Level 2 (addition to level 1) authentication requires that a client certificate be registered with RACF (or other SAF-compliant security products) and mapped to a valid user ID. When AT-TLS receives the client certificate during the SSL handshake, it queries RACF to verify that the certificate maps to a valid user ID before allowing a secure connection to be established. This level of client authentication provides additional access control at the server and ensures that the client is known to have a valid user ID on the server host.
- Level 3 (addition to levels 1 and 2) authentication provides the capability to restrict access to a server based on the user ID associated with a client certificate. A client can access a server only if the client itself is valid to the server, its certificate is valid, and a user ID associated with the certificate is valid. This level of authentication uses the RACF SERVAUTH general resource class to restrict access to the server based on the user ID of the client. If the SERVAUTH general resource class is not active or the SERVAUTH profile for the server is not defined, AT-TLS assumes that this level of authentication is not requested. However, if the SERVAUTH general resource class is active and the server's SERVAUTH profile is defined, a remote secure connection is be established only if the user ID that is associated with the client certificate is permitted to the server's SERVAUTH profile. Otherwise, the secure connection is not established and the connection itself is dropped.

Configuring SSL authentication levels

The Secure Socket Layer (SSL) protocol supports server and client authentication during the handshake phase. You can specify to use either server authentication, client authentication, or both depending on your security need.

Procedure

To specify whether to use server authentication, client authentication, or both, use the following approaches:

- If you need only a minimum level of security to authenticate the communications between a server and its clients, consider using server authentication. To use server authentication, specify the HandshakeRole Server parameter for the TTLSEnvironmentAction statement in the AT-TLS policy, as shown in the following example:

```
TTLSEnvironmentAction DB2ServerSecureEnvAct
{
   TTLSKeyRingParms
   {
      Keyring DB2ServerKeyring
   }
   HandshakeRole Server
}
```

With this configuration, AT-TLS sends the server certificate to the client during the handshake phase of a connection request. The client then validates the server by examining the server certificate that it receives.

- If you need additional security, consider using client authentication. To use client authentication:
  1. Specify the HandshakeRole ServerWithClientAuth parameter for the TTLSEnvironmentAction statement in the AT-TLS policy, as shown in the following example:

     ```
     TTLSEnvironmentAction DB2ServerSecureEnvAct
     {
        TTLSKeyRingParms
        {
           Keyring DB2SERVERKEYRING
        }
        HandshakeRole ServerWithClientAuth
        TTLSEnvironmentAdvancedParms
        {
           ClientAuthType SAFCheck
        }
     }
     ```

  2. Determining the level of client authentication by specifying the ClientAuthType parameter for the TTLSEnvironmentAdvancedParms statement in the AT-TLS policy.

Table 80. Client authentication levels

Client Authentication Level	**ClientAuthType**	**Client Certificate**	**SERVAUTH Class Active and Server SERVAUTH Profile Defined**	**Certificate Validation**
None	PassThru	Optional	N/A	None
None	Full	Optional	N/A	Certificate is validated against key ring, if provided
Level 1	Required (default)	Required	N/A	Certificate is validated against key ring
Level 2	SAFCheck	Required	Optional	Certificate is validated against key ring and must be associated with a user ID in the security product
Level 3	SAFCheck	Required	Required	Certificate is validated against key ring and must be associated to a user ID in the security product and must be permitted to access server's SERVAUTH profile

Depending on the authentication type (ClientAuthType) you specify, AT-TLS may not require the client to present its certificate during the SSL handshake phase.

3. Register the client Certificate Authority (CA) certificate to RACF as trusted by issuing the RACDCERT ADD command, as shown in the following example:

```
RACDCERT ID(USRT001) ADD('USRT001.CLIENT.CRT') TRUST
```

This registers the client CA certificate in data set 'USRT001.CLIENT.CRT' to the RACF database. The certificate is owned by RACF-defined user USRT001. The client CA certificate is also marked as trusted so that RACF can use it to verify the client certificate when it is presented to the system.

4. Add the client CA certificate to a key ring and map it to a user ID by issuing the RACDCERT CONNECT command, as shown in the following example:

```
RACDCERT ID(SYSDSP) CONNECT(ID(USRT001) LABEL('LABEL00000001')
RING(DB2SERVERKEYRING) USAGE(PERSONAL))
```

This adds the client CA certificate to server key ring DB2SERVERKEYRING. The certificate is owned by user USRT001.

Results

DB2 is now ready to accept secure connections from remote clients that use SSL client and server authentication.

Creating and activating client certificate name filters

A *certificate name filter* enables you to associate many client certificates with one user ID based on the unique user information in the certificate, such as the user's affiliation. You can create one or more certificate name filters to map a large number of client certificates to a limited number of user IDs, which helps you reduce administrative costs.

Procedure

To create and activate a certificate name filter:

1. Create a certificate name filter by issuing the **RACDCERT MAP** command, as shown in the following example:

```
RACDCERT MAP ID(USRT001) -
   SDNFILTER('O=IBM.L=San Jose.SP=CA.C=US')
   WITHLABEL('IBMers') TRUST
```

This creates a new certificate name filter based on the subject's distinguished name in the certificate. The filter associates user ID USRT001 to any user presenting a certificate with subject name 'O=IBM, L=San Jose, ST=CA, C=US'.

2. Activate the SETROPTS RACLIST processing for the DIGTNMAP class.

Using the **RACDCERT MAP** command to create a certificate name filter automatically generates a mapping profile in the DIGTNMAP class that represents the new filter. Both the DIGTNMAP class and the SETROPTS RACLIST processing for the DIGTNMAP class must be active before you can complete the creation of the new certificate name filter. Issue the following command to activate the SETROPTS RACLIST processing for the DIGTNMAP class:

```
SETROPTS CLASSACT(DIGTNMAP) RACLIST(DIGTNMAP)
```

3. Refresh the DIGTNMAP class.

Once SETROPTS RACLIST processing for the DIGTNMAP class is active, you must refresh the DIGTNMAP class for the certificate name filter to take effect. Issue the following command to refresh the DIGTNMAP class:

```
SETROPTS RACLIST(DIGTNMAP) REFRESH
```

4. Register a client CA certificate to use with the certificate name filter.

During the SSL handshake phase of establishing a secure connection, AT-TLS retrieves certificate information from RACF if client authentication is specified.

In order for AT-TLS to retrieve the client CA certificate and private keys from RACF, the client CA certificate must be connected to the server key ring. You can use the new certificate name filter to register the client CA certificate to RACF, connect to the server key ring, and map to the user ID CERTAUTH as trusted by issuing the following command:

```
RACDCERT CERTAUTH ADD('USRT001.CLIENT.CRT') TRUST
RACDCERT ID(SYSDSP) CONNECT(CERTAUTH LABEL('LABEL00000001')
RING(DB2SERVERKEYRING) USAGE(CERTAUTH))
```

This registers the client CA certificate to RACF and maps it to the ID CERTAUTH as TRUST. It the adds the certificate to key ring DB2ASERVERKEYRING (owned by ID SYSDSP) and and indicates it is used for certificate authority purposes. As a result, when a remote client establishes a secure connection with DB2, AT-TLS is able to authenticate the client from the client CA certificate in RACF. Because the certificate name filter is active, user ID USRT001 is returned by AT-TLS to DB2.

Configuring the DB2 server for SSL

To implement SSL support for a DB2 server, you need to make sure that the TCP/IP SQL Listener service task of DDF is capable of listening to a secondary secure port for inbound SSL connections.

About this task

The TCP/IP Listener accepts regular (non-SSL) connections on the DRDA port, whereas the secure port accepts only SSL connections to provide secure communications with a partner. Clients are assured of getting the SSL protocol connections that they require.

The secure port is used only for accepting secure connections that use the SSL protocol. When the TCP/IP Listener accepts an inbound connection on the secure port, DDF invokes the SIOCTTLSCTL IOCTL service with TTLSi_Req_Type set to TTLS_QUERY_ONLY. It also retrieves the following AT-TLS policy information:

- Status of the connection. The status of a connection is either SECURE or NOT SECURE.
- Policy status of the connection. The IOCTL returns one of the following policy status:
  - If the IOCTL returns a policy status of TTLS_POL_NO_POLICY, a matching policy rule is not found for the connection and subsequently the connection status is not secure.
  - If the IOCTL returns a policy status of TTLS_POL_NOT_ENABLED, a matching policy rule is found for the connection but the policy is not configured to allow a secure connection for that client.
  - If the IOCTL returns a policy status of TTLS_POL_ENABLED, a matching policy rule is found, and SSL is enabled for the connection.
- Security type for the connection. The security type is either server or server with client authentication (with ClientAuthType = SAFCheck)
- RACF-defined user ID that is associated with a client certificate. If a client certificate is provided by the client and validated by AT-TLS and if a user ID is mapped to the certificate, the user ID is returned. Otherwise, the user ID is not returned.

If a secure port is not properly configured, DDF rejects the inbound connection request on the secure port. You must change the client system to either use the non-secure port, or you can configure the secure port to access DB2 remotely.

Procedure

To specify a secure port to DB2, use one of the following approaches:

- Specify the TCP/IP port number in the DRDA SECURE PORT field of the Distributed Data Facility Panel 2 (DSNTIP5) during DB2 installation.

  The DRDA SECURE PORT field specifies the port number that is to be used for accepting TCP/IP connection requests from remote DRDA clients that want to establish a secure connection using the SSL protocol. The value of the port number is a decimal number between 1 and 65534, and it cannot have the same value as the values of the DRDA PORT and RESYNC PORT fields. Any non-zero port numbers are verified to ensure that they are all unique port numbers. If an error is detected, installation is not allowed to proceed until you resolve the error condition. If the DRDA SECURE PORT field is blank, SSL verification support is disabled, and the DB2 TCP/IP SQL Listener does not accept any inbound SSL connections on the secure port.
- Update the SECPORT parameter of the DDF statement in the BSDS with the change log inventory (DSNJU003) stand-alone utility.

  The SECPORT parameter specifies the port number for the DB2 TCP/IP SQL Listener to accept inbound SSL connections. The value of the port number is a decimal number between 0 to 65535, and it cannot have the same value as the values of the PORT and RESPORT parameters. If the value of SECPORT secure port is the same as the value of PORT or RESPORT, DB2 issues an error message. If you specify a value of 0 for the SECPORT parameter, SSL verification support is disabled, and the DB2 TCP/IP SQL Listener does not accept any inbound SSL connections on the secure port.

  If the value of SECPORT is disabled, the client can still use the DRDA PORT and use SSL on it, but DB2 does not validate whether the connection uses SSL protocol.

What to do next

Data Sharing Considerations: For a data sharing environment, each DB2 member with SSL support must specify a secure port. The secure port for each DB2 member of the group should be the same, just as the DRDA PORT for each member should also be the same. If each DB2 member specifies a unique secure port, unpredictable behaviors might occur. For example, Sysplex member workload balancing might not work correctly.

Similarly, for DB2 members that are defined as a subset of the data sharing group, each DB2 member that belongs to the subset needs to configure the secure port. You do not need to define a separate unique secure port for the location alias.

Related information:

DB2 10 for z/OS: Configuring SSL for Secure Client-Server Communications

Configuring the DB2 requester for SSL

A DB2 requester must be able to insist on an SSL-protected connection to certain servers. To ensure SSL-protected connections, you can make communications database (CDB) changes that indicate that SSL-protected connections are required to certain remote locations.

About this task

If a secure connection is required, DDF must determine whether an AT-TLS policy rule is defined and whether AT-TLS is enabled for the connection. To obtain this AT-TLS information, DDF invokes SIOCTTLSCTL IOCTLwith TTLSi_Req_Type = TTLS_QUERY_ONLY. If the IOCTL returns a policy status of TTLS_POL_NO_POLICY, a matching policy rule is not found for the connection.

If the IOCTL returns a policy status of TTLS_POL_NOT_ENABLED, a policy rule is defined for the connection, but AT-TLS is not enabled, and a secure connection is not established with the remote server. DDF issues a message, and the connection is closed.

If the IOCTL returns a policy status of TTLS_POL_ENABLED, a matching policy rule is found, and SSL is enabled for the connection.

Procedure

To specify a secure connection to DB2, use one of the following approaches:

- Specify 'Y' for the SECURE column in the SYSIBM.LOCATIONS table.
- Specify a value for the PORT column in the SYSIBM.LOCATIONS table for SSL connections.

  For SSL support, the PORT column must contain the value of the configured secure DRDA port at the remote server. However, if the value of the PORT column is blank and the value of the SECURE column is 'Y', DB2 uses the reserved secure DRDA port (448) as the default.

What to do next

Some DB2 applications might require SSL protection and accept the performance cost for this level of security. However, some applications might be satisfied with unprotected connections. This flexibility can be accomplished by the use of the LOCATION ALIAS name feature.

Consider a DB2 server that is configured to support both non-secure and secure connections. At the DB2 requester, you can define two rows in the SYSIBM.LOCATIONS table: one row that specifies the location name and the non-secure DRDA port of the server and another row that specifies a different location name and the secure DRDA port of the server and SECURE='Y'. At the DB2 server, you can define a LOCATION ALIAS name to provide alternative names for any DB2 requesters that need to access the server by using the SSL protocol.

Related information:

DB2 10 for z/OS: Configuring SSL for Secure Client-Server Communications

Protecting data sets through RACF

To fully protect the data in DB2, you must take steps to ensure that no other process has access to the data sets in which DB2 data resides.

Use RACF, or a similar external security system, to control access to the data sets just as RACF controls access to the DB2 subsystem. This section explains how to create RACF profiles for data sets and allow their use through DB2.

Assume that the RACF groups DB2 and DB2USER, and the RACF user ID DB2OWNER, have been set up for DB2 IDs. Given that setting, the examples that follow show you how to:

- Add RACF groups to control data sets that use the default DB2 qualifiers.
- Create generic profiles for different types of DB2 data sets and permit their use by DB2 started tasks.
- Permit use of the profiles by specific IDs.
- Allow certain IDs to create data sets.

Related concepts:

"Encrypting your data through DB2 built-in functions" on page 296

"Encrypting your data with Secure Socket Layer support" on page 287

Adding groups to control DB2 data sets

The default high-level qualifier for data sets that contain DB2 databases and recovery logs is DSNC110. The default high-level qualifier for distribution, target, SMP, and other installation data sets is DSNB10.

About this task

The DB2OWNER user ID can create groups that control those data sets by issuing the following commands:

```
ADDGROUP DSNC110 SUPGROUP(DB2) OWNER(DB2OWNER)
ADDGROUP DSNB10 SUPGROUP(DB2) OWNER(DB2OWNER)
```

Creating generic profiles for data sets

DB2 uses specific names to identify data sets for special purposes.

About this task

Suppose that SYSDSP is the RACF user ID for DB2 started tasks in the following examples. DB2OWNER can issue the following commands to create generic profiles for the data sets and give complete control over the data sets to DB2 started tasks:

- For active logs, issue the following commands:

  ```
  ADDSD  'DSNC110.LOGCOPY*' UACC(NONE)
  PERMIT 'DSNC110.LOGCOPY*' ID(SYSDSP) ACCESS(ALTER)
  ```

- For archive logs, issue the following commands:

  ```
  ADDSD  'DSNC110.ARCHLOG*' UACC(NONE)
  PERMIT 'DSNC110.ARCHLOG*' ID(SYSDSP) ACCESS(ALTER)
  ```

- For bootstrap data sets, issue the following commands:

  ```
  ADDSD  'DSNC110.BSDS*'    UACC(NONE)
  PERMIT 'DSNC110.BSDS*'    ID(SYSDSP) ACCESS(ALTER)
  ```

- For table spaces and index spaces, issue the following commands:

  ```
  ADDSD  'DSNC110.DSNDBC.*' UACC(NONE)
  PERMIT 'DSNC110.DSNDBC.*' ID(SYSDSP) ACCESS(ALTER)
  ```

- For installation libraries, issue the following command:

  ```
  ADDSD 'DSNB10.*'          UACC(READ)
  ```

  Started tasks do not need control.

- For other general data sets, issue the following commands:

  ```
  ADDSD  'DSNC110.*'        UACC(NONE)
  PERMIT 'DSNC110.*'        ID(SYSDSP) ACCESS(ALTER)
  ```

Although all of those commands are not absolutely necessary, the sample shows how you can create generic profiles for different types of data sets. Some parameters, such as universal access, could vary among the types. In the example, installation data sets (DSNB10.*) are universally available for read access.

If you use generic profiles, specify NO on installation panel DSNTIPP for ARCHIVE LOG RACF, or you might get a z/OS error when DB2 tries to create the archive log data set. If you specify YES, DB2 asks RACF to create a separate profile for each archive log that is created, which means that you cannot use generic profiles for these data sets.

To protect VSAM data sets, use the cluster name. You do not need to protect the data component names, because the cluster name is used for RACF checking.

The VSAM resource that is used to store the administrative scheduler task list must be protected in RACF against unauthorized access. Only the administrative scheduler started task user has the UPDATE authority on VSAM resources.

Access by stand-alone DB2 utilities: The following DB2 utilities access objects that are outside of DB2 control:

- DSN1COPY and DSN1PRNT: table space and index space data sets
- DSN1LOGP: active logs, archive logs, and bootstrap data sets
- Change Log Inventory (DSNJU003) and Print Log Map (DSNJU004): bootstrap data sets

The Change Log Inventory and Print Log Map utilities run as batch jobs that are protected by the USER and PASSWORD options on the JOB statement. To provide a value for the USER option, for example SVCAID, issue the following commands:

- For DSN1COPY:

```
PERMIT 'DSNC110.*' ID(SVCAID) ACCESS(CONTROL)
```

- For DSN1PRNT:

```
PERMIT 'DSNC110.*' ID(SVCAID) ACCESS(READ)
```

- For DSN1LOGP:

```
PERMIT 'DSNC110.LOGCOPY*' ID(SVCAID) ACCESS(READ)
PERMIT 'DSNC110.ARCHLOG*' ID(SVCAID) ACCESS(READ)
PERMIT 'DSNC110.BSDS*'    ID(SVCAID) ACCESS(READ)
```

- For Change Log Inventory:

```
PERMIT 'DSNC110.BSDS*' ID(SVCAID) ACCESS(CONTROL)
```

- For Print Log Map:

```
PERMIT 'DSNC110.BSDS*' ID(SVCAID) ACCESS(READ)
```

The level of access depends on the intended use, not on the type of data set (VSAM KSDS, VSAM linear, or sequential). For update operations, ACCESS(CONTROL) is required; for read-only operations, ACCESS(READ) is sufficient.

You can use RACF to permit programs, rather than user IDs, to access objects. When you use RACF in this manner, IDs that are not authorized to access the log data sets might be able to do so by running the DSN1LOGP utility. Permit access to database data sets through DSN1PRNT or DSN1COPY.

Authorizing DB2 IDs to use data set profiles

Authorization IDs with the installation SYSADM or installation SYSOPR authority need access to most DB2 data sets.

About this task

The following command adds the two default IDs that have the SYSADM and SYSOPR authorities if no other IDs are named when DB2 is installed:

```
ADDUSER (SYSADM SYSOPR)
```

The next two commands connect those IDs to the groups that control data sets, with the authority to create new RACF database profiles. The ID that has the installation SYSOPR authority (SYSOPR) does not need that authority for the installation data sets.

```
CONNECT (SYSADM SYSOPR)  GROUP(DSNC110) AUTHORITY(CREATE) UACC(NONE)
CONNECT (SYSADM)         GROUP(DSNB10)  AUTHORITY(CREATE) UACC(NONE)
```

The following set of commands gives the IDs complete control over DSNC110 data sets. The system administrator IDs also have complete control over the installation libraries. Additionally, you can give the system programmer IDs the same control.

```
PERMIT 'DSNC110.LOGCOPY*' ID(SYSADM SYSOPR) ACCESS(ALTER)
PERMIT 'DSNC110.ARCHLOG*' ID(SYSADM SYSOPR) ACCESS(ALTER)
PERMIT 'DSNC110.BSDS*'    ID(SYSADM SYSOPR) ACCESS(ALTER)
PERMIT 'DSNC110.DSNDBC.*' ID(SYSADM SYSOPR) ACCESS(ALTER)
PERMIT 'DSNC110.*'        ID(SYSADM SYSOPR) ACCESS(ALTER)
PERMIT 'DSNB10.*'         ID(SYSADM)        ACCESS(ALTER)
```

Enabling DB2 IDs to create data sets

You can enable DB2 IDs to create data sets by connecting them to the DSNC110 group that has the CREATE authority.

About this task

You can issue the following command to connect several IDs to the DSNC110 group:

```
CONNECT (USER1 USER2 USER3 USER4 USER5)
         GROUP(DSNC110) AUTHORITY(CREATE) UACC(NONE)
```

Those IDs can now explicitly create data sets whose names have DSNC110 as the high-level qualifier. Any such data sets that are created by DB2 or by these RACF user IDs are protected by RACF. Other RACF user IDs are prevented by RACF from creating such data sets.

If no option is supplied for PASSWORD on the ADDUSER command that adds those IDs, the first password for the new IDs is the name of the default group, DB2USER. The first time that the IDs sign on, they all use that password, but they must change the password during their first session.

Encrypting your data through DB2 built-in functions

DB2 provides built-in data encryption and decryption functions that you can use to encrypt sensitive data, such as credit card numbers and medical record numbers.

You can encrypt data at the column or value level. You must install the Integrated Cryptographic Service Facility to use the built-in functions for data encryption.

When you use data encryption, DB2 requires the correct password to retrieve the data in a decrypted format. If an incorrect password is provided, DB2 does not decrypt the data.

The ENCRYPT keyword encrypts data. The DECRYPT_BIT, DECRYPT_CHAR, and DECRYPT_DB keywords decrypt data. These functions work like other built-in functions. To use these functions on data, the column that holds the data must be properly defined.

Built-in encryption functions work for data that is stored within DB2 subsystem and is retrieved from within that same DB2 subsystem. The encryption functions do not work for data that is passed into and out of a DB2 subsystem. This task is handled by DRDA data encryption, and it is separate from built-in data encryption functions.

Attention: DB2 cannot decrypt data without the encryption password, and DB2 does not store encryption passwords in an accessible format. If you forget the encryption password, you cannot decrypt the data, and the data might become unusable.

Related concepts:

"Encrypting your data with Secure Socket Layer support" on page 287

"Protecting data sets through RACF" on page 293

Defining columns for encrypted data

When data is encrypted, it is stored as a binary data string. Therefore, encrypted data should be stored in columns that are defined as VARCHAR FOR BIT DATA.

About this task

Columns that hold encrypted data also require additional bytes to hold a header and to reach a multiple of 8 bytes.

Suppose that you have non-encrypted data in a column that is defined as VARCHAR(6). Use the following calculation to determine the column definition for storing the data in encrypted format:

```
Maximum length of non-encrypted data        6 bytes
Number of bytes to the next multiple of 8   2 bytes
24 bytes for encryption key                24 bytes
                                           --------
Encrypted data column length               32 bytes
```

Therefore, define the column for encrypted data as VARCHAR(32) FOR BIT DATA.

If you use a password hint, DB2 requires an additional 32 bytes to store the hint. Suppose that you have non-encrypted data in a column that is defined as VARCHAR(10). Use the following calculation to determine the column definition for storing the data in encrypted format with a password hint:

```
Maximum length of non-encrypted data       10 bytes
Number of bytes to the next multiple of 8   6 bytes
24 bytes for encryption key                24 bytes
32 bytes for password hint                 32 bytes
                                           --------
Encrypted data column length               72 bytes
```

Therefore, define the column for encrypted data as VARCHAR(72) FOR BIT DATA.

Related tasks:

"Defining column-level encryption"

"Defining value-level encryption" on page 300

"Optimizing performance of encrypted data" on page 302

Defining column-level encryption

For column-level encryption, all encrypted values in a column are encrypted with the same password.

Procedure

To define column-level encryption:

1. Create the EMP table with the EMPNO column. The EMPNO column must be defined with the VARCHAR data type, must be defined FOR BIT DATA, and must be long enough to hold the encrypted data. The following statement creates the EMP table:

   GUPI

   ```
   CREATE TABLE EMP (EMPNO VARCHAR(32) FOR BIT DATA);
   ```

   GUPI

2. Set the encryption password. The following statement sets the encryption password to the host variable :hv_pass:

   GUPI

   ```
   SET ENCRYPTION PASSWORD = :hv_pass;
   ```

   GUPI

3. Use the ENCRYPT keyword to insert encrypted data into the EMP table by issuing the following statements:

   GUPI

   ```
   INSERT INTO EMP (EMPNO) VALUES(ENCRYPT('47138'));
   INSERT INTO EMP (EMPNO) VALUES(ENCRYPT('99514'));
   INSERT INTO EMP (EMPNO) VALUES(ENCRYPT('67391'));
   ```

   GUPI

4. Select the employee ID numbers in decrypted format:

   GUPI

   ```
   SELECT DECRYPT_CHAR(EMPNO) FROM EMP;
   ```

   GUPI

   If you provide the correct password, DB2 returns the employee ID numbers in decrypted format.

Related tasks:

"Defining columns for encrypted data" on page 297

"Defining value-level encryption" on page 300

"Optimizing performance of encrypted data" on page 302

Creating views with column-level encryption

You can create a view that uses column-level encryption and selects decrypted data from a table.

About this task

You can define the view with a decryption function in the defining fullselect. If the correct password is provided when the view is queried, DB2 will return decrypted data. Suppose that you want to create a view that contains decrypted employee ID numbers from the EMP table.

Procedure

To create a view that uses column-level encryption and selects decrypted data:

1. Create a view on the EMP table by using the following statement:

   GUPI

   ```
   CREATE VIEW CLR_EMP (EMPNO) AS SELECT DECRYPT_CHAR(EMPNO) FROM EMP;
   ```

   GUPI

2. Set the encryption password so that the fullselect in the view definition can retrieve decrypted data.

   Use the following statement: GUPI

   ```
   SET ENCRYPTION PASSWORD = :hv_pass;
   ```

   GUPI

3. Select data from the view by using the following statement:

   GUPI

   ```
   SELECT EMPNO FROM CLR_EMP;
   ```

   GUPI

Using password hints with column-level encryption

DB2 can store encryption password hints to help with forgotten encryption passwords. Each password hint uses 32 bytes in the encrypted column.

Procedure

To use password hints with column-level encryption, choose one of the following options:

- Issue the SET ENCRYPTION PASSWORD statement to set the password hint. Use the following statement to set the password hint to the host variable hv_hint: GUPI

  ```
  SET ENCRYPTION PASSWORD = :hv_pass WITH HINT = :hv_hint;
  ```

GUPI

- Use the GETHINT function to return the password hint. Suppose that the EMPNO column in the EMP table contains encrypted data and that you submitted a password hint when you inserted the data. Suppose that you cannot remember the encryption password for the data. Use the following statement to return the password hint: GUPI

```
SELECT GETHINT (EMPNO) FROM EMP;
```

GUPI

Defining value-level encryption

When you use value-level encryption, each value in a given column can be encrypted with a different password. You set the password for each value by using the ENCRYPT keyword with the password.

About this task

The following keywords are used with value-level encryption:

ENCRYPT
Indicates which data requires encryption. Also, encryption passwords, and optionally password hints, are indicated as part of the ENCRYPT keyword for value-level encryption.

Recommendation: Use host variables instead of literal values for all passwords and password hints. If statements contain literal values for passwords and password hints, the security of the encrypted data can be compromised in the DB2 catalog and in a trace report.

DECRYPT_BIT, DECRYPT_CHAR, DECRYPT_DB
Checks for the correct password and decrypts data when the data is selected.

Example

Suppose that a web application collects user information about a customer. This information includes the customer name, which is stored in host variable custname; the credit card number, which is stored in a host variable cardnum; and the password for the card number value, which is stored in a host variable userpswd. The application uses the following statement to insert the customer information: GUPI

```
INSERT INTO CUSTOMER (CCN, NAME)
  VALUES(ENCRYPT(:cardnum, :userpswd), :custname);
```

GUPI

Before the application displays the credit card number for a customer, the customer must enter the password. The application retrieves the credit card number by using the following statement:

GUPI

```
SELECT DECRYPT_CHAR(CCN, :userpswd) FROM CUSTOMER WHERE NAME = :custname;
```

GUPI

Related tasks:

"Defining columns for encrypted data" on page 297

"Defining column-level encryption" on page 298

"Optimizing performance of encrypted data" on page 302

Using password hints with value-level encryption

DB2 can store encryption password hints to help with forgotten encryption passwords. Each password hint uses 32 bytes in the encrypted column.

About this task

For value-level encryption, the password hint is set with the ENCRYPT keyword. The GETHINT function returns the password hint.

Recommendation: Use host variables instead of literal values for all passwords and password hints. If the statements contain literal values for passwords and password hints, the security of the encrypted data can be compromised in the DB2 catalog and in a trace report.

Example

Suppose that you want the application from the previous example to use a hint to help customers remember their passwords. The application stores the hint in the host variable pswdhint. For this example, assume the values 'Tahoe' for userpswd and 'Ski Holiday' for pswdhint. The application uses the following statement to insert the customer information: GUPI

```
INSERT INTO CUSTOMER (CCN, NAME)
  VALUES(ENCRYPT(:cardnum, :userpswd, :pswdhint), :custname);
```

GUPI

If the customer requests a hint about the password, the following query is used:

GUPI

```
SELECT GETHINT(CCN) INTO :pswdhint FROM CUSTOMER WHERE NAME = :custname;
```

GUPI

The value for pswdhint is set to 'Ski Holiday' and returned to the customer. Hopefully the customer can remember the password 'Tahoe' from this hint.

Encrypting non-character values

DB2 supports encryption for numeric and datetime data types indirectly through casting. If non-character data is cast as VARCHAR or CHAR, the data can be encrypted.

Example

Suppose that you need to encrypt timestamp data and retrieve it in decrypted format. Perform the following steps:

1. Create a table to store the encrypted values and set the column-level encryption password by using the following statements:
   ```
   CREATE TABLE ETEMP (C1 VARCHAR(124) FOR BIT DATA);
   SET ENCRYPTION PASSWORD :hv_pass;
   ```
2. Cast, encrypt, and insert the timestamp data by using the following statement:
   ```
   INSERT INTO ETEMP VALUES ENCRYPT(CHAR(CURRENT TIMESTAMP));
   ```
3. Recast, decrypt, and select the timestamp data by using the following statement:
   ```
   SELECT TIMESTAMP(DECRYPT_CHAR(C1)) FROM ETEMP;
   ```

Using predicates for encrypted data

When data is encrypted, only = and <> predicates provide accurate results. Predicates such as >, <, and LIKE return inaccurate results for encrypted data.

About this task

Suppose that the value 1234 is encrypted as H71G. Also suppose that the value 5678 is encrypted as BF62. If you use a <> predicate to compare these two values in encrypted format, you receive the same result as you will if you compare these two values in decrypted format:

```
Decrypted:  1234 <> 5678    True
Encrypted:  H71G <> BF62    True
```

In both case, they are not equal. However, if you use a < predicate to compare these values in encrypted format, you receive a different result than you will if you compare these two values in decrypted format:

```
Decrypted:  1234 < 5678    True
Encrypted:  H71G < BF62    False
```

To ensure that predicates such as >, <, and LIKE return accurate results, you must first decrypt the data.

Optimizing performance of encrypted data

Encryption typically degrades the performance of most SQL statements. Decryption requires extra processing, and encrypted data requires more space in DB2.

About this task

If a predicate requires decryption, the predicate is a stage 2 predicate, which can degrade performance. Encrypted data can also impact your database design, which can indirectly impact performance. To minimize performance degradation, use encryption only in cases that require encryption.

Recommendation: Encrypt only a few highly sensitive data elements, such credit card numbers and medical record numbers.

Some data values are poor candidates for encryption. For example, boolean values and other small value sets, such as the integers 1 through 10, are poor candidates for encryption. Because few values are possible, these types of data can be easy to guess even when they are encrypted. In most cases, encryption is not a good security option for this type of data.

Data encryption and indexes: Creating indexes on encrypted data can improve performance in some cases. Exact matches and joins of encrypted data (if both

tables use the same encryption key to encrypt the same data) can use the indexes that you create. Because encrypted data is binary data, range checking of encrypted data requires table space scans. Range checking requires all the row values for a column to be decrypted. Therefore, range checking should be avoided, or at least tuned appropriately.

Encryption performance scenario: The following scenario contains a series of examples that demonstrate how to improve performance while working with encrypted data.

Example: Suppose that you must store EMPNO in encrypted form in the EMP table and in the EMPPROJ table. To define tables and indexes for the encrypted data, use the following statements:

GUPI

```
CREATE TABLE EMP (EMPNO VARCHAR(48) FOR BIT DATA, NAME VARCHAR(48));
CREATE TABLE EMPPROJ(EMPNO VARCHAR(48) FOR BIT DATA, PROJECTNAME VARCHAR(48));
CREATE INDEX IXEMPPRJ ON EMPPROJ(EMPNO);
```

GUPI

Example: Next, suppose that one employee can work on multiple projects, and that you want to insert employee and project data into the table. To set the encryption password and insert data into the tables, use the following statements:

GUPI

```
SET ENCRYPTION PASSWORD = :hv_pass;
SELECT INTO :hv_enc_val FROM FINAL TABLE
  (INSERT INTO EMP VALUES (ENCRYPT('A7513'),'Super Prog'));
INSERT INTO EMPPROJ VALUES (:hv_enc_val,'UDDI Project');
INSERT INTO EMPPROJ VALUES (:hv_enc_val,'DB2 10');
SELECT INTO :hv_enc_val FROM FINAL TABLE
  (INSERT INTO EMP VALUES (ENCRYPT('4NF18'),'Novice Prog'));
INSERT INTO EMPPROJ VALUES (:hv_enc_val,'UDDI Project');
```

GUPI

You can improve the performance of INSERT statements by avoiding unnecessary repetition of encryption processing. Note how the host variable hv_enc_val is defined in the SELECT INTO statement and then used in subsequent INSERT statements. If you need to insert a large number of rows that contain the same encrypted value, you might find that the repetitive encryption processing degrades performance. However, you can dramatically improve performance by encrypting the data, storing the encrypted data in a host variable, and inserting the host variable.

Note: Next, suppose that you want to find the programmers who are working on the UDDI Project. Consider the following pair of SELECT statements:

- **Poor Performance:** The following query shows how not to write the query for good performance:

  GUPI

```
SELECT A.NAME, DECRYPT_CHAR(A.EMPNO) FROM EMP A, EMPPROJECT B
  WHERE DECRYPT_CHAR(A.EMPNO) = DECRYPT_CHAR(B.EMPNO) AND
        B.PROJECT ='UDDI Project';
```

GUPI Although the preceding query returns the correct results, it decrypts every EMPNO value in the EMP table and every EMPNO value in the EMPPROJ table where PROJECT = 'UDDI Project' to perform the join. For large tables, this unnecessary decryption is a significant performance problem.

- **Good performance:** The following query produces the same result as the preceding query, but with significantly better performance. To find the programmers who are working on the UDDI Project, use the following statement:

GUPI

```
SELECT A.NAME, DECRYPT_CHAR(A.EMPNO) FROM EMP A, EMPPROJ B
  WHERE A.EMPNO = B.EMPNO AND B.PROJECT ='UDDI Project';
```

GUPI

Example: Next, suppose that you want to find the projects that the programmer with employee ID A7513 is working on. Consider the following pair of SELECT statements:

- **Poor performance:** The following query requires DB2 to decrypt every EMPNO value in the EMPPROJ table to perform the join:

GUPI

```
SELECT PROJECTNAME FROM EMPPROJ WHERE DECRYPT_CHAR(EMPNO) = 'A7513';
```

GUPI

- **Good performance:** The following query encrypts the literal value in the predicate so that DB2 can compare it to encrypted values that are stored in the EMPNO column without decrypting the whole column. To find the projects that the programmer with employee ID A7513 is working on, use the following statement:

GUPI

```
SELECT PROJECTNAME FROM EMPPROJ WHERE EMPNO = ENCRYPT('A7513');
```

GUPI

Related tasks:

"Defining columns for encrypted data" on page 297

"Defining column-level encryption" on page 298

"Defining value-level encryption" on page 300

Chapter 10. Auditing access to DB2

Security auditing allows you to inspect and examine the adequacy and effectiveness of the policies and procedures that you put in place to secure your data.

DB2 provides the ability for you to monitor if your security plan is adequately designed based on your security objectives and determine if your implementation techniques and procedures are effectively carried out to protect your data access and consistency. It enables you to address the following fundamental questions about your data security.

- What sensitive data requires authorized access?
- Who is privileged to access the data?
- Who has actually accessed the data?
- What attempts are made to gain unauthorized access?

The DB2 catalog contains critical authorization and authentication information. This information provides the primary audit trail for the DB2 subsystem. You can retrieve the information from the catalog tables by issuing SQL queries.

Most of the catalog tables describe the DB2 objects, such as tables, views, table spaces, packages, and plans. Other tables, particularly those with the "AUTH" character string in their names, hold records of every granted privilege and authority. Each catalog record of a grant contains the following information:

- Name of the object
- Type of privilege
- IDs that receive the privilege
- IDs that grant the privilege
- Time of the grant

The DB2 audit trace can help you monitor and track all the accesses to your protected data. The audit trace records provide another important trail for the DB2 subsystem. You can use the the audit trace to record the following access information:

- Changes in authorization IDs
- Changes to the structure of data, such as dropping a table
- Changes to data values, such as updating or inserting records
- Access attempts by unauthorized IDs
- Results of GRANT statements and REVOKE statements
- Mapping of Kerberos security tickets to IDs
- Other activities that are of interest to auditors

Related tasks:

"Auditing manager access" on page 11

"Auditing payroll operations and management" on page 14

Determining active security measures

If you are a security auditor, you must know the security measures that are enabled on the DB2 subsystem.

About this task

You can determine whether DB2 authorization checking, the audit trace, and data definition control are enabled in the following ways:

Audit trace
To see whether the trace is running, display the status of the trace by the command DISPLAY TRACE(AUDIT).

DB2 authorization checking
Without changing anything, look at panel DSNTIPP. If the value of the USE PROTECTION field is YES, DB2 checks privileges and authorities before permitting any activity.

Data definition control
Data definition control is a security measure that provides additional constraints to existing authorization checks. With it, you control how specific plans or collections of packages can use data definition statements. To determine whether data definition control is active, look at option 1 on the DSNTIPZ installation panel.

DB2 audit trace

The audit trace enables you to trace different events or categories of events by authorization IDs, object ownership, and so on.

When started, the audit trace records certain types of actions and sends the report to a named destination. The trace reports can indicate who has accessed data.

As with other types of DB2 traces, you can choose the following options for the audit trace:
- Categories of events
- Particular authorization IDs or plan IDs
- Methods to start and stop the audit trace
- Destinations for audit records

You can choose whether to audit the activity on a table by specifying an option of the CREATE and ALTER statements.

Audit trace classes

Table 81. Classes for DB2 audit trace

Class	Description of class	Activated IFCIDs
1	Access attempts denied due to inadequate authorization. This default class is also activated when you omit the CLASS keyword from the START TRACE command when you start the audit trace.	0140
2	Explicit GRANT and REVOKE.	0141
3	CREATE, ALTER, and DROP operations against audited tables.	0142
4	First change of audited object.	0143
5	First read of audited object.	0144
6	Bind time information about SQL statements that involve audited objects.	0145

Table 81. Classes for DB2 audit trace (continued)

Class	Description of class	Activated IFCIDs
7	Assignment or change of authorization ID.	0055, 0083, 0087, 0169, 0319
8	Utilities.	0023, 0024, 0025, 0219, 0220
9	Installation-defined audit record.	0146
10	Trusted context information.	0269, 0270
11	Audits of successful access.	0361[1]
12 - 29	Reserved.	
30 - 32	Available for local use.	

Notes:

1. If IFCID 0361 is started through START TRACE, all successful access is traced. If IFCID 0361 is started because audit policy category SYSADMIN is on, only successful access using the SYSADMIN administrative authority is traced. If IFCID 0361 is started because audit policy category DBADMIN is on, only successful access using the DBADMIN administrative authority is traced.

Related concepts:

"Audit trace records" on page 309

"Audit trace reports" on page 309

Related tasks:

"Starting the audit trace" on page 310

"Stopping the audit trace" on page 311

Related reference:

-START TRACE (DB2) (DB2 Commands)

Authorization IDs traced by auditing

An audit traces generally identifies a process by its primary authorization ID. It records the primary ID before and after the invocation of an authorization exit routine. Therefore, you can identify the primary ID that is associated with a data change.

Exception: If a primary ID has been translated many times, you might not be able to identify the primary ID that is associated with a change. Suppose that the server does not recognize the translated ID from the requesting site. In this case, you cannot use the primary ID to gather all audit records for a user that accesses remote data.

The AUTHCHG record shows the values of all secondary authorization IDs that are established by an exit routine.

With the audit trace, you can also determine which primary ID is responsible for the action of a secondary ID or a current SQL ID. Suppose that the user with primary ID SMITHJ sets the current SQL ID to TESTGRP to grant privileges over the table TESTGRP.TABLE01 to another user. The DB2 catalog records the grantor of the privileges as TESTGRP. However, the audit trace shows that SMITHJ issued the grant statement.

Recommendation: Consider carefully the consequences of altering that ID by using an exit routine because the trace identifies a process by its primary ID. If the primary ID identifies a unique user, individual accountability is possible. However,

if several users share the same primary ID, you cannot tell which user issues a particular GRANT statement or runs a particular application plan.

Audit classes

When you start the trace, you choose the events to audit by specifying one or more audit classes.

PSPI

The trace records are limited to 5000 bytes; the descriptions that contain long SQL statements might be truncated. The following table describes the available classes and the events that they include.

Table 82. Audit classes and the events that they trace

Audit class	Events that are traced
1	Access attempts that DB2 denies because of inadequate authorization. This class is the default.
2	Explicit GRANT and REVOKE statements and their results. This class does not trace implicit grants and revokes.
3	Traces CREATE, DROP, and ALTER operations against an audited table or a table that is enabled with multilevel security with row-level granularity. For example, it traces the updates to a table created with the AUDIT CHANGES or AUDIT ALL clause. It also traces the deletion of a table as the result of a DROP TABLESPACE or DROP DATABASE statement.
4	Changes to audited tables. Only the first attempt to change a table, within a unit of recovery, is recorded. (If the agent or the transaction issues more than one COMMIT statement, the number of audit records increases accordingly.) The changed data is not recorded; only the attempt to make a change is recorded. If the change is not successful and is rolled back, the audit record remains; it is not deleted. This class includes access by the LOAD utility. Accesses to a dependent table that are caused by attempted deletions from a parent table are also audited. The audit record is written even if the delete rule is RESTRICT, which prevents the deletion from the parent table. The audit record is also written when the rule is CASCADE or SET NULL, which can result in deletions that cascade to the dependent table.
5	All read accesses to tables that are identified with the AUDIT ALL clause. As in class 4, only the first access within a DB2 unit of recovery is recorded. References to a parent table are also audited.
6	The bind of static and dynamic SQL statements of the following types: • INSERT, UPDATE, DELETE, CREATE VIEW, and LOCK TABLE statements for audited tables. Except for the values of host variables, the audit record contains the entire SQL statement. • SELECT statements on tables that are identified with the AUDIT ALL clause. Except for the values of host variables, the audit record contains the entire SQL statement.
7	Assignment or change of an authorization ID because of the following reasons: • Changes through an exit routine (default or user-written) • Changes through a SET CURRENT SQLID statement • An outbound or inbound authorization ID translation • An ID that is being mapped to a RACF ID from a Kerberos security ticket

Table 82. Audit classes and the events that they trace (continued)

Audit class	Events that are traced
8	The start of a utility job, and the end of each phase of the utility
9	Various types of records that are written to IFCID 0146 by the IFI WRITE function
10	CREATE and ALTER TRUSTED CONTEXT statements, establish trusted connection information and switch user information
11	Audit the use of any administrative authority and the successful execution of any authorization ID

PSPI

Audit trace reports

If you regularly start the audit trace for all classes, you can generate audit reports based on the data that you accumulate.

Consider producing audit trace reports that focus on the following important security events:

Use of sensitive data
You should define tables that contain sensitive data, such as employee salary records, with the AUDIT ALL option. You can report use by table and by authorization ID to look for access by unusual IDs, at unusual times, or of unexpected types. You should also record any ALTER or DROP operations that affect the data. Use audit classes 3, 4, and 5.

Grants of critical privileges
Carefully monitor IDs with special authorities, such as SYSADM and DBADM. Also carefully monitor IDs with privileges over sensitive data, such as an update privilege on records of accounts payable. You can query the DB2 catalog to determine which IDs hold privileges and authorities at a particular time. To determine which IDs received privileges and then had them revoked, use audit class 2 and consult the audit records.

Unsuccessful access attempts
Investigate all unsuccessful access attempts. Although some access failures are only user errors, others can be attempts to violate security. If you have sensitive data, always use trace audit class 1. You can report by table or by authorization ID.

Related concepts:

"DB2 audit trace" on page 306

"Audit trace records"

Audit trace records

An audit trace record contains the information about the authorization ID that initiated the activity that is traced.

In addition, it contains the following information:

- The LOCATION of the ID that initiated the activity (if the access was initiated from a remote location)
- The type of activity and the time that the activity occurred
- The DB2 objects that were affected

- Whether access was denied
- The owner of a particular plan and package
- The database alias (DBALIAS) that was used to access a remote location or a location alias that was accepted from a remote application.

Related concepts:

"DB2 audit trace" on page 306

"Audit trace reports" on page 309

Related tasks:

"Collecting audit trace records" on page 312

"Formatting audit trace records" on page 312

Limitations of the audit trace

The audit trace has certain limitations, including that it does not automatically record everything.

The audit trace has the following additional limitations:

- The audit trace must be turned on; it is not on by default.
- The trace does not record old data after it is changed.
- If an agent or transaction accesses a table more than once in a single unit of recovery, the audit trace records only the first access.
- The audit trace does not record accesses if you do not start the audit trace for the appropriate class of events.
- Except class 8, the audit trace does not audit certain utilities. For example, the trace audits the first access of a table with the LOAD utility, but it does not audit access by the COPY, RECOVER, and REPAIR utilities. The audit trace does not audit access by stand-alone utilities, such as DSN1PRNT.
- The trace audits only the tables that you specifically choose to audit.
- You cannot audit access to auxiliary tables.
- You cannot audit the catalog tables because you cannot create or alter catalog tables.

This auditing coverage is consistent with the goal of providing a moderate volume of audit data with a low impact on performance. However, when you choose classes of events to audit, consider that you might ask for more data than you are willing to process.

Starting the audit trace

You can start an audit trace at any time or specify that an audit trace starts automatically whenever DB2 is started.

About this task

The default option for the AUDITST subsystem parameter is NO. When NO is specified, audit traces do not start automatically.

Procedure

To start an audit trace, choose one of the following options:

- Set the AUDITST subsystem parameter to * (an asterisk). This will cause a complete audit trace to start automatically whenever DB2 is started.

- Set the AUDITST subsystem parameter to YES. This will cause an audit trace for the default class (class 1: access denials) and the default destination (the SMF data set) to start automatically whenever DB2 is started.
- Set the AUDITST subsystem parameter to a list of those classes (for example, 1,3,5). This will cause an audit trace for specific audit trace classes to start automatically whenever DB2 is started.
- Issue the START TRACE command at any time. This will cause an audit trace to start. You can choose the audit classes to trace and the destination for trace records. You can also include an identifying comment. The following command starts an audit trace for classes 4 and 6 with distributed activity: GUPI

```
-START TRACE (AUDIT) CLASS (4,6) DEST (GTF) LOCATION (*)
  COMMENT ('Trace data changes; include text of dynamic DML statements.')
```

GUPI

Related concepts:

"DB2 audit trace" on page 306

Related tasks:

"Stopping the audit trace"

Related reference:

AUDIT TRACE field (AUDITST subsystem parameter) (DB2 Installation and Migration)

Tracing parameters panel: DSNTIPN (DB2 Installation and Migration)

-START TRACE (DB2) (DB2 Commands)

Stopping the audit trace

You can have multiple traces that run at the same time, including more than one audit trace. You can stop a particular trace by issuing the STOP TRACE command with the same options that you use for START TRACE.

About this task

GUPI

You must include enough options to uniquely identify a particular trace when you issue the command.

Example: The following command stops the trace that you started:

```
-STOP TRACE (AUDIT) CLASS (4,6) DEST (GTF)
```

If you did not save the START command, you can determine the trace number and stop the trace by its number. Use DISPLAY TRACE to find the number.

Example: DISPLAY TRACE (AUDIT) might return a message like the following output:

```
TNO  TYPE     CLASS         DEST     QUAL
01   AUDIT    01            SMF      NO
02   AUDIT    04,06         GTF      YES
```

The message indicates that two audit traces are active. Trace 1 traces events in class 1 and sends records to the SMF data set. Trace 1 can be a trace that starts automatically whenever DB2 starts. Trace 2 traces events in classes 4 and 6 and sends records to GTF.

You can stop either trace by using its identifying number (TNO).

Example: To stop trace 1, use the following command:

```
-STOP TRACE AUDIT TNO(1)
```

GUPI

Related concepts:

"DB2 audit trace" on page 306

Related tasks:

"Starting the audit trace" on page 310

Collecting audit trace records

You can prepare the System Management Facility (SMF) or Generalized Trace Facility (GTF) to accept audit trace records the same way as you prepare performance trace records. The records are of SMF type 102, as are performance trace records.

About this task

If you send trace records to SMF (the default), data might be lost in the following circumstances:

- SMF fails while DB2 continues to run.
- An unexpected abend (such as a TSO interrupt) occurs while DB2 is transferring records to SMF.

In those circumstances, SMF records the number of records that are lost. z/OS provides an option to stop the system rather than to lose SMF data.

Related concepts:

"Audit trace records" on page 309

Related tasks:

"Formatting audit trace records"

Formatting audit trace records

You can extract, format, and print DB2 trace records.

About this task

You can use any of the following methods to extract, format, and print the trace records:

- DB2 Audit Management Expert for z/OS
- IBM Tivoli zSecure Audit
- IBM Tivoli OMEGAMON XE on z/OS
- Your own application program to access the SMF data
- The instrumentation facility interface (IFI) as an online resource to retrieve audit records.

Related concepts:

"Audit trace records" on page 309

Related tasks:

"Collecting audit trace records" on page 312

Auditing in a distributed data environment

The DB2 audit trace records any access to your data, whether the request is from a remote location or from your local DB2 subsystem.

The trace record for a remote request reports the authorization ID as the final result of one of the following conditions:

- An outbound translation
- An inbound translation
- Activity of an authorization exit routine

Essentially, the ID on a trace record for a remote request is the same as the ID to which you grant access privileges for your data. Requests from your location to a remote DB2 are audited only if an audit trace is active at the remote location. The output from the trace appears only in the records at that location.

DB2 audit policy

An *audit policy* is a set of criteria that determines the categories to be audited. It helps you configure and control the audit requirements of your security policies and to monitor data access by applications and individual users (authorization IDs or roles), including administrative authorities.

GUPI You can create an audit policy by inserting a row in the SYSIBM.SYSAUDITPOLICIES table. The SECADM, ACCESSCTRL, DATAACCESS, system DBADM, SQLADM, SYSCRTL, and SYSADM authorities all have the implicit SELECT privilege on the SYSIBM.SYSAUDITPOLICIES table. The SECADM authority also has implicit INSERT, UPDATE, and DELETE privileges on the SYSIBM.SYSAUDITPOLICIES table.

If you have the required privileges to issue the **START TRACE**, **STOP TRACE**, and **DISPLAY TRACE** commands, you can activate, deactivate, and display an audit policy by issuing those commands with the AUDTPLCY option. The SECADM authority has the implicit privileges to issue the **START TRACE**, **STOP TRACE**, and **DISPLAY TRACE** commands. GUPI

Audit category

DB2 audit policies are created and stored in the SYSIBM.SYSAUDITPOLICIES table. Each policy is specified with specific audit categories.

PSPI DB2 supports the following audit categories:

Table 83. DB2 audit policy categories

Category	Description
CHECKING	Generates IFCID 140 trace records for denied access attempts due to inadequate DB2 authorization and IFCID 83 trace records for RACF authentication failures

Table 83. DB2 audit policy categories (continued)

Category	Description
VALIDATE	Generates IFCID 55, 83, 87, 169, and 319 trace records for new or changed assignments of authorization IDs and IFCID 269 trace records for the establishment of trusted connections or the switch of users in existing trusted connections
OBJMAINT	Generates IFCID 142 trace records when tables are altered or dropped. When an audit policy is defined, it specifies the tables to be audited. The same audit policy can be used to audit different tables in a schema by specifying the table names with the SQL LIKE predicate. Only tables that are defined in the following types of table spaces can be audited: • Universal table space (UTS), including UTS that contains implicitly created tables, such as XML tables • Traditional partitioned table space • Segmented table space. In addition to tables, an audit policy can also be used to audit clone tables and tables that are implicitly created for XML columns. The type of the object to be audited can be specified by using the OBJECTTYPE column. The default OBJECTTYPE column value of blank indicates that all of the supported object types are audited.
EXECUTE	Generates IFCID 143, 144 and 145 trace records for every SQL statement that changes or reads against tables that are identified in the audit policy. IFCID 145 records SQL bind time information that includes the text and the unique ID of a SQL statement. The SQL statement ID is used in the IFCID 143 and 144 trace records to record any change or reading by the SQL statement identified in the IFCID 145 trace records. When an audit policy is defined, it specifies the tables to be audited. The same audit policy can be used to audit different tables in a schema by specifying the table names with the SQL LIKE predicate. Only tables that are defined in the following types of table spaces can be audited: • Universal table space (UTS), including UTS that contains implicitly created tables, such as XML tables • Traditional partitioned table space • Segmented table space. In addition to tables, an audit policy can also be used to audit clone tables and tables that are implicitly created for XML columns. The type of the object to be audited can be specified by using the OBJECTTYPE column. The default OBJECTTYPE column value of blank indicates that all of the supported object types are audited. These trace records are written when the table that is identified by the OBJECTSCHEMA, OBJECTNAME and OBJECTTYPE is accessed during the first operation by each unit of work. If the audit policy is started after the SQL query is started, access to the table will not be audited.
CONTEXT	Generates IFCID 23, 24, and 25 records.

Table 83. DB2 audit policy categories (continued)

Category	Description
SECMAINT	Generates IFCID 141 trace records for granting and revoking privileges or administrative authorities, IFCID 270 trace records for creating and altering trusted contexts, and IFCID 271 trace records for creating, altering, and dropping row permissions or column masks.
SYSADMIN	Generates IFCID 361 trace records when an administrative authority, in the order of installation SYSADM, installation SYSOPR, SYSOPR, SYSCTRL, or SYSADM, satisfies the required privilege for performing an operation If the Access Control Authorization Exit (ACAE) is active, only the operations that are performed by the installation SYSADM and installation SYSOPR authorities are audited.
DBADMIN	Generates IFCID 361 trace records when an administrative authority, in the order of DBMAINT, DBCTRL, DBADM, PACKADM, SQLADM, system DBADM, DATAACCESS, ACCESSCTRL, or SECADM, satisfies the required privilege for performing an operation The database name can be specified for auditing the DBADM, DBCTRL and DBMAINT authorities. If the database name is not specified, all the databases, including implicit databases, are audited. The collection ID can be specified for auditing the PACKADM authority. If the collection ID is specified, all packages in that collection are audited. If the collection ID is not specified, the packages in all collections are audited. If the Access Control Authorization Exit (ACAE) is active, only the operations that are performed by the SECADM authority are audited.

For the SYSADMIN and DBADMIN categories, DB2 checks a set of rules for each operation to determine the required authorization. In general, the rules are checked in the order of installation SYSADM, installation SYSOPR (if applicable), specific privileges required for the operation (i.e., SELECT, UPDATE), database authorities (i.e., DBMAINT, DBCTRL, DBADM), system database authorities (i.e., SQLADM, system DBADM, DATAACCESS, and ACCESSCTRL), and system authorities (i.e., SYSCTRL, SYSADM, and SECADM).

For example, to determine whether a user can alter a table, DB2 checks the required privilege in the following order:

1. Installation SYSADM
2. ALTER table privilege
3. DBADM authority on the database that the table is in
4. System DBADM
5. SYSCTRL
6. SYSADM

If the user has only the ALTER privilege on the table and if the audit policy is activated to audit the SYSADM authority, DB2 does not generate an IFCID 361 audit record on the ALTER operation. If the user also has the SYSADM authority, DB2 still does not generate an IFCID 361 record because the lowest (ALTER) privilege permits the operation.

In general, DB2 always checks the installation SYSADM and installation SYSOPR authorities prior to the lowest (ALTER) privilege. If the user has the installation SYSADM authority and the audit policy is activated to audit the installation SYSADM authority, DB2 generates an IFCID 361 record. PSPI

Creating and activating audit policies

With the SECADM authority, you can create, display, activate, or inactivate DB2 audit policies.

Procedure

To create and activate an audit policy:

1. Obtain the SECADM authority if you don't have it. Alternately, you can have the SECADM authority grant you the required privileges to create an audit policy. A user with the SYSOPR authority can activate the policy.
2. Create a new audit policy by issuing the INSERT statement.

   You need to specify a name for the new audit policy. An audit policy name is an identifier that is 1 to 128 letters or digits in length, begins with a letter.

   You also need to specify proper audit categories in the new audit policy. If you specify the OBJMAINT or EXECUTE category, you must also specify the OBJECTSCHEMA, OBJECTNAME, and OBJECTTYPE columns in the SYSIBM.SYSAUDITPOLICIES table that identify the table to be audited.

   For example, if you want to create a new AUDITADMIN1 policy to audit the SYSADM authority, you can specify SYSADMIN as the category: GUPI

   ```
   INSERT INTO SYSIBM.SYSAUDITPOLICIES(AUDITPOLICYNAME, SYSADMIN)
      VALUES('AUDITADMIN1','S');
   ```

   GUPI

   You can also use the SQL LIKE predicate to audit tables of the same characteristics. For example, you can audit all tables that start with EMP in schema TSCHEMA by issuing the following INSERT statement: GUPI

   ```
   INSERT INTO SYSIBM.SYSAUDITPOLICIES
          (AUDITPOLICYNAME, OBJECTSCHEMA, OBJECTNAME, OBJECTTYPE, EXECUTE)
        VALUES('TEST2','TSCHEMA','''E_P%''','T','C');
   ```

   GUPI
3. Activate the audit policy by issuing the **START TRACE** command with the AUDTPLCY option.

   You need to specify the AUDTPLCY option on the command to enable a specific audit policy: GUPI

   ```
   -STA TRACE (AUDIT) DEST (GTF) AUDTPLCY(AUDITADMIN1)
   ```

   GUPI

   This command starts IFCID 361 trace record to audit the use of the SYSADM authority. DB2 also starts an IFCID 362 trace record to trace the audit policy information as defined in the catalog. If multiple audit policies are specified to start at the same time, the IFCID 362 record is cut for every audit policy specified and contains the information about whether the policies successfully started or failed.

Depending on the categories in the audit policy, DB2 starts the associated audit trace records, one for each IFCID that is related to the specified audit category.

DB2 runs against the audit policies that are already defined in the SYSIBM.SYSAUDITPOLICIES table when you issue the **START TRACE** command; it ignores any change you make to a specific audit policy after you start the START TRACE command. If you want DB2 to run against the updated audit policy, you need to stop and then start the audit policy trace. In addition, you cannot specify the CLASS or IFCID option when you specify the AUDTPLCY option on the **START TRACE** command.

If you prefer the audit policy to be automatically started, you need to set the DB2START column to Y or S in the SYSIBM.SYSAUDITPOLICIES table. The audit policy will be started during DB2 startup. When you specify DB2START='S', only users (authorization IDs or roles) with the SECADM authority can stop the policy. If you set DB2START='S' to an audit policy that is already started, you must stop and restart the policy for the new setting to take effect.

You can automatically start up to 8 audit policies during DB2 startup. If you specify to automatically start multiple audit policies with different DB2START column settings, DB2 will start two traces, one for policies with DB2START = 'Y' and the other for policies with DB2START = 'S'. If you need to stop any audit policy that is automatically started, you must simultaneously stop all the policies that are assigned the same trace number.

4. If necessary, display the audit policy by issuing the **DISPLAY TRACE** command.

   You need to specify the AUDTPLCY option on the command to show the name and other details about the AUDITADMIN1 audit policy: GUPI

   ```
   -DISPLAY TRACE (AUDIT) DETAIL(2) DEST (GTF) AUDTPLCY(AUDITADMIN1)
   ```

   GUPI

   The command returns an output like the following sample: GUPI

   ```
   15.49.46                -DIS TRACE(AUDIT) DETAIL(2)
   15.49.47    STC00125    DSNW143I - CURRENT TRACE QUALIFICATIONS ARE -
   15.49.47    STC00125    DSNW152I - BEGIN TNO 04 QUALIFICATIONS:
   NO QUALIFICATIONS
   END TNO 04 QUALIFICATIONS
   15.49.47    STC00125    DSNW185I - BEGIN TNO 04 AUDIT POLICIES:
   ACTIVE AUDIT POLICY: AUDITADMIN1
   ACTIVE AUDIT POLICY: AUDITTABLE1
   END TNO 04 AUDIT POLICIES
   15.49.47    STC00125    DSNW148I - ******END OF DISPLAY TRACE QUALIFICATION
        DATA******
   15.49.47    STC00125    DSN9022I - DSNWVCM1 '-DIS TRACE' NORMAL COMPLETION
   ```

   GUPI

5. If necessary, disable the audit policy by issuing the **STOP TRACE** command.

   You need to specify the AUDTPLCY option on the command to stop all the trace activities that are started by a specific audit policy: GUPI

   ```
   -STO TRACE (AUDIT) DEST (GTF) AUDTPLCY(AUDITADMIN1)
   ```

   GUPI

   Only the **STOP TRACE** command can stop all the trace activities that are started by a specific audit policy; deleting the active policy row from the SYSIBM.SYSAUDITPOLICIES table does not stop the tracing.

Auditing the use of an administrative authority

You can create and activate an audit policy to audit how a DB2 administrative authority is used.

About this task

Suppose that you have the SECADM authority and are responsible for making sure that all security policies, including audit policies, work as designed. You want to audit the use of the SYSADM authority by user SYSADMIN1.

Procedure

To audit the use of the SYSADM authority by SYSADMIN1:

1. Create audit policy AUDITADMN1 by issuing the following INSERT statement:

   GUPI

   ```
   INSERT INTO SYSIBM.SYSAUDITPOLICIES(AUDITPOLICYNAME, SYSADMIN)
     VALUES('AUDITADMN1','S');
   ```

   GUPI

   DB2 checks to make sure that you have the required privilege to issue the INSERT statement. Upon successful verification, it inserts a row in SYSIBM.SYSAUDITPOLICIES to include the new policy.
2. Activate the audit policy by issuing the **START TRACE** command:

   GUPI

   ```
   -STA TRACE (AUDIT) DEST (GTF) AUDTPLCY(AUDITADMN1)
   ```

   GUPI

   PSPI DB2 checks to make sure that you have the required privilege to run the **START TRACE** command. Upon successful verification, it starts an IFCID 361 trace record.

   For example, if SYSADM1 issues the ALTER BUFFERPOOL command to alter the attributes for active buffer pools, DB2 records the ALTER activity in the IFCID 361 trace record. PSPI

Auditing tables without specifying the AUDIT clause

With the SECADM authority, you can set up audit policies and dynamically enable auditing of tables that do not have the AUDIT clause specified.

Procedure

To audit the activities on table EMPLOYEE.SALARY without having to specify the AUDIT clause:

1. Obtain the SECADM authority if you do not have it. Alternately, you can have the SECADM authority grant you the required privileges to create an audit policy. A user with the SYSOPR authority can activate the policy.
2. Create audit policy TABADT1 by issuing the following INSERT statement:

   GUPI

```
INSERT INTO SYSIBM.SYSAUDITPOLICIES(AUDITPOLICYNAME, OBJECTSCHEMA,
      OBJECTNAME, OBJECTTYPE, EXECUTE)
  VALUES('TABADT1','EMPLOYEE','SALARY','T','A');
```

GUPI

DB2 checks to make sure that you have the required privilege to issue the INSERT statement. Upon successful verification, it inserts a row in SYSIBM.SYSAUDITPOLICIES to include the new policy.

3. Activate the audit policy by issuing the **START TRACE** command:

GUPI

```
-STA TRACE (AUDIT) DEST (GTF) AUDTPLCY(TABADT1);
```

GUPI

PSPI DB2 checks to make sure that you have the required privilege to run the **START TRACE** command. Upon successful verification, it starts the IFCID 143, 144, and 145 trace records.

For example, if a user issues the SELECT statement to select from the EMPLOYEE.SALARY table, DB2 records the query activity in the IFCID 144 trace record. PSPI

Additional sources of audit information

In addition to the audit trace, DB2 offers other sources of audit information for you to use.

Additional DB2 traces
DB2 accounting, statistics, and performance traces are also available. You can also use DB2 Performance Expert to print reports of these traces.

Recovery log
Although the recovery log is not an all-purpose log, it can be useful for auditing. You can print information from the log by using the DSN1LOGP utility. For example, the summary report can show which table spaces have been updated within the range of the log that you scan. The REPORT utility can indicate what log information is available and where it is located.

Image copies of table spaces
Typical recovery procedures generate image copies of table spaces. You can inspect these copies, or use them with the RECOVER utility to recover a table space to a particular point in time. If you recover to a point in time, you narrow the time period during which a particular change could have been made.

z/OS console log
The z/OS console log contains messages about exceptional conditions that are encountered during DB2 operation. Inspect this log for symptoms of problems.

Determining ID privileges and authorities

As an auditor, you must be aware of the privileges and authorities that are associated with the IDs or roles in the DB2 subsystem.

About this task

You can use the following methods to determine the privileges and authorities that a specific ID or role holds:

- Query the DB2 catalog to determine which IDs or roles hold particular privileges.
- Check on individual IDs that are associated with group IDs or roles. Some authorization IDs that you encounter are probably group IDs, to which many individual IDs can be connected. To see which IDs are connected to a group, obtain a report from RACF or from whatever external security system you are using. These reports can tell you which IDs have the required privileges to use DB2 data sets and other resources.

Auditing specific IDs or roles

As with other types of DB2 traces, you can start an audit trace for a particular plan name, a primary authorization ID, a role, or all of the above.

About this task

You might consider having audit traces on at all times for IDs with the SYSADM authority because they have complete access to every table. If you have a network of DB2 subsystems, you might need to trace multiple authorization IDs if the primary authorization IDs are translated several times. For embedded SQL, the audited ID is the primary authorization ID of the plan or package owner. For dynamic SQL, the audited ID is the primary authorization ID.

You can also start an audit trace for a particular role in a trusted context by using the ROLE and XROLE filters. For example, you can issue the following command to write accounting records for threads with a ROLE = abc:

GUPI

```
-start trace(acctg) dest(smf) role(abc)
```

GUPI

You can also issue the following command to write accounting records for threads with a ROLE= abc:

GUPI

```
-start trace(acctg) dest(smf) xrole(abc)
```

GUPI

In addition, you can use the asterisk (*) wildcard character (as in "abc*") or the underscore (_) wildcard character (as in "a_c") for more flexibility in audit tracing.

Related tasks:

"Auditing specific tables"

Auditing specific tables

You can issue the CREATE TABLE or ALTER TABLE statement to audit a specific table.

About this task

GUPI

For the CREATE TABLE statement, the default audit option is NONE. For the ALTER TABLE statement, no default option exists. If you do not use the AUDIT clause in an ALTER TABLE statement, the audit option for the table is unchanged.

When CREATE TABLE statements or ALTER TABLE statements affect the audit of a table, you can audit those statements. However, the results of those audits are in audit class 3, not in class 4 or class 5. Use audit class 3 to determine whether auditing was turned off for a table for an interval of time.

If an ALTER TABLE statement turns auditing on or off for a specific table, any packages that use the table are invalidated and must be rebound. If you change the auditing status, the change does not affect packages, or dynamic SQL statements that are currently running. The change is effective only for packages or dynamic SQL statements that begin running after the ALTER TABLE statement has completed.

Procedure

To audit your table, choose any of the following options:

- To audit a table whenever the audit trace is on, include the AUDIT CHANGES option when you create the table.

```
CREATE TABLE DSN8B10.DEPT
      (DEPTNO    CHAR(3)           NOT NULL,
       DEPTNAME  VARCHAR(36)       NOT NULL,
       MGRNO     CHAR(6)                   ,
       ADMRDEPT  CHAR(3)           NOT NULL,
       LOCATION  CHAR(16)                  ,
       PRIMARY KEY (DEPTNO)                )
  IN DSN8D11A.DSN8S11D
  AUDIT CHANGES;
```

  Because this statement includes the AUDIT CHANGES option, DB2 audits the table for each access that inserts, updates, or deletes data (trace class 4).

- To also audit the table for read accesses (class 5), issue the following statement:

```
ALTER TABLE DSN8B10.DEPT
  AUDIT ALL;
```

  The statement is effective regardless of whether the table was previously chosen for auditing.

Related tasks:

"Auditing specific IDs or roles" on page 320

Preventing audits of tables

You can use the AUDIT NONE clause in the ALTER TABLE statement to prevent auditing of a table.

About this task

GUPI

For the CREATE TABLE statement, the default audit option is NONE. For the ALTER TABLE statement, no default option exists. If you do not use the AUDIT clause in an ALTER TABLE statement, the audit option for the table is unchanged.

If an ALTER TABLE statement turns auditing on or off for a specific table, any packages that use the table are invalidated and must be rebound. If you change the auditing status, the change does not affect packages, or dynamic SQL statements that are currently running. The change is effective only for packages or dynamic SQL statements that begin running after the ALTER TABLE statement has completed.

Procedure

To prevent audits of tables:

Issue the following statement:

```
ALTER TABLE DSN8B10.DEPT
  AUDIT NONE;
```

GUPI

Ensuring data accuracy and integrity

DB2 provides many controls that you can apply to data entry and update.

Some of the controls are automatic; some are optional. All of the controls prohibit certain operations and provide error or warning messages if those operations are attempted. You can use these controls as a set auditing techniques to ensure data accuracy and integrity.

The set of techniques is not intended to be exhaustive. Other combinations of techniques are possible. For example, you can use table check constraints or a view with the check option to ensure that data values are members of a certain set. Or you can set up a master table and define referential constraints. You can also enforce the controls through application programs, and restrict the INSERT and UPDATE privileges only to those programs.

Related tasks:

"Ensuring data consistency" on page 325

Ensuring data presence and uniqueness

You can ensure data presence with the NOT NULL clause and control the type of data by assigning data types and lengths to column data.

About this task

You can define columns with the NOT NULL clause to ensure that the required data is present. You can also control the type of data by assigning data types and lengths to column data. For example, you can specify that alphabetic data cannot be entered into a column with one of the numeric data types. You can also specify that the data for a DATE or TIME column must use a specific format.

You must ensure that the data in a column or a set of columns is unique. You can do so by creating a unique index on a column or set of columns.

Protecting data integrity

Triggers and table check constraints enhance the ability to control data integrity.

About this task

Triggers are very useful for defining and enforcing rules that involve different states of DB2 data. For example, a rule can prevent a salary column from more than a ten percent increase. A trigger can enforce this rule and provide the value of the salary before and after the increase for comparison.

Table check constraints designate the values that specific columns of a base table can contain. A check constraint can express simple constraints, such as a required pattern or a specific range, and rules that refer to other columns of the same table.

As an auditor, you can verify that the table definitions express the required constraints on column values as table check constraints. You can also create a view with the check option and insert or update values only through that view.

Example

GUPI Suppose that, in table T, data in column C1 must be a number between 10 and 20. Suppose also that data in column C2 is an alphanumeric code that must begin with A or B. Create view V1 with the following statement:

```
CREATE VIEW V1 AS
  SELECT * FROM T
    WHERE C1 BETWEEN 10 AND 20
    AND  (C2 LIKE 'A%' OR C2 LIKE 'B%')
  WITH CHECK OPTION;
```

Because of the CHECK OPTION, view V1 allows only data that satisfies the WHERE clause. GUPI

You cannot use the LOAD utility with a view, but that restriction does not apply to user-written exit routines; you can consider using the following types of user-written routines:

Validation routines
: You can use validation routines to validate data values. Validation routines access an entire row of data, check the current plan name, and return a nonzero code to DB2 to indicate an invalid row.

Edit routines
: Edit routines have the same access as validation routines, and can also change the row that is to be inserted. Auditors typically use edit routines

to encrypt data and to substitute codes for lengthy fields. However, edit routines can also validate data and return nonzero codes.

Field procedures
Field procedures access data that is intended for a single column; they apply only to short-string columns. However, they accept input parameters, so generalized procedures are possible. A column that is defined with a field procedure can be compared only to another column that uses the same procedure.

Tracking data changes

Triggers offer an efficient means of maintaining an audit trail. You can define a trigger to activate in response to certain DELETE, INSERT, or UPDATE statements that change data.

About this task

You can qualify a trigger by providing a list of column names when you define the trigger. The qualified trigger is activated only when one of the named columns is changed. A trigger that performs validation for changes that are made in an UPDATE operation must access column values both before and after the update. Transition variables (available only to row triggers) contain the column values of the row change that activated the trigger. The old column values and the column values from after the triggering operation are both available.

Checking for lost and incomplete transactions

You can use the database balancing technique to alert you about lost and incomplete transactions. For each set of data, database balancing determines whether the opening balance and control totals equal the closing balance and control totals of processed transactions.

About this task

DB2 has no automatic mechanism to calculate control totals and column balances and compare them with transaction counts and field totals. Therefore, to use database balancing, you must design these mechanisms into the application program.

Example

Use your application program to maintain a control table. The control table contains information to balance the control totals and field balances for update transactions against a user's view. The control table might contain these columns:

- View name
- Authorization ID
- Number of logical rows in the view (not the same as the number of physical rows in the table)
- Number of insert transactions and update transactions
- Opening balances
- Totals of insert transaction amounts and update transaction amounts
- Relevant audit trail information such as date, time, workstation ID, and job name

The program updates the transaction counts and amounts in the control table each time it completes an insert or update to the view. To maintain coordination during recovery, the program commits the work only after it updates the control table. After the application processes all transactions, the application writes a report that verifies the control total and balancing information.

Ensuring data consistency

When you control data entry, you perform only part of a complete security and auditing policy. You must also verify the results when data is accessed and changed. In addition, you need to make sure that your data is consistent.

Related concepts:

"Ensuring data accuracy and integrity" on page 322

Using referential integrity for data consistency

Referential integrity ensures that data is consistent across tables.

About this task

When you define primary and foreign keys, DB2 automatically enforces referential integrity. As a result, every value of a foreign key in a dependent table must be a value of a primary key in the appropriate parent table. However, DB2 does not enforce informational referential constraints across subsystems.

Recommendation: Use referential integrity to ensure that a column allows only specific values. Set up a master table of allowable values, and define its primary key. Define foreign keys in other tables that must have matching values in their columns. In most cases, you should use the SET NULL delete rule.

Related tasks:

"Using locks for data consistency"

"Checking data consistency" on page 326

Using locks for data consistency

Locks can ensure that data remains consistent even when multiple users try to access the same data at the same time. You can use locks to ensure that only one user is privileged to change data at a given time and that no user is privileged to access uncommitted data.

About this task

If you use repeatable read (RR), read stability (RS), or cursor stability (CS) as your isolation level, DB2 automatically controls access to data by using locks. However, if you use uncommitted read (UR) as your isolation level, users can access uncommitted data and introduce inconsistent data. As an auditor, you must know the applications that use UR isolation and that can introduce inconsistent data or create security risks.

GUPI For static SQL, you can determine the plans and packages that use UR isolation by querying the catalog.

Example: For static SQL statements, use the following query to determine which plans use UR isolation:

```
SELECT DISTINCT Y.PLNAME
   FROM SYSIBM.SYSPLAN X, SYSIBM.SYSSTMT Y
   WHERE (X.NAME = Y.PLNAME AND X.ISOLATION = 'U')
       OR Y.ISOLATION = 'U'
   ORDER BY Y.PLNAME;
```

Example: For static SQL statements, use the following query to determine which packages use UR isolation:

```
SELECT DISTINCT Y.COLLID, Y.NAME, Y.VERSION
   FROM SYSIBM.SYSPACKAGE X, SYSIBM.SYSPACKSTMT Y
   WHERE (X.LOCATION = Y.LOCATION AND
          X.LOCATION = ' '        AND
          X.COLLID   = Y.COLLID   AND
          X.NAME     = Y.NAME     AND
          X.VERSION  = Y.VERSION  AND
          X.ISOLATION = 'U')
       OR Y.ISOLATION = 'U'
   ORDER BY Y.COLLID, Y.NAME, Y.VERSION;
```

For dynamic SQL statements, turn on performance trace class 3 to determine which plans and packages use UR isolation. GUPI

Consistency between systems: When an application program writes data to both DB2 and IMS, or to both DB2 and CICS, the subsystems prevent concurrent use of data until the program declares a point of consistency.

Related tasks:

"Using referential integrity for data consistency" on page 325

"Checking data consistency"

Checking data consistency

Whenever an operation changes the contents of a data page or an index page, DB2 verifies that the modifications do not produce inconsistent data.

About this task

You can use a variety of SQL queries, commands, and utilities to check data consistency.

Related tasks:

"Using referential integrity for data consistency" on page 325

"Using locks for data consistency" on page 325

Checking data consistency with SQL queries

If you suspect that a table contains inconsistent data, you can submit an SQL query to search for a specific type of error.

About this task

Consider the view that is created by the following statement as an example of submitting an SQL query to search for an error:

```
CREATE VIEW V1 AS
  SELECT * FROM T
    WHERE C1 BETWEEN 10 AND 20
    AND  (C2 LIKE 'A%' OR C2 LIKE 'B%')
  WITH CHECK OPTION;
```

The view allows an insert or update to table T1 only if the value in column C1 is between 10 and 20 and if the value in C2 begins with A or B. To check that the control has not been bypassed, issue the following statement:

```
SELECT * FROM T1
  WHERE  NOT (C1 BETWEEN 10 AND 20
  AND  (C2 LIKE 'A
```

If the control has not been bypassed, DB2 returns no rows and thereby confirms that the contents of the view are valid. You can also use SQL statements to get information from the DB2 catalog about referential constraints that exist.

Checking data consistency with the CHECK utilities

One way to check data consistency is to use the CHECK DATA, CHECK INDEX, and CHECK LOB online utilities. You might want to use these utilities when you do a conditional restart or a point-in-time recovery or repair data.

Before you begin

Before you run CHECK DATA or CHECK LOB, you can find out all of the related tables spaces by using the REPORT utility with the TABLESPACESET option.

Procedure

To check data consistency with the CHECK utilities:

Run one of the following utilities as needed:

CHECK DATA

The CHECK DATA utility checks referential constraints (but not informational referential constraints). It determines whether each foreign key value in each row is a value of the primary key in the appropriate parent table.

The CHECK DATA utility also checks table check constraints and checks the consistency between a base table space and any associated LOB or XML table spaces. It determines whether each value in a row is within the range that was specified for that column when the table was created.

The CHECK DATA utility also performs consistency checks on XML table spaces and related NodeID indexes. It verifies the consistency of XML documents that are stored in an XML table space and validates the documents against one or more XML schemas that are specified in the XML type modifier.

CHECK INDEX

The CHECK INDEX utility checks the consistency of indexes with the data to which the indexes point. It determines whether each index pointer points to a data row with the same value as the index key. If an index key points to a LOB, the CHECK INDEX utility determines whether the index key points to the correct LOB. If an index key points to an XML, the CHECK INDEX utility determines whether the index key points to the correct XML.

CHECK LOB

The CHECK LOB utility checks the consistency of a LOB table space. It determines whether any LOBs in the LOB table space are invalid.

Related reference:

Syntax and options of the REPORT control statement (DB2 Utilities)

CHECK DATA (DB2 Utilities)

CHECK INDEX (DB2 Utilities)

CHECK LOB (DB2 Utilities)

Checking data consistency with the DISPLAY DATABASE command

If you allow a table to be loaded without enforcing referential constraints on its foreign key columns, the table might contain data that violates the constraints. In this case, DB2 places the table space that contains the table in the CHECK-pending status.

About this task

You can determine the table spaces with the CHECK-pending status by using the DISPLAY DATABASE command with the RESTRICT option. You can also use the DISPLAY DATABASE command to display table spaces with invalid LOBs.

Checking data consistency with the operation log

You can use the operation log to verify that DB2 is operated reliably and to reveal unauthorized operations and overrides. The operation log consists of an automated log of DB2 operator commands, such as those for starting and stopping the subsystem, and DB2 abends.

About this task

The operation log records the following information:

- Command or condition type
- Date and time when the command was issued
- Authorization ID that issued the command
- Database connection code

You can obtain this information from the system log (SYSLOG), the SMF data set, or the automated job scheduling system. To obtain the information, use SMF reporting, job-scheduler reporting, or a user-developed program. As a good practice, review the log report daily and keep a history file for comparison. Because abnormal DB2 termination can indicate integrity problems, implement an immediate notification procedure to alert the appropriate personnel (DBA, systems supervisor, and so on) of abnormal DB2 terminations.

Checking data consistency with internal integrity reports

You can generate internal integrity reports for application programs and utilities.

About this task

For application programs, you can record any DB2 return codes that indicate possible data integrity problems, such as inconsistency between index and table information, physical errors on database disk, and so on. All programs must check the SQLCODE or the SQLSTATE for the return code that is issued after an SQL statement is run. DB2 records, on SMF, the occurrence (but not the cause) of physical disk errors and application program abends. The program can retrieve and report this information; the system log (SYSLOG) and the DB2 job output also

have this information. However, in some cases, only the program can provide enough detail to identify the exact nature of problem.

You can incorporate these integrity reports into application programs, or you can use them separately as part of an interface. The integrity report records the incident in a history file and writes a message to the operator's console, a database administrator's TSO terminal, or a dedicated printer for certain codes. The recorded information includes the following:

- Date
- Time
- Authorization ID
- Terminal ID or job name
- Application
- Affected view or affected table
- Error code
- Error description

When a DB2 utility reorganizes or reconstructs data in the database, it produces statistics to verify record counts and to report errors. The LOAD and REORG utilities produce data record counts and index counts to verify that no records were lost. In addition to that, keep a history log of any DB2 utility that updates data, particularly REPAIR. Regularly produce and review these reports, which you can obtain through SMF customized reporting or a user-developed program.

Information resources for DB2 for z/OS and related products

Information about DB2 for z/OS and products that you might use in conjunction with DB2 for z/OS is available in online information centers or on library websites.

Obtaining DB2 for z/OS publications

The current DB2 for z/OS publications are available from the following website:

http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2z11.doc/src/alltoc/db2z_lib.htm

Links to the information center version and the PDF version of each publication are provided.

DB2 for z/OS publications are also available for download from the IBM Publications Center (http://www.ibm.com/shop/publications/order).

In addition, books for DB2 for z/OS are available on a CD-ROM that is included with your product shipment:

- DB2 11 for z/OS Licensed Library Collection, LK5T-8882, in English. The CD-ROM contains the collection of books for DB2 11 for z/OS in PDF format. Periodically, IBM refreshes the books on subsequent editions of this CD-ROM.

Installable information center

You can download or order an installable version of the Information Management Software for z/OS Solutions Information Center, which includes information about DB2 for z/OS, QMF, IMS, and many DB2 and IMS Tools products. You can install this information center on a local system or on an intranet server. For more information, see http://pic.dhe.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.dzic.doc/installabledzic.htm.

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Programming interface information

This information is intended to help you to plan for and administer DB2 11 for z/OS. This information also documents General-use Programming Interface and Associated Guidance Information and Product-sensitive Programming Interface and Associated Guidance Information provided by DB2 11 for z/OS.

General-use Programming Interface and Associated Guidance Information

General-use Programming Interfaces allow the customer to write programs that obtain the services of DB2 11 for z/OS.

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Glossary

The glossary is available in the Information Management Software for z/OS Solutions Information Center.

See the Glossary topic for definitions of DB2 for z/OS terms.

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Product Number: 5615-DB2
5697-P43

Printed in USA

SC19-4061-00

Spine information:

DB2 11 for z/OS

Managing Security