



IBM i  
Database  
Database administration

*7.1*







IBM i

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**Note**

Before using this information and the product it supports, read the information in "Notices," on page 17.

This edition applies to IBM i 7.1 (product number 5770-SS1) and to all subsequent releases and modifications until otherwise indicated in new editions. This version does not run on all reduced instruction set computer (RISC) models nor does it run on CISC models.

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## Database administration

DB2® for i provides database administration, backup and recovery, query, and security functions.

You can also explore other database information using the main navigation tree or Database information finder.

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### What's new for IBM i 7.1



Read about new or significantly changed information for the Database administration topic collection.

#### Authority Options for SQL Analysis and Tuning

- | The security officer has additional capability to authorize access to database analysis tools and the SQL Plan Cache with the “Authority Options for SQL Analysis and Tuning” on page 10

#### How to see what's new or changed

To help you see where technical changes have been made, the information center uses:

- The  image to mark where new or changed information begins.
- The  image to mark where new or changed information ends.

In PDF files, you might see revision bars (|) in the left margin of new and changed information.

To find other information about what's new or changed this release, see the Memo to users.

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### PDF file for Database administration

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## Database administration

DB2 for i provides various methods for setting up and managing databases.

#### Related concepts:

Journal management

## Accessing data through client interfaces

You can access DB2 for i data through client interfaces on the server, such as the Java Database Connectivity (JDBC) driver, the Open Database Connectivity (ODBC) driver, IBM® i Portable Application Solutions Environment (IBM i PASE), OLE DB Provider, .Net Provider, Net.Data®, or Distributed Relational Database Architecture™ (DRDA).

### Accessing data with Java

You can access DB2 for i data in your Java™ programs by using the Java Database Connectivity (JDBC) driver that is included with the IBM Developer Kit for Java licensed program.

The driver allows you to perform the following tasks:

- Access database files.
- Access JDBC database functions with embedded Structured Query Language (SQL) for Java.
- Run SQL statements and process results.

#### Related concepts:

Accessing your System i5 database with the IBM Developer Kit for Java JDBC driver

### Accessing data with Domino

You can use IBM Lotus® Domino® for i5/OS to integrate data from DB2 for i databases and Domino databases in both directions.

To take advantage of this integration, you need to understand and manage how authorizations work between the two types of databases.

#### Related concepts:

Lotus Domino for i5/OS

### Accessing data with ODBC

You use the IBM i Access for Windows Open Database Connectivity (ODBC) driver to enable your ODBC client applications to effectively share data with each other and with the server.

#### Related concepts:

ODBC administration

### Accessing data with IBM i PASE

IBM i Portable Application Solutions Environment (IBM i PASE) is an integrated runtime environment for AIX®, UNIX, or other applications that are running on the IBM i operating system. IBM i PASE supports the DB2 for i call level interface (CLI).

#### Related concepts:

Database

### Accessing data with IBM i Access for Windows OLE DB Provider

The IBM i Access for Windows OLE DB Provider, along with the Programmer's Toolkit, facilitates the System i® client/server application development from the Microsoft Windows client PC.

The IBM i Access for Windows OLE DB Provider gives programmers record-level access interfaces to DB2 for i database files. In addition, it provides support for SQL, data queues, programs, and commands.

#### Related reference:

System i Access for Windows OLE DB Provider

### Accessing data with IBM i Access for Windows .Net Provider

The IBM i Access for Windows .Net Provider access.

The IBM i Access for Windows .Net Provider allows access to DB2 for IBM i through the Microsoft ADO.NET interface.



## Accessing data with Net.Data

Net.Data is an application that runs on a server. You can use Net.Data to easily create dynamic Web documents that are called Web macros. Web macros that are created for Net.Data have the simplicity of HTML with the functionality of CGI-BIN applications.

Net.Data makes it easy to add live data to static Web pages. Live data includes information that is stored in databases, files, applications, and system services.

### Related concepts:

Net.Data applications for the HTTP Server

## Accessing data through a Linux partition

IBM and a variety of Linux distributors have cooperated to integrate the Linux operating system with the reliability of the System i architecture.

Linux brings a new generation of Web-based applications to the System i product. IBM has changed the Linux PowerPC® kernel to run in a secondary logical partition and contributed the kernel back to the Linux community.

### Related concepts:

Linux in a logical partition

## Accessing data using Distributed Relational Database Architecture (DRDA)

A *distributed relational database* consists of a set of SQL objects that are spread across interconnected computer systems. Each relational database has a relational database manager to manage the tables in its environment.

The database managers communicate and cooperate with each other in a way that allows a given database manager access to run SQL statements on a relational database on another system.

### Related reference:

Distributed relational database function and SQL

## Altering and managing database objects

DB2 for i provides both Structured Query Language (SQL) and system methods for altering and managing database objects.

Several methods are available for working with database objects. You can use the System i Navigator interface, SQL methods, or the traditional system interface. The following table shows the available options for each task. Click the appropriate X for more information about performing the task.

The System i Navigator tasks are documented in the online help.

Task	System i Navigator	SQL	Traditional system interface
Adding a column to a table	X	X	X
Adding or altering an identity column	X	X	
Altering a sequence	X	X	
Changing a table (file) definition	X	X	X
Changing the schema (library) list	X		X
Copying a table (file)	X		X
Copying column definitions	X		

Task	System i Navigator	SQL	Traditional system interface
Displaying contents of tables and views (files)	X	X	X
Displaying locked rows (records)	X		X
Displaying table (file) attributes (catalog)	X	X	X
Dropping database objects	X	X	X
Editing table (file) data	X	X	X
Moving a table (file)	X		X
Reorganizing a table (physical file member)	X		X

**Related concepts:**

System i Navigator database tasks

**Related reference:**

Terminology: SQL versus traditional file access

## Creating database objects

The first step in developing your database is to create the objects that hold your data. You can create tables, views, and indexes with SQL. You can also create physical and logical files using the traditional system interface.

You can create database objects using System i Navigator, SQL, or the traditional system interface. The following table shows the available options for each task. Click the appropriate X for more information about performing the task.

The System i Navigator tasks are documented in the online help.

Task	System i Navigator	SQL	Traditional system interface
Creating a map of database object relationships	X		
Creating an alias	X	X	X
Creating an index or access path	X	X	X
Creating an object using Run SQL Scripts	X		
Creating a package	X	X	X
Creating a schema (library)	X	X	
Creating a sequence	X	X	
Creating a stored procedure	X	X	
Creating a table (physical file)	X	X	X
Creating a user-defined function	X	X	
Creating a user-defined type	X	X	

Task	System i Navigator	SQL	Traditional system interface
Creating a view (logical file)	X	X	X
Generating SQL for database objects	X		

**Related concepts:**

System i Navigator database tasks

**Related reference:**

Terminology: SQL versus traditional file access

## Ensuring data integrity

DB2 for i provides several integrity measures, such as constraints, trigger programs, and commitment control.

Constraints, triggers, and commitment control can protect your database against inadvertent insertions, deletions, and updates. Constraints basically govern how data values can change, while triggers are automatic actions that start, or *trigger*, an event, such as an update of a specific table.

**Related concepts:**

Commitment control

“Working with triggers and constraints” on page 6

You can use triggers or constraints to manage data in your database tables.

## Importing and exporting data between systems

*Importing data* is the process of retrieving data from external sources, while *exporting data* is the process of extracting data from DB2 for i and copying data to another system.

Importing data into DB2 for i can be a one-time event or it can be an ongoing task, like weekly updates for business reporting purposes. These types of data move operations are typically accomplished through import, export, or load functions.

**Related concepts:**

Copying a file

Copying files

Copying source file data

Moving a file

**Related tasks:**

Importing and exporting data

Loading and unloading data from systems other than System i

## Working with multiple databases

The system provides a system database (identified as *SYSBAS*) and the ability to work with one or more user databases.

User databases are implemented through the use of independent disk pools, which are set up in the disk management function of System i Navigator. After an independent disk pool is set up, it appears as another database in the Databases folder of System i Navigator.

When you expand a system in System i Navigator and then expand **Databases**, a list of databases that you can work with is shown. To establish a connection to a database, expand the database that you want to work with.

**Related concepts:**

Disk management

## Working with triggers and constraints

You can use triggers or constraints to manage data in your database tables.

A *trigger* is a type of stored procedure program that is automatically called whenever a specified action is performed on a specific table. Triggers are useful for keeping audit trails, detecting exceptional conditions, maintaining relationships in the database, and running applications and operations that coincide with the change operation.

A *constraint* is a restriction or limitation that you place on your database. Constraints are implemented at the table level. You can use constraints to create referential integrity in your database.

You can work with triggers and constraints using System i Navigator, SQL, or the traditional system interface. The following table shows the available options for each task. Click the appropriate **X** for more information about performing the task.

The System i Navigator tasks are also documented in the online help.

Task	System i Navigator	SQL	Traditional system interface
Adding an external trigger	X		X
Adding an SQL trigger	X	X	
Creating a check constraint	X	X	X
Creating a key constraint	X	X	X
Creating a referential constraint	X	X	X
Enabling and disabling a referential constraint	X		X
Enabling and disabling a trigger	X		X
Managing check pending constraints	X		
Removing a check constraint	X	X	X
Removing a key constraint	X	X	X
Removing a referential constraint	X	X	X
Removing a trigger	X	X	X
Writing an external trigger program	X		X
Writing an SQL trigger program	X	X	

**Related concepts:**

System i Navigator database tasks

## Writing DB2 programs

DB2 for i provides various methods for writing applications that access or update data.

You can write embedded SQL programs, external functions, external procedures, DB2 for i CLI applications, and trigger programs.

### Related concepts:

Embedded SQL programming

Writing a DB2 for i5/OS CLI application

### Related tasks:

Creating trigger programs

### Related reference:

Defining an external procedure

Writing UDFs as external functions

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## Database backup and recovery

Saving your data can be time-consuming and requires discipline. However, it is crucial that you back up your data because you never know when you might need to recover it.

### Related concepts:

Backup and recovery

Journal management

Recovering and restoring your database

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## Distributed database administration

With DB2 for i, you can work with databases that are distributed across several systems.

### Related concepts:

Distributed database programming

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## Queries and reports

You can use SQL, the Open Query File (OPNQRYF) command, the Query (QQQRY) API, Open Database Connectivity (ODBC), or the IBM Query for i licensed program to create and run queries.

One of the most common tasks that you perform with your database is to retrieve information. The system provides several methods to create and run queries and reports.

You can use an SQL statement to retrieve information. This SQL statement is called a *query*. The query searches the tables stored in your database to find the answer to the question that you posed with your SQL statement. The answer is expressed as a set of rows, which is referred to as the result set. After a query has been run, you can also create a report to display the data provided in your result set.

In addition to using SQL, you can use other functions and products to create and run queries and reports. See the following information for details.

- IBM DB2 Web Query for System i overview

- Query for IBM i 

- Query Management Programming 

- Query Manager Use 

In addition, you can build SELECT, INSERT, UPDATE, and DELETE SQL statements in the SQL Assist window of System i Navigator.

**Related concepts:**

SQL programming

**Related tasks:**

Building SQL statements with SQL Assist

**Related reference:**

Open Query File (OPNQRYF) command

Query (QQQRY) API

## BINARY, VARBINARY, HEX, and LENGTH functions for Query

This topic describes the BINARY, VARBINARY, HEX, and LENGTH built-in functions that are supported by the IBM Query for i licensed program.

**Note:** In addition to the BINARY, VARBINARY, HEX, and LENGTH functions, the Query for IBM i licensed program provides the following support:

- Support for BINARY, VARBINARY, BLOB, CLOB, DBCLOB, and ROWID data types.
- Support for larger numeric and decimal numbers and for large numeric literals.
- The VARCHAR function supports conversion from CLOB to VARCHAR.
- The VARGRAPHIC function supports conversion from CLOB to DBCS graphic, CLOB to UCS2 graphic, DBCLOB to DBCS graphic, and DBCLOB to UCS2 graphic.

A binary constant is used for comparing a literal with a binary field (BINARY, VARBINARY, or BLOB). Binary constants are represented with an X followed by a sequence of characters that starts and ends with a string delimiter. The characters between the string delimiters must be an even number of hexadecimal digits. A hexadecimal digit is a digit or any of the letters A through F (uppercase and lowercase), as shown in the following example:

Field	Test	Value
binarycol	eq	X'12AF'

### BINARY built-in function

The BINARY function returns a BINARY representation of a string of any type. The form is:

►►—BINARY—(—*string-expression*—, *integer*—)——►►

The result of the function is a fixed-length binary string. If the first argument can be null, the result can be null; if the first argument is null, the result is the null value.

The first argument must be a string-expression whose value must be a built-in character string, graphic string, binary string, or row ID data type.

The second argument specifies the length attribute for the resulting binary string. The value must be between 1 and 32766. If the second argument is not specified, the following rules apply:

- If the string-expression is the empty string constant, the length attribute of the result is 1.
- Otherwise, the length attribute of the result is the same as the length attribute of the first argument, unless the argument is a graphic string. In this case, the length attribute of the result is twice the length attribute of the argument.

The actual length is the same as the length attribute of the result. If the length of the string-expression is less than the length of the result, the result is padded with hexadecimal zeros up to the length of the result. If the length of the string-expression is greater than the length attribute of the result, truncation is performed.

## VARBINARY built-in function

The VARBINARY function returns a VARBINARY representation of a string of any type. The form is:

►►—VARBINARY—(—*string-expression*—, *integer*)—►►

The result of the function is VARBINARY. If the first argument can be null, the result can be null; if the first argument is null, the result is the null value.

The first argument is a string-expression whose value can be a character string, graphic string, binary string, or row ID.

The second argument specifies the length attribute for the resulting binary string. The value must be between 1 and 32740 (32739 if nullable). If the second argument is not specified, the following rules apply:

- If the string-expression is the empty string constant, the length attribute of the result is 1.
- Otherwise, the length attribute of the result is the same as the length attribute of the first argument, unless the argument is a graphic string. In this case, the length attribute of the result is twice the length attribute of the argument.

The actual length is the same as the length attribute of the result. If the length of the string-expression is less than the length of the result, the result is padded with hexadecimal zeros up to the length of the result. If the length of the string-expression is greater than the length attribute of the result, truncation is performed.

## HEX built-in function

The HEX function returns a hexadecimal representation of a value. The form is:

►►—HEX—(—*expression*—)►►

The argument can be of any built-in data type. The result of the function is a character string. If the argument can be null, the result can be null; if the argument is null, the result is the null value.

The result is a string of hexadecimal digits. The first two digits represent the first byte of the argument, the next two digits represent the second byte of the argument, and so forth. If the argument is a datetime value, the result is the hexadecimal representation of the internal form of the argument.

The length attribute of the result is twice the storage length attribute of the argument. The length attribute of the result cannot be greater than 32766 for fixed-length results or greater than 32740 for varying-length results. If the argument is a varying-length string, the result is a varying-length string. Otherwise, the result is a fixed-length string.

The coded character set identifier (CCSID) of the string is the default single-byte character set (CCSID) on the current system.

## LENGTH built-in function

The LENGTH function returns the length of a value. The form is:

►►—LENGTH—(—*expression*—)—————►►

The argument must be an expression that returns a value of any built-in data type. The result of the function is a large integer. If the argument can be null, the result can be null; if the argument is null, the result is the null value.

The result is the length of the argument. The length of strings includes blanks. The length of a varying-length string is the actual length, not the length attribute. The length of a graphic string is the number of double-byte characters (the number of bytes divided by 2). The length of all other values is the number of bytes used to represent the value:

- 2 for small integer
- 4 for large integer
- 8 for big integer
- The integral part of  $(p/2)+1$  for packed decimal numbers with precision  $p$
- $p$  for zoned decimal numbers with precision  $p$
- 4 for single-precision float
- 8 for double-precision float
- The length of the string for strings
- 3 for time
- 4 for date
- 10 for timestamp
- 26 for row ID

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## Security

Authorizing users to data at the system and data levels allows you to control access to your database.

Securing your database requires you to establish ownership and public authority to objects and specific authority to your applications.

### Related concepts:

DRDA server access control exit programs

Granting file and data authority

Limiting access to specific fields in a database file

Security

Specifying public authority

Using database file capabilities to control I/O operations

Using logical files to secure data

## | Authority Options for SQL Analysis and Tuning

| This topic describes the authority options for SQL analysis and tuning.

| DB2 for i has a rich set of commands, stored procedures, APIs and tools for analysis and tuning of the performance aspects of database applications. Previously, a system security officer would need to grant \*JOBCTL user special authority to enable database analysts and database administrators to use the database tools. Since \*JOBCTL authority allows a user to change many system critical settings that are



| unrelated to database activity, it was not an easy decision for security officers to grant this authority. In  
| some cases, it was an easy decision and \*JOBCTL was not granted to database analysts, thus prohibiting  
| the use of the full set of database tools.

| Note: For more information about setting overrides for the QAQQINI file refer to the following link:  
| QAQQINI file override support.

| Now the security officer has additional capability to authorize access to database analysis tools and the  
| SQL Plan Cache. DB2 for i which takes advantage of the function usage capability available in the  
| operating system. A new function usage group called QIBM\_DB has been created with two function IDs  
| in the QIBM\_DB group:

- | 1. QIBM\_DB\_SQLADM (IBM i Database Administrator tasks)
- | 2. QIBM\_DB\_SYSMON (IBM i Database Information tasks)

| The security officer now has flexibility to grant authorities by either; granting \*JOBCTL special authority  
| or authorizing a user or group to the IBM i Database Administrator Function through Application  
| Administration in System i Navigator of IBM Navigator for i. The Change Function Usage  
| (CHGFCNUSG) command, with a function ID of QIBM\_DB\_SQLADM, can also be used to change the list  
| of users that are allowed to perform Database Administration operations. The function usage controls  
| allow groups or specific users to be allowed or denied authority. The CHGFCNUSG command also  
| provides a parameter which can be used to grant function usage authority to any user that has \*ALLOBJ  
| user special authority. (e.g. ALLOBJAUT(\*USED))

| The **Database Administrator** function is needed whenever a user is analyzing and viewing SQL  
| performance data. Some of the more common functions are displaying statements from the SQL Plan  
| Cache, analyzing SQL Performance Monitors and SQL Plan Cache Snapshots, and displaying the SQL  
| details of a job other than your own.

| The database administrator function usage is an alternative to granting \*JOBCTL, but it does not replace  
| the requirement of having the correct object authority. To enable database administrator tasks which are  
| unrelated to performance analysis, refer to the specific task for details on the authorization requirements.  
| For example, to allow an administrator to reorganize a table, they must have object authorities granted,  
| which are not covered by QIBM\_DB\_SQLADM.

| In addition to QIBM\_DB\_SQLADM, the Change Function Usage (CHGFCNUSG) command, with a  
| function ID of QIBM\_DB\_SYSMON, can also be used to change the list of users that are allowed to  
| perform Database Information operations.

| The **Database Information** function provides much less authority than Database Administrator. The  
| primary use is to allow a user to examine high-level database properties. For example, a user that does  
| not have \*JOBCTL or QIBM\_DB\_SQLADM, could be allowed to view the SQL Plan Cache properties if  
| granted authority to QIBM\_DB\_SYSMON.

| Note: For more information about using Application Administration refer to the following link:  
| [https://www.ibm.com/support/knowledgecenter/ssw\\_ibm\\_i\\_61/rzahg/icmain.htm](https://www.ibm.com/support/knowledgecenter/ssw_ibm_i_61/rzahg/icmain.htm) .

| To work with QIBM\_DB database group function usage from System i Navigator, follow these steps:

- | 1. Launch Application Administration as shown in figure 1.
- | 2. Expand the 'IBM i' and 'Database' folders under the Host Applications tab as shown in figure 2.
- | 3. Customize the Database Administrator (QIBM\_DB\_SQLADM) function usage as shown in figure 3.

| In this example, the security officer determined that they wanted to set up a group called Dbagroup that  
| would contain all the users that they wanted to give this level of authority. And they explicitly wanted to  
| deny access to Slfuser. Now the security officer has one convenient and easily monitored place to view  
| and authorize users to these functions.

Figure 1. Launch Application Administration.

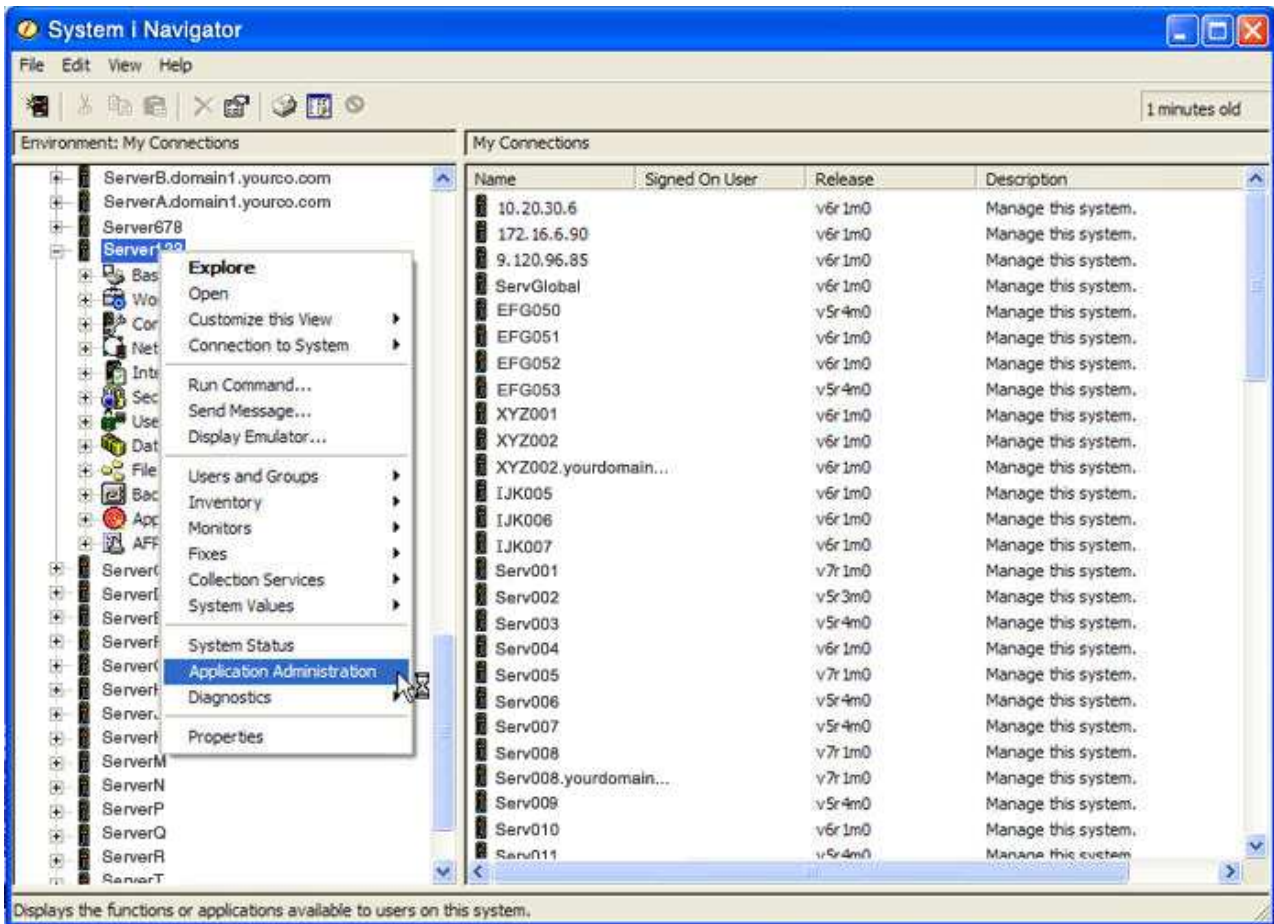


Figure 2. Expand the Database group

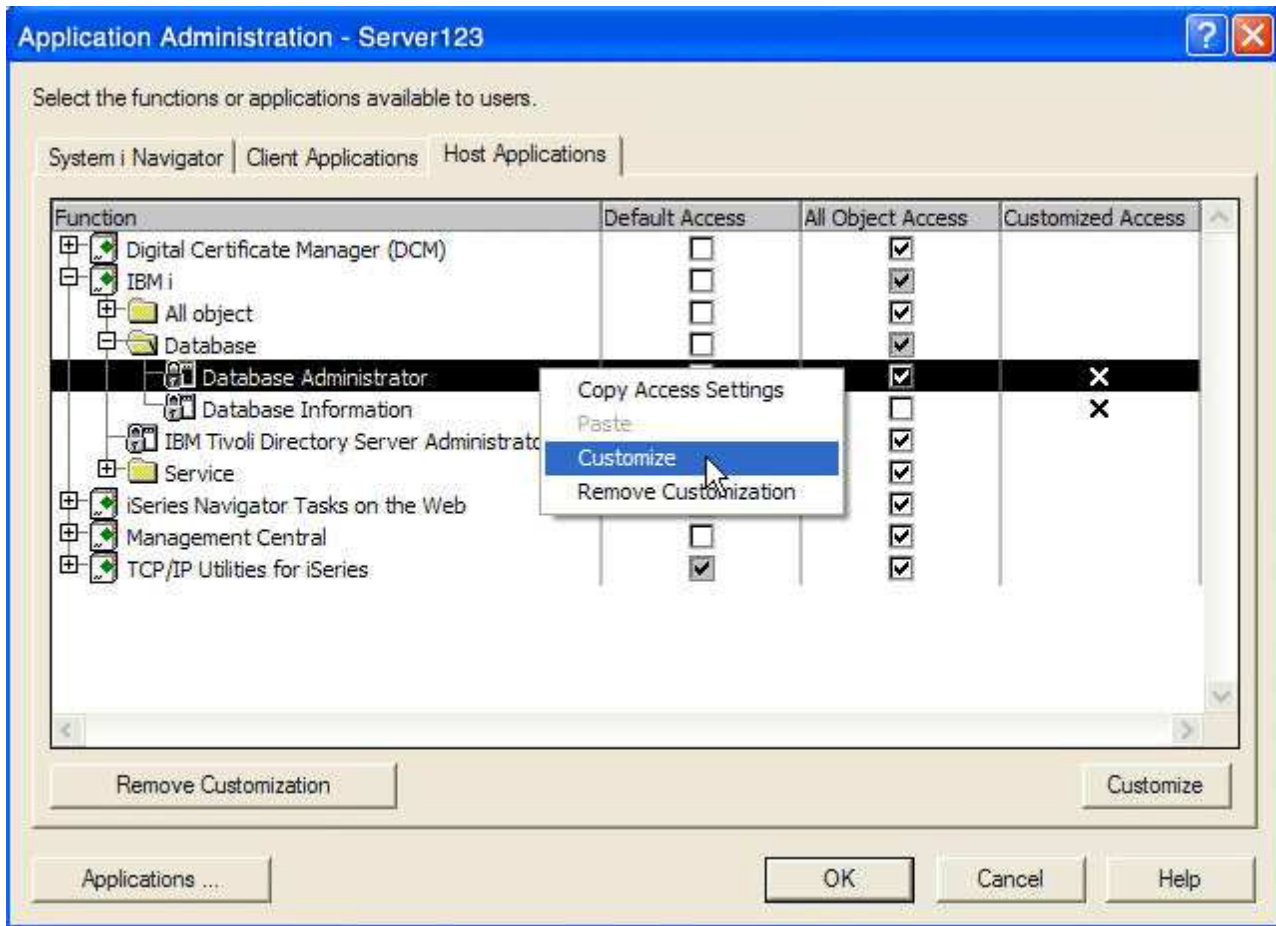
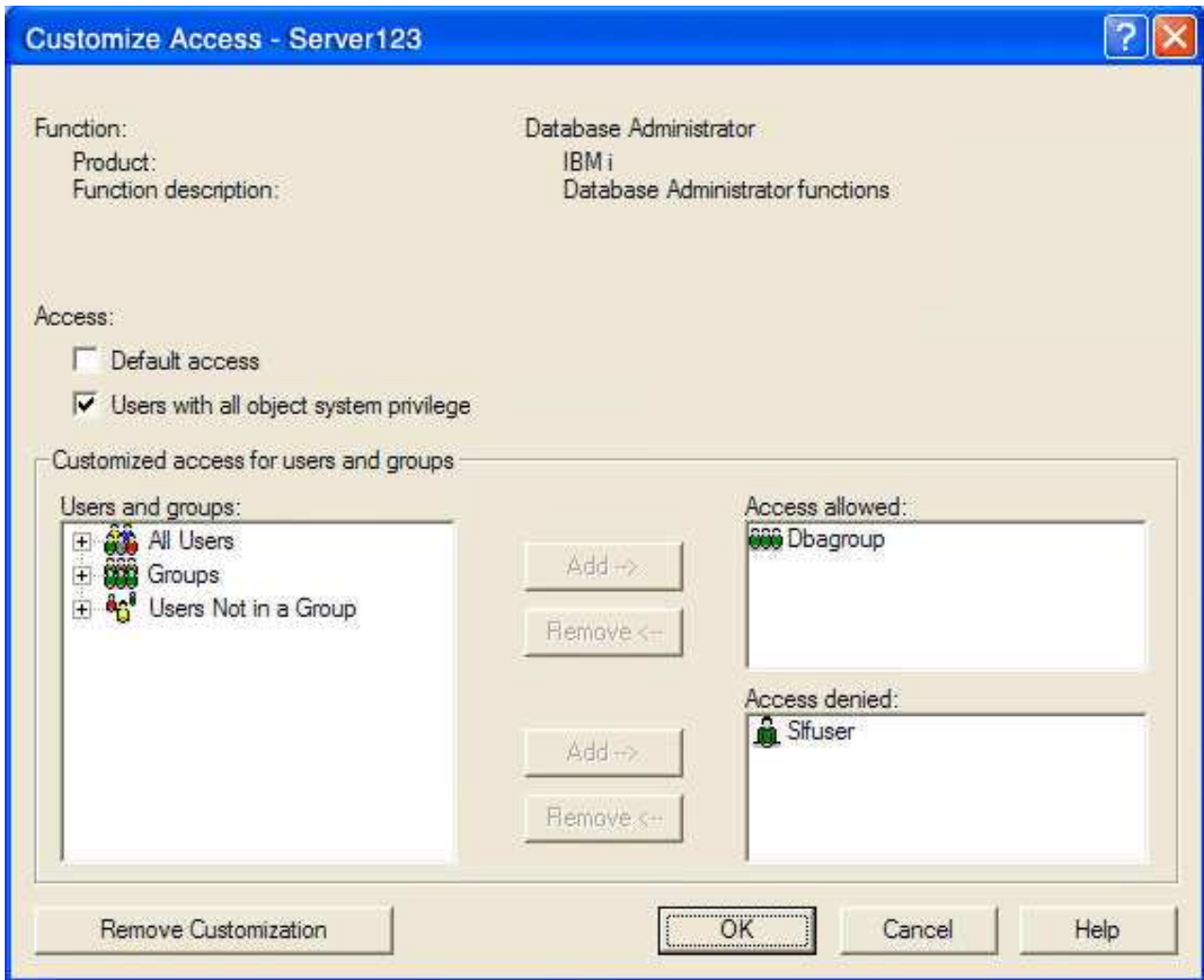


Figure 3. Change the QIBM\_DB\_SQLADM function usage settings



Note: The Security Reference has more information about the function usage commands:  
[https://www.ibm.com/support/knowledgecenter/ssw\\_ibm\\_i\\_61/rzahg/icmain.htm](https://www.ibm.com/support/knowledgecenter/ssw_ibm_i_61/rzahg/icmain.htm).

Table 1 describes some of the authorization changes related to DB2 commands, Stored Procedures, and APIs.

Table 1. Authorization requirements for Database performance and analysis

User Action	*JOBCTL	QIBM_DB_SQLADM	QIBM_DB_SYSMON	No Authority
SET CURRENT DEGREE (SQL statement)	Allowed	Allowed	Not Allowed	Not Allowed
CHGQRYA command targeting a different user's job	Allowed	Allowed	Not Allowed	Not Allowed
STRDBMON or ENDDBMON commands targeting a different user's job	Allowed	Allowed	Not Allowed	Not Allowed
STRDBMON or ENDDBMON commands targeting a job that matches the current user	Allowed	Allowed	Allowed	Allowed
QUSRJOBI() API format 900 or System i Navigator's SQL Details for Job	Allowed	Allowed	Allowed	Not Allowed

Table 1. Authorization requirements for Database performance and analysis (continued)

User Action	*JOBCTL	QIBM_DB_SQLADM	QIBM_DB_SYSMON	No Authority
DUMP PLAN CACHE PROPERTIES procedure	Allowed	Allowed	Allowed	Not Allowed
Visual Explain within Run SQL Scripts	Allowed	Allowed	Allowed	Allowed
Visual Explain outside of Run SQL Scripts	Allowed	Allowed	Not Allowed	Not Allowed
ANALYZE PLAN CACHE procedure	Allowed	Allowed	Not Allowed	Not Allowed
DUMP PLAN CACHE procedure	Allowed	Allowed	Not Allowed	Not Allowed
MODIFY PLAN CACHE procedure	Allowed	Allowed	Not Allowed	Not Allowed
MODIFY PLAN CACHE PROPERTIES procedure (currently does not check authority)	Allowed	Allowed	Not Allowed	Not Allowed
CHANGE PLAN CACHE SIZE procedure (currently does not check authority)	Allowed	Allowed	Not Allowed	Not Allowed
START PLAN CACHE EVENT MONITOR procedure	Allowed	Allowed	Not Allowed	Not Allowed
END PLAN CACHE EVENT MONITOR procedure	Allowed	Allowed	Not Allowed	Not Allowed
END ALL PLAN CACHE EVENT MONITORS procedure	Allowed	Allowed	Not Allowed	Not Allowed



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## Appendix. Notices

This information was developed for products and services offered in the U.S.A.

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