SAP HANA Database – Administration Guide

▪ SAP HANA Appliance Software SPS04

Target Audience

- Consultants
- Administrators
- SAP Hardware Partners
- Others

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Contents

Introduction

This document describes the administration of the SAP HANA® database using the Administration Console of the SAP HANA® studio.

SAP HANA and SAP HANA Database Guides

For more information about SAP HANA and the SAP HANA database landscape, installation and administration, see the resources listed in the following table:

Topic	Guide/Tool	Quick Link
SAP HANA landscape, deployment and installation	*SAP HANA Knowledge Center on SAP Service Marketplace*	https://service.sap.com/hana ➔ SAP HANA Master Guide ➔ SAP HANA Installation Guides
SAP HANA administration and security	*SAP HANA Knowledge Center on SAP Help Portal*	http://help.sap.com/hana_appliance ➔ SAP HANA Technical Operations Manual ➔ SAP HANA Database – Security Guide

What is the SAP HANA Database?

The SAP HANA database is a relational database that has been optimized to leverage state-of-the-art hardware. It provides all of the SQL features of a standard relational database along with a feature-rich set of analytical capabilities and an SAP-specific programming language for stored procedures called SQLScript. With these facilities, the SAP HANA database is capable of embedding application logic within the database itself. This allows complex queries to be executed directly inside the database, thus reducing the requirement of data transfer to and from the database. This enables SAP HANA-based applications to process vast amounts of data whilst operating in a responsive, real-time manner.

From the administrator's perspective, the SAP HANA database is conceptually about leveraging modern hardware system landscapes to increase database performance and reliability. Traditionally, databases have been designed to operate in a situation where there are limited memory and CPU resources. Currently however, servers can provide in excess of 1TB of memory and up to 80 CPU cores on a single system.

To better understand how the SAP HANA database improves on traditional database concepts, in the next section we compare the two approaches to database systems.

Impact of Modern Hardware on Database System Architecture

Historically, database systems were designed to perform well on computer systems with limited RAM. This had the effect that slow disk I/O was the main bottleneck in data throughput. Consequently, the architecture of these systems was designed with a focus on optimizing disk access, for example, by minimizing the number of disk blocks (or pages) to be read into main memory when processing a query.

Computer architecture has changed in recent years. Now, multi-core CPUs (multiple CPUs on one chip or in one package) are standard, with fast communication between processor cores enabling

parallel processing. Main memory is no longer a limited resource. Modern servers can have 1 TB of system memory and this allows complete databases to be held in RAM. Currently, server processors have up to 80 cores, and 128 cores will soon be available. With the increasing number of cores, CPUs are able to process increased data per time interval. This shifts the performance bottleneck from disk I/O to the data transfer between CPU cache and main memory.

Hardware Architecture: Current and Past Performance Bottlenecks
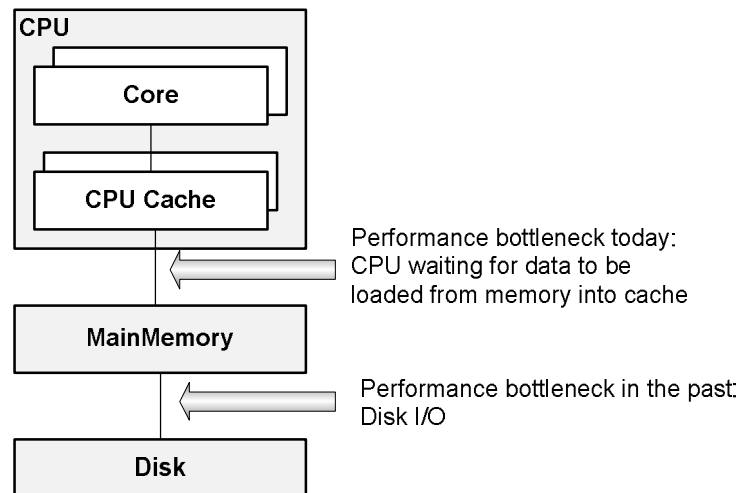
Modern Database for Modern Hardware

It is therefore apparent that traditional databases do not always make the most efficient use of current hardware. So, what are the ideal characteristics of a database system running on modern hardware?

In-memory database

All relevant data should be available in main memory, which avoids the performance penalty of disk I/O. To use the advantages of in-memory computation, a cache-conscious implementation of data structures and algorithms is necessary.

Support for parallel execution

Higher CPU execution speeds are currently achieved by adding more cores to a CPU package. Multiple CPUs call for new parallel algorithms to be used in databases in order to fully utilize the computing resources available. SAP HANA addresses these requirements by storing all of its data in RAM and also enabling queries to be split and optimized across multiple CPU cores and multiple SAP HANA servers.

Disk storage

Disk storage is still required to ensure the ability to restart in case of power failure and for permanent persistency. However, this is not a performance issue as the required disk write operations can be performed asynchronously as a background task. SAP HANA database tries to optimize the performance from the different storage types, like main memory, solid state disks (SSD), and traditional mechanical hard drives (HDD).

About the SAP HANA Studio

The SAP HANA studio is a collection of tools that allows database administrators and developers to manage data and monitor the SAP HANA database. The SAP HANA studio runs on the Eclipse platform, which presents these tools in the form of "perspectives".

This guide focuses on the Administration Console perspective, which targets the SAP HANA database administrator. Additional perspectives are the Modeler and Lifecycle Management perspectives, which are covered in other documents.

For more information about the installation of the SAP HANA studio, see SAP HANA Database - Studio Installation Guide on SAP Help Portal at http://help.sap.com/hana_appliance.

For more information about the Eclipse platform, see http://www.eclipse.org.

Updating the SAP HANA Studio

Prerequisites

You have specified the site from which the SAP HANA studio is to download updates.
For more information about how to configure the source for updates, see SAP HANA Database - Studio Installation Guide on SAP Help Portal at http://help.sap.com/hana_appliance.

Procedure

1. From the main menu, choose *Window → Preferences → Install/Update → Available Software Sites.*
2. Choose *Add…* and specify the update server settings:
   - Name: Optional entry, name of the location of the update repository
   - Location: Update repository location (for example
     ```
     http://<host_name>:<port_number>/tools/hdb.studio.update
     ```
     or `file:////update_server/hdbstudio/repository/`)

Updating the SAP HANA Studio Manually

1. From the main menu, choose *Help → Check for Updates.*
   The system checks if there is an update available.
2. If an update is available, follow the onscreen instructions.

Configuring Automatic Updates of the SAP HANA Studio

1. From the main menu, choose *Window → Preferences → Install/Update → Automatic Updates.*
2. Specify your update settings.

You are automatically notified if an update is available in line with your settings.

SAP HANA Studio Screen Areas

The SAP HANA studio consists of several screen areas, views and editors, which you can show and hide as necessary. The following figure shows the screen areas of the SAP HANA studio with the Administration Console perspective open.

SAP HANA Studio Screen Areas
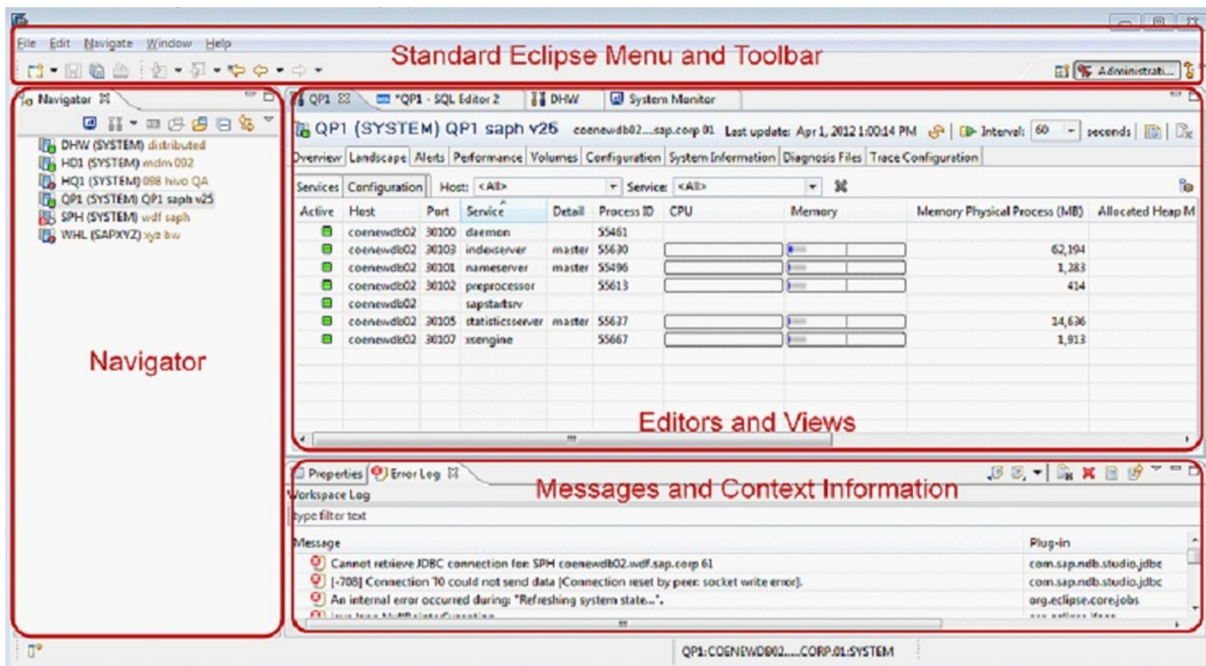
The following is a brief overview of the various screen areas:

Screen Area	Description
Eclipse standard menu and toolbar	Standard Eclipse functions More information: Eclipse Workbench User Guide at http://help.eclipse.org/indigo/index.jsp

Navigator	The navigator provides you with a list of all SAP HANA systems managed in the SAP HANA studio and allows you to drill down easily into each system.
	
	The navigator toolbar contains icons that provide you with quick access to several views and editors, including:
	• The System Monitor
	  More information: Monitoring SAP HANA Systems with the System Monitor
	• The Administration Console
	  More information: Monitoring
	• The SQL Editor
	  More information:
	  Troubleshooting
	
	You can also filter the entries in several of the nodes in the navigator by right-clicking the node and choosing *Filter...*

Editors and views	Each perspective has its own editors and views for editing and browsing resources. The Administration Editor and SQL Editor are available in the Adminstration Console perspective, for example. More information: Eclipse Workbench User Guide at http://help.eclipse.org/indigo/index.jsp

| Messages and context information | This screen area contains error and information messages, as well as context-related information for editors and views (such as properties). |

More information: Customizing the Administration Console

Starting the Administration Console of the SAP HANA Studio

1. From your file explorer, start hdbstudio[.exe].

2. On the Welcome page, choose *Open Administration Console.*

Once you have closed the Welcome page, you can always change from another perspective to the Administration Console perspective by choosing *Window* → *Open Perspective* → *Administration Console* or by selecting the perspective in the upper-right corner of the screen.

Managing Multiple SAP HANA Systems

You can manage multiple SAP HANA database systems in the SAP HANA studio.

Systems are displayed in the navigator, where they are labeled with their system ID (SID) and description (if one was specified). When you expand a system node in the navigator, you see the default catalog, which contains public synonyms, schemas with column views (info cubes), functions, indexes, procedures, sequences, (private) synonyms, tables, and views.

Adding Systems

Before you can carry out administrative tasks on an SAP HANA database, you must add it to the navigator. Note that the hostname of the server that hosts the database must be accessible from the client where the SAP HANA studio runs, even if the system is added by means of its IP address.

Prerequisites

All the relevant ports in your firewall are open.

More information: SAP HANA Database - Security Guide on SAP Help Portal at
http://help.sap.com/hana_appliance

Procedure

1. In context menu of the navigator, choose *Add System.*

   💡 Note
   You can also import existing systems. More information: Importing Systems

2. Enter the following data:
   - *Hostname*
     Name of the host where the system is installed
   - *Instance Number*
     Instance number of the system

   💡 Note
   To add a distributed system, you specify the host of one of its index servers (that is, instances). Every index server in a system has information about all the other index servers within the same system.
   - *Description*
     You can enter a description for the system, which is displayed next to the system name in the navigation structure.
   - *Folder*

> If you have already created a system landscape in the navigator, choose the folder to which you want to add the system.

- *Locale*
  Your location

3. Choose *Next*.
4. If required, choose your authentication type and enter your user information.
   More information: Managing Users
5. If you want to use a secure connection, choose *Connect using SSL*.
6. To enter advanced connection properties, choose *Next*. The following options are available:

   - *Connection URL:* Defines the properties of the connection to the database.
   - *Auto-Reconnect:* If you select this option, the SAP HANA studio automatically reconnects after the connection to the system has broken.

7. Choose *Validate SSL Certificate* to ensure that the SSL connection is secure.
   To override the system hostname in the certificate, enter a hostname with a defined certificate.
8. Choose *Use user key store as trust store* to validate the server certificate's validity (whether signed by a known certificate issuer) using the user key store.
   The trust store property configures the trust store for SSL connect, which is used to validate that the SSL certificate of the server is issued by a trusted entity. Each user can to import certificates into his or her own user key store in Java using the "keytool" option (part of JRE). The set of root certificates delivered with the JRE from well-known issuers (for example, Verisign, Thawte, Deutsche Telekom) is used when this option is not selected.
9. Choose *Finish*.

Result

The system is added in the navigator.

> 🔆 Note
> Systems that you added using a secure connection are shown with a padlock icon.

Creating Folder Structures

If you add several systems in the navigator, you can organize them by defining a folder structure and assigning the systems to individual folders.

Once folders have been created, you can assign a system to a specified folder when adding it to the navigator.

Procedure

1. From the main menu, choose *New → Folder*.
2. Enter a folder name.
3. In the navigator, move your system to the new folder using drag and drop.
4. Repeat this procedure until you have added all your systems.

Exporting Systems

You can export a list of SAP HANA system from the SAP HANA studio to files and then use these to import the data into another instance of the SAP HANA studio.

Procedure

1. From the main menu, choose *File → Export...*
2. Expand the *SAP HANA Studio* folder and then choose *Landscape.*
3. Choose *Next.*
4. Select the systems to be exported and enter a target file location.
5. Choose *Finish.*

Importing Systems

You can import a list of systems that you previously exported from another instance of the SAP HANA studio.

Procedure

1. From the main menu, choose *File → Import...*
2. Expand the *SAP HANA Studio* folder and then choose *Landscape.*
3. Choose *Next.*
4. Choose *Browse...* and select the file containing the list of systems that you want to import.
5. Select the folder into which you want to import the file.
6. Choose *Finish.*

Finding Systems

1. From the navigator toolbar, choose (*Find System*).
2. Enter a search string.
   Matching systems are displayed immediately. You can also use * or ? as wildcards.
3. Select the system you were searching for.
   You can select several systems in the search results using the CTRL key. You can use this, for example, to mark duplicate systems.
4. Choose whether you want to open the system in the Administration Editor and/or the SQL editor.
   Note:
   If you do not select either checkbox, the selected system will only be marked in the navigator.

Monitoring SAP HANA Systems with the System Monitor

The System Monitor provides you with an overview of all your SAP HANA systems at a glance. You can drill down into the details of an individual system in the Administration Editor (see Monitoring).

To start the System Monitor, in the navigator toolbar choose the (*System Monitor*) button.

The System Monitor view displays the following information:

Column	Description
System ID	ID assigned to system when added
Operational State	Indication of whether all database services have started, some have not started, or

	some are still in the process of starting
Alerts	The statistics server generates alerts for the system when resource usage and statistical thresholds are violated. These alerts are displayed as low, medium, or high priority. The number of alerts and their status is shown here.
Data Disk (GB)	The size of the database data volume on the disk(s) holding data files
Log Disk (GB)	The size of the database log volume on the disk(s) holding log files
Trace Disk (GB)	The size of database trace files on the disk(s) holding trace files
Used Memory (GB)	The amount of physical memory used by the SAP HANA database
CPU (%)	Percentage of CPU used by the SAP HANA database
Hostname	The name of the server hosting the SAP HANA database.
Instance Number	The instance number is the administrative unit that comprises the server software components.
System Data Disk (GB)	Total disk space occupied on the disk(s) containing data files
System Log Disk (GB)	Total disk space occupied on the disk(s) containing log files
System Trace Disk (GB)	Total disk space occupied on the disk(s) containing trace files
System Physical Memory (GB)	Total amount of physical memory used
Virtual Memory (GB)	The total combined physical and virtual memory used
System CPU (%)	Overall CPU usage
Distributed	Indicates whether the system is running on a single host or it is a distributed system running on more than one host
Start Time First	Time that the first service started This is updated when system is restarted for any reason.
Start Time Latest	Time that the last service was started, if, for example, one of the services was re-started individually
Version	SAP HANA studio software version number
Platform	Operating system on which the SAP HANA studio is running

More information: Monitoring

Starting and Stopping Systems

Starting a System

Prerequisites
You have the credentials of the operating system administrator (user <sid>adm).

More information: Managing Users

Procedure

1. In the navigator, right-click the system to be started and choose *Start...*

2. Optional: Specify a start timeout.

   The start timeout defines how long to wait for an instance to start. If the end of the timeout period is reached, the remaining instances are not started.

3. Enter the user name and password of the operating system administrator that was defined when the system was installed (that is, `<sid>adm`).

Result
The system is started. A green icon appears in the system icon in the navigator.

> 💡 Note:
>
> You can stop and start a system in one step by right-clicking the system and choosing *Restart...*

Stopping a System

Prerequisites
You have the credentials of the operating system administrator (user <sid>adm).

More information: Managing Users

Procedure

1. In the navigator, right click the system to be stopped and choose *Stop...*

2. Select how you want to stop the system:

   * Hard

     Forces all components to stop immediately.
     ⚠ Caution
     This may lead to data loss.

   * Soft

     Waits for all components to stop. You can specify a timeout after which a hard shutdown is to be triggered.

   * Stop wait timeout (sec)

     If the timeout expires, the operation continues stopping the remaining instances.

3. Enter user name and password of the system administrator.

Result

The system is stopped. A red icon appears in the system icon in the navigator.

Monitoring During System Startup and Stop

The SAP HANA studio normally collects information about the system using SQL statements. However, when the system has not yet started, no SQL connection is available. Therefore, while the system is starting up or is stopped, the SAP HANA studio collects information about the database using the sapstartsrv connection. You can view this information in the Adminstartion Editor "diagnosis mode". In this way, you analyze any problems that may occur during startup or while the system is stopped. You can also read diagnosis files even when the system is stopped.

When you open the Administration Editor for a non-running system, it opens automaically in diagnosis mode. The Administration Editor also opens automatically in diagnosis mode when you initiate the start or stop of a system.

You can manually open diagnosis mode for a system by choosing *Open Diagnosis Mode* from the drop-down menu of the (*Administration*) button.

> Note
>
> To be able to open the Administration Editor of a system in diagnosis mode, you must be able to log on using the credentials of the operating system user (user <sid>adm).

Managing Licenses

License keys are required to use SAP HANA databases.

The SAP HANA database supports two kinds of license keys: temporary license keys and permanent license keys. While temporary license keys are automatically installed in an SAP HANA database, permanent license keys have to be requested on the SAP Service Marketplace and applied to the individual SAP HANA database.

Temporary License Keys

A temporary license key, which is valid for 90 days, is automatically installed with a new SAP HANA database. During this period, you should request and apply a permanent license key.

Permanent License Keys

You can request a permanent license key on the SAP Service Marketplace at https://service.sap.com/support under *Keys & Requests*. Permanent license keys are valid until the predefined expiration date. Furthermore, they specify the amount of memory licensed to the target SAP HANA database. Before a permanent license key expires, you should request and apply a new permanent license key. If a permanent license key expires, a temporary license key valid for 28 days is automatically installed. During this time, you can request and install a new permanent license key.

There are two types of permanent license key available for the SAP HANA database: *unenforced* and *enforced*. If an unenforced license key is installed, the operation of the SAP HANA database is not

affected if its memory consumption exceeds the licensed amount of memory. However, if an enforced license is installed, the system is locked down when the current memory consumption of the SAP HANA database exceeds the licensed amount of memory plus some tolerance. If this happens, either the SAP HANA database needs to be restarted, or a new license key that covers the amount of memory in use needs to be installed.

The two types of permanent license key differ from each other in the following line in the license key file:

- Unenforced license key: SWPRODUCTNAME=SAP-HANA
- Enforced license key: SWPRODUCTNAME=SAP-HANA-ENF

> Note:
> Although enforced license keys currently only apply to SAP Business One, it is technically possible to install such a license in an SAP HANA instance with a regular, unenforced permanent license. In this case, the unenforced license key has priority. That is, if a valid unenforced license key is found, no memory consumption check is enforced. However, if one license key expires and becomes invalid, the other one, if valid, becomes the valid license key of the instance. If the latter is an enforced license key, then the memory consumption check is enforced.

In the following situations, the system goes into lockdown mode:

- The temporary license key has expired.
- You were using a temporary license key and the hardware key has changed.
- The permanent license key has expired and you did not renew it within 28 days.
- The installed license key is an enforced license key and the current memory consumption exceeds the licensed amount plus the tolerance.
- You deleted all license keys installed in your database.
- The system ID and/or hardware key of your database have changed, for example, after system copy or renaming.

In lockdown mode, no queries are possible. Only a user with the system privilege LICENSE ADMIN can connect to the database and execute license-related queries, such as, obtain previous license data, install a new license key, and delete installed license keys. Note that the database cannot be backed up if it is lockdown mode.

Checking the Current License Key

Prerequisites
You have the system privilege LICENSE ADMIN.

Procedure
1. In the navigator, right-click the system and choose *Properties*.
2. Choose *License*.
   In the *Current License Key* screen area, the following information is displayed:
   - License type
   - Start date of the license key
   - Expiration date of the license key

Installing Permanent Licenses

Prerequisites

You have the system privilege LICENSE ADMIN.

Procedure

1. To request the first permanent license key for a newly installed SAP HANA database, you need to provide the hardware key and the system ID. To request a subsequent permanent license key, you have to enter the installation number and system number of your SAP HANA database. You can get the required information from the SAP HANA studio as follows:

   a. In the navigator, right-click the system and choose *Properties*.

   b. Choose *License*.

   If the database is currently running on a temporary license key, the *Request License Key* screen area displays the hardware key and the system ID. If the database already has a valid permanent license key, the installation number and system number are displayed. Alternatively, you can use SQL to access the required information from the M_LICENSE system view.

2. In the license key request on SAP Service Marketplace, enter all necessary information. If you have the installation number and system number, then enter them first so that the other input fields are auto-completed. When you have finished, choose *Submit*.

   Permanent licenses are sent by e-mail attachment.

3. To install the license key, you have the following options:

   a. In the *Request License Key* screen area in the SAP HANA studio, choose *Install License Key* and select the file that you received by e-mail.

   b. Execute the following SQL command: SET SYSTEM LICENSE '<license file content>'.

   🔅 Note:

   A subsequent permanent license key must have the same system-identification data as the permanent license key previously installed in the database. In particular, the system ID, hardware key, installation number, and system number must be the same. If any difference is detected in this data, the installation of the license key fails and no change is made to the license key in the database.

Deleting Existing Permanent License Keys

It is possible to delete all existing license keys in an SAP HANA database. This can be helpful if permanent license keys with an incorrect installation number or incorrect system number were installed on the database. Deleting existing license keys results in a lockdown of the database. The installation of a new, valid permanent license key is required to unlock the database.

Prerequisites

You have the system privilege LICENSE ADMIN.

Procedure

1. In the navigator, right-click the system and choose *Properties*.

2. Choose *License*.
3. Choose *Delete License Key*.

    Alternatively, you can use SQL to delete all installed license keys by executing the following SQL command: UNSET SYSTEM LICENSE ALL

License Auditing

More information: SAP Note 1704499 – License Memory Audit

Managing Users

The right to access resources and to perform operations in SAP HANA is determined exclusively by the privileges of the database user who attempts to perform these operations. SAP HANA supports the concept of a role, which is fundamentally a set of privileges. Roles are granted to database users, and users thereby gain the respective privileges.

Database Users

When you install the SAP HANA database, a database user, called SYSTEM, is created by default. The database user SYSTEM has irrevocable system privileges, such as the ability to create other database users, access system tables, and so on.

> 🔒 Note:
> For security reasons, it is highly recommended that you do not use user SYSTEM for day-to-day activities. Use SYSTEM to create administration users with the minimum privilege set required for their duties, and use those users for day-to-day administrative activities.

Several "internal database users" are also created, such as SYS and _SYS_STATISTICS. These users cannot log on to the SAP HANA database.

Operating System User

In addition to the SAP HANA database user SYSTEM, the installation process also creates an external operating system user (*SID*adm, for example, sp1adm or xyzadm). This operating system user, referred to here as the *operating system administrator*, simply exists to provide an operating system context. From the operating system perspective, the operating system administrator is the user that owns all SAP HANA files and all related operating system processes. Within the SAP HANA studio, the operating system administrator's credentials are required, for example, to start or stop database processes or to execute a recovery. The operating system administrator is not an SAP HANA database user.

Authentication

To be able to use the SAP HANA database, the identity of the database users first need to be verified in a process called authentication. Several types of authentication are possible.

Internal Authentication

Users are created in SAP HANA database only. Authentication is handled by the SAP HANA database by means of a username-password combination.

Using External User Repositories for Authentication

The SAP HANA database supports the mapping of users created in the SAP HANA database to external users through the integration of the MIT Kerberos network authentication protocol or through the Security Assertion Markup Language (SAML).

Kerberos

If you want to use Kerberos, you must install the relevant Kerberos client software from your operating system software package and configure the SAP HANA database accordingly.

The users stored in the MIT Kerberos Key Distribution Center can then be mapped to database users in SAP HANA database. For this purpose, specify the User Principal Name (UPN) as the external ID when creating or changing the database user.

The following is an example of how to check whether or not Kerberos client software is installed:

Example (for Linux SLES 11, without SP1):

```
bash> rpm -qa | grep krb
krb5-32bit-1.6.3-133.10
krb5-1.6.3-133.10
```

SAML

To be able to use SAML authentication, at least one SAML identity provider must have been created.

More information: SAP HANA Database – Security Guide on SAP Help Portal at http://help.sap.com

Authorization

Once their identity has been verified, database users can perform database operations. The confirmation that the database user is entitled to perform the operation is called *authorization.* The user must have both the privilege to perform the operation and access rights to the resources (such as schemas and tables) to which the operation applies.

Database users can have the following types of privilege:

- Privileges that were directly granted to them ("direct privileges")
- Privileges that were granted to roles that they were assigned to ("inherited privileges")

More information: SAP HANA Database – Security Guide on SAP Help Portal at
http://help.sap.com/hana_appliance

Privileges for Adminstration Tasks

The following is an overview of the privileges that database users require to perform particular database operations in the Administration Editor:

Action	Privilege Needed
Open the Administration Editor with read-only access to the system, monitoring views, and statistics services	- System privilege CATALOG READ or DATA ADMIN - SQL privilege SELECT for SQL schema _SYS_STATISTICS 🔲 Note A read-only role, MONITORING, is shipped with the SAP HANA database installation. It includes the abovementioned privileges and can be assigned to users to give them read-only access.
Stop and start database services on the *Landscape* tab	System privilege SERVICE ADMIN
Change check settings on the *Alerts* tab	System privilege INIFILE ADMIN
View alert information on the *Overview* and *Alerts* tabs	SQL privilege SELECT for the SQL schema _SYS_STATISTICS

Mark disk full events as handled	System privilege MONITOR ADMIN
Cancel operations on the *Threads* sub-tab of the *Performance* tab	System privilege SERVICE ADMIN
Change the settings on the *Configuration* tab.	System privilege INIFILE ADMIN
View diagnosis files of systems without an SQL connection	To be able to view the diagnosis files of a system without and SAL connection, you must be logged on as system administrator. To do so, proceed as follows: 1. In the navigator, right-click the system and choose *Properties.* 2. Choose *SAP System Logon.* 3. Enter the <sid>adm user name and password. Choose *Apply* and *OK.* 💡 Note: If an SQL connection cannot be established, the *Diagnosis Files* tab is automatically displayed when you open the Administration Editor, regardless of user privileges. However, the file list is only displayed if you are logged on as system administrator.
Configure database traces on the *Trace Configuration* tab.	System privilege INIFILE ADMIN
Configure the SQL trace on the *Trace Configuration* tab.	System privilege INIFILE ADMIN
Delete trace files on the *Diagnosis Files* tab.	System privilege TRACE ADMIN
Start and stop the performance trace on the *Trace Configuration* tab.	System privilege TRACE ADMIN
Move tables and table partitions to another host in a distributed system	• System prililege DATA ADMIN, or • System privilege CATALOG READ and SQL privilege ALTER for the table being moved 💡 Note: If a user with system privilege CATALOG READ is also the owner of the table, they can also move the table without SQL privilege ALTER.
Import and export tables	• System privileges IMPORT and EXPORT • SQL privilege INSERT for import and SELECT for export

More information: SAP HANA Database – Security Guide on SAP Help Portal at
http://help.sap.com/hana_appliance

Provisioning Users

As a database user with privileges for user management, you can set up other users to work with the SAP HANA database. To do this, you can define roles with different privileges and then assign database users to these roles.

💡 Note:

If you are using an Identity Management (IDM) system for user provisioning, it is highly recommended that you create a dedicated technical user for that system that has the USER

ADMIN and ROLE ADMIN privileges. This database user account should then be used exclusively by the IDM system for its user provisioning tasks.

Creating Roles

Prerequisites

- To create a role, you must have the privilege ROLE ADMIN.
- To grant a privilege to a role, you must have the privilege yourself and be authorized to grant it to other users and roles.

Procedure

1. In the navigator, expand the system, then the *Catalog* folder and the *Authorization* folder.
2. Right-click the *Roles* folder and choose *New Role*.
3. Create the role by specifying a unique role name and assigning the required privileges (SQL privileges, analytical privileges, system privileges).
4. Choose *Deploy* to create the role.

   Note

   You can delete a role by right-clicking it in the navigator and choosing *Delete*.

Creating Users

Prerequisites

- To create a user, you must have the privilege USER ADMIN.
- To grant a privilege to a user, you must have the privilege yourself and be authorized to grant it to other users and roles.

Procedure

1. In the navigator, expand the system, followed by the *Catalog* folder, and the *Authorization* folder.
2. Right-click the *Users* folder and choose *New User.*
3. Specify the following information:
   - A unique user name
   - Authentication details

     You can set up one or more of the following types of user authentication:
     - Internal authentication by specifying a user name and password
     - Kerberos authentication (external) by specifying the external ID known by the external identity provider
     - SAML authentication (external) by specifying the identity provider and the user ID known by the SAML identity provider

       To use identity provider based user mapping, select the checkbox in the *Any* column.
   - Roles and privileges

     You can grant roles and/or privileges (SQL privileges, analytical privileges, and system privileges) to the user.

To allow <mark>the user to pass on his or her privileges to other users, select *Grantable to other users and roles*.</mark>

4. Choose *Deploy* to create the user.

Changing Users

1. In the navigator, expand the system, followed by the *Catalog* folder and the *Authorization* folder.
2. Double-click the user and make the required changes. You can change the following:
    * Password for internal authentication
    * External ID for Kerberos authentication
    * Identity provider and external user ID for SAML authentication
    * Granted roles and privileges (SQL privileges, analytical privileges, system privileges)
    * Whether or not the user is allowed to pass on his or her privileges to other users (*Grantable to other users and roles* option*)*
3. Choose *Deploy* to save the changes.

🔒 Note

You can delete a role by right-clicking it in the navigator and choosing *Delete*.

Deactivating and Reactivating Users

Users can be automatically deactivated for security reasons, for example, if they violate password policy rules. However, as a database administrator, you may need to explicitly deactivate a user, for example, if an employee temporarily leaves the company or if a security violation is detected.

Prerequisites

You have system privilege <mark>USER ADMIN.</mark>

Procedure

1. In the navigator, select *Catalog* → *Authorization* → *Users* → <username>.
2. From the toolbar of the User Editor, choose *Deactivate User…*
   The database user is now deactivated and remains so until you reactivate. The user still exists in the database, but cannot connect to the database any more. The reason (explicit deactivation) and the time of deactivation are displayed in the user's details.
3. To reactivate the user, from the toolbar of the User Editor, choose *Activate User…*
   You are prompted to enter a new password for the user. The user is now reactivated.

Disabling Default User Filtering of Schemas

Schemas are filtered according to user by default. This is because in large SAP HANA systems hosting multiple applications with hundreds, thousands, maybe even hundreds of thousands of users, it would be impossible for individual users to identify the schemas with which they are permitted to work if all schemas were visible.

Therefore, the connected user sees only those schemas for which at least one of the following criteria applies:
* <mark>The user is the schema owner</mark>
* <mark>The user has at least one privilege on the schema</mark>

- The user has at least one privilege on at least one object in the schema
- The user owns at least one object in the schema

  🔔 Note:

  For all privilege checks, not only privileges directly granted to the user but also privileges granted to one of his or her roles (or to roles in these roles) are considered.

As a result, users with DATA ADMIN or CATALOG READ privilege, in particular user SYSTEM, do not see all available schemas. If, as a database administrator, you need to see all available schemas, you must disable the default schema filter.

Procedure

1. In the navigator, right-click *Catalog* and choose *Filters…*
   The *Filter for Schema* dialog box opens.
2. Select *Display all schemas*.
3. Optional: Specify a filter pattern to reduce the number of schemas displayed.
   This is useful if the total number of schemas exceeds the number of displayable items in the tree (configured under *Preferences → Catalog)*. If this is the case, then you will not see all schemas at once and will have to browse.
4. Choose *OK*.

Monitoring

To identify problems with the database early and avoid disruptions, you need to monitor your systems continuously. While the System Monitor provides you with an overview of all your systems, you use the Administration Editor to monitor each individual system in detail.

To open the Administration Editor for a particular system, select the system in the navigator and then from the toolbar choose the (*Administration*) button. The header of Administration Editor contains general information about the system (name, host, instance number, time of last refresh), as well a toolbar with the following functions:

- The (*Refresh current page*) button allows you to manually refresh the tab you are viewing.
- The (Stop/Start automatic refresh) button allows you to activate and deactivate automatic refresh. You can specify the interval between automatic refresh (in seconds) in the corresponding field.
- The (*Copy to clipboard*) button allows you to copy the details of the tab you are viewing to the clipboard and then to paste this to another program, for example Notepad.
- The (*Clear messages in the header*) button allows you to clear any messages displayed in the header.

Monitoring Overall Resource Usage

When you open the Administration editor for a particular SAP HANA database system, the *Overview* tab provides you with a summary of the overall status of the system as well as an overview of resource usage. Resource indicators are presented at the level of the SAP HANA database system and at the level of the host(s) on which the database system resides. In this way, you can more clearly identify where resource issues lie.

The following information is available:

- SAP HANA Database
  - General information about the SAP HANA database system, such as operational state, whether or not the system is distributed, the number of hosts (if distributed), and database version
  - Priority-rated alerts and messages reported by the statistics server
  - The maximum amount of memory that can be reserved by SAP HANA from the operating system (allocation limit) and the amount of memory that is currently used
  - Number of CPUs available and percentage used by the SAP HANA database system
  - Disk space occupied by data, log, and trace files belonging only to the SAP HANA database system
- Host(s)
  - The amount of physical memory available on the host machine(s) and the amount of physical memory used overall (that is, including that used by the activities of Linux and all other programs on the host)

- o The amount of virtual memory available on the host machine(s) and the amount of virtual memory used
  Note:
  The physical memory bar and the virtual memory bar are related. Physical memory is the actual physical RAM on the host machine. Virtual memory includes swap-space on disk. SAP HANA should always execute out of physical memory; a virtual memory size that is much larger than physical memory size is an indication of system performance degradation, possibly requiring the addition of memory.
- o Total disk space occupied on disks containing data, log, and trace files
- o Number of CPUs available and overall usage

Note:

The resource indicator bars (memory, CPU, and disk) change color (red, yellow, and green) based on configurable thresholds. In the "SAP HANA Database" area, these bars reflect values measured for the SAP HANA database system, while in the "Host(s)" area they reflect values measured on the machine(s) as a whole. For this reason, the color of bars may differ.

If the database system is distributed, then resource usage values displayed are aggregated across all hosts. An additional bar shows the host with the highest (most critical) resource usage.

Monitoring System Components

The *Landscape* tab enables you to check that your system is running and the status of its hosts and processes. The *Landscape* tab has two subtabs, *Services* and *Configuration*.

Services

The *Services* subtab contains information about the status of the OS processes of your SAP HANA system. Information about resource usage and possible bottlenecks is also displayed.
The following table lists the information displayed by default:

Column	Description
Active	This column displays a green, yellow, or red symbol to indicate the following: • Green: Service is started • Yellow: Service is starting or stopping • Red: Service is stopped Note: The daemon is shown as yellow while the host or any if its child services are starting or stopping.
Host	The name of the host on which the service is running Distributed systems show more than one host.
Port	Port that the system uses for internal communication between services
Service	Service name
Detail	The role of the host on which the service is running (master or stanby) This is relevant only for distributed systems installed on more than one host.

Process ID	The process ID at operating system level
CPU	Bar view showing the CPU usage of the service
Memory	Bar view showing the memory usage of the service in relation to total memory available and the effective allocation limit of the service
Used Memory (MB)	The amount of memory used by the service
Effective Allocation Limit (MB)	The effective maximum memory pool size considering the current memory pool sizes of other processes
Physcial Memory on Host (MB)	Total memory available on the host
Start Time	Start time of the service Two of these times in this column should match the *Start time of first started service* and *Start time of latest started service* times shown on *Overview* tab.

For more information, see Monitoring Memory Usage.

You can display the following addtional columns by configuring the table (⚙ button):

- Allocated memory (heap and shared)
- Memory used (heap and shared)
- Size of caches
- Shrinkable size of caches
- All process memory on host (MB)
- Virtual memory on host (MB)
- Size of shared libraries
- Size of thread stacks

The following filters are available and are primarily for use with a distributed system:

- *Host*

  This filter enables you to view one or more selected hosts.
- *Service*

  This filter shows the same service on each server. For example, you can choose to view all the nameservers in a distributed system only.

You can restart services by choosing the corresponding entry in the context menu. If you choose to stop or kill a service, it is stopped or killed and then automatically started again.

Configuration

The *Configuration* sub-tab of the *Landscape* tab lists the hosts in the SAP HANA system with additional information on status and role. This is only relevant for distributed systems and in particular, if failover is configured.

Column	Description
Host	Displays the host name
Active	Indicates whether or not the host is active

Host Status	Indicates whether or not the host is running correctly
Failover Status	Displays the failover status so you can see which servers are active and which are on standby
Nameserver Role (Configured)	Displays the role of the *nameserver* as it has been configured: master1, master2, master3, or slave nameserver
Nameserver Role (Actual)	Displays the role of the nameserver as it is currently running: master or slave nameserver
Indexserver Role (Configured)	Displays the role of the indexserver as it has been configured: worker indexserver or standby
Indexserver Role (Actual)	Displays the role of the indexserver as it is currently running: master indexserver, worker indexserver, or standby indexserver
Failover Group	In case of failover, the server tries to fail over to a host within the same group
Storage Partition	Displays the number of the mnt000... subdirectory used below DATA and LOG directory

To change the configured role of the host, choose the *Configure Hosts for Failover Situation* button in the toolbar.

More information: Failover Concept

Monitoring Alerts

The statistics server is one of the services of the SAP HANA database system. In addition to collecting historical performance and resource data, the statistics server issues system resource alerts to warn you of potential problems.

> 🔹 Note
>
> You can access the historical performance and resource data collected by the statistics server by viewing the content of the tables in the _SYS_STATISTICS schema.
> More information: Displaying the Content of Tables

Some critical information that you want to have as early as possible is:

- A hard disk is becoming full
- CPU usage is critical
- A server has crashed

By default, when the system is started, the statistics server is started automatically on the host of the master nameserver. The statistics server internally uses SQL statements to collect information from all index servers. Important alerts from the collected information on the system state are summarized on the *Overview* tab of the Administration Editor, and displayed in detail on the *Alerts* tab. To always see the latest information, the display must be regularly refreshed.

You can also receive e-mail alerts. More information: Configuring Alerts

Navigating Alerts

At the top of the *Alerts* tab is a field displaying the time of the last check. You can view either *All alerts* or *Current alerts* in the main area of the window.

If you choose *All alerts,* the alerts are broken down according to time period:

- *Last 15 minutes*, *Last 30 minutes*, *Last hour*, *Last 2 hours*, and *Today* all show the alerts shown in those periods. For example, if an alert was generated 10 minutes ago, it would be shown under all these headings.
- *Yesterday* displays alerts that were generated yesterday only.
- *Last week* displays alerts generated during the previous week (Sunday to Saturday).
- *Two weeks ago* displays the alerts generated during that week, and so on.

  Note:

  These alerts are not "rolled over" into the following weeks. This enables you to compare the performance of the system over selected periods as well as view the alerts.

If you choose *Current alerts*, only those alerts that are current and have not been resolved are displayed.

Filtering Alerts

In the *Filter* field, you can enter a filter parameter to view only alerts that contain the text in your filter.

You can also choose *Select Alert Filters* to set filters according to priority, host, and timeframe.

Displaying Detailed Alert Information

Double-click an alert to see detailed information, including:

- A full description of the alert
- The time stamp for this instance of the alert
- Information about how to resolve the alert
- A history of when this alert was generated in the past

The *Copy* function allows you to copy the hint in the alert to the clipboard.

Monitoring Disk Space

Data files contain all the data in the database. Data is copied to the disk at regular intervals in case of data loss as a result of a power failure. You must always ensure that there is enough space on the disk for these files to be saved. Data within a system is contained in volumes. Currently there is one volume per instance/index server.

You can monitor disk space on the *Volumes* tab of the Administration Editor.

You can view volume information according to the following filters:

- The *Show* filter enables you to view the volumes information either by service or storage ID.
- The *Host* filter enables you to view volumes information either on all hosts or on selected hosts.

Volume information displayed when the *Show* filter is set to *Service* is:

Column	Description
Service/Volume	List of services storing data in the database. These are the nameserver, indexserver and statisticsserver. Other services do not store any data in the

	database and are therefore not displayed. This column shows the host and the internal communications port on which the server is running. You can view individual Log and Data information by clicking on the arrow to the left of the host name.
Service Name	These are the nameserver, indexserver and statistics server. In a distributed system, there are multiple instances of each of the services.
Total Size	Total size in MB of the data and log of this service.
Data Size	Size in MB of the service data stored on the host.
Log Size	Size in MB of the service log stored on the host.
Full Path	Full path of the service log and data files. This can be viewed by clicking the arrow next to the host name.
Storage Device ID	Identifies the storage device. This can be useful for checking if the log and data files are stored on the same device.
Total Storage Size	Total storage size in MB of the hard disk of the host.
Used Storage Size	Used storage in MB on the hard disk of the host.
Free Storage Size	Free storage space in MB on the hard disk of the host.
Volume Subpath	The directory where each service is stored on the disk.
Storage ID	Storage identifier.
Volume ID	Volume identifier.

Volume information displayed when the *Show* filter is set to *Storage* is similar to that shown above, but is displayed in a different format and includes trace files.

Storage/Service shows the storage type, Data, Log and Trace. If you click the arrow to the left of each storage type, you are shown the individual service information.

The *Details for Volume of Service* area shows further details on the selected indexserver and statistics server. Currently the system does not show these extra details for the nameserver.

This information is useful for detailed performance analysis.

Column	Description
Files	Displays the name and type of file. It also shows the size of the file and how much of the file is currently in use (in MB and also in %). If the data in the file reaches the total size of the file, the system will automatically expand the file size. The file path is also shown.
Volume I/O Statistics	Shows general file I/O statistics for specific paths (storage/volume/service). Aggregated I/O statistics are also displayed for example number of read/ write requests, data volume (throughput), total I/O time and speed (MB/s).
Volume I/O Performance Statistics	Displays specific file I/O statistics for specific paths (storage/volume/service). I/O statistics are broken down according to the I/O buffer size, for example number of read/write requests, durations, waiting situations, and so on. These figures can be useful when analyzing database problems.
Data Volume Superblock Statistics	Displays general data volume block statistics (data storage/data volume/service). Aggregated block statistics are displayed. The data volume is partitioned into superblocks, which are partitioned into smaller blocks (pages) of a specific size. Only blocks of the same size are stored in the same superblock

Data Volume Page Statistics	Shows specific data volume block statistics (data storage/data volume/service). The block statistics are broken down according to the "page size class". You can analyze how many superblocks are used for the specific size class and also how many pages/blocks are used.

Monitoring Performance

In addition to the general information about the overall system performance that you can see in the System Monitor and on the *Overview* tab of the Administration Editor, you can monitor more detailed aspects of system performance on the *Performance* tab, for example, to detect and resolve optimization issues.

> 🔔 Note:
> We recommend that you use the available filters and column configuration options of the views below to restrict the amount of information displayed.

Tab	More Information
Threads	By default, the *Threads* tab shows you a list of all currently active threads in your landscape. It may be useful to see, for example, how long a thread is running, if a thread is blocked for inexplicable length of time, and so on. A blocked thread is indicated by a warning icon in the *Status* column, and you can see detailed information about the blocking situation by hovering the cursor over this icon. The following features are also available on the *Threads* tab: • You can end the operation of a specific thread. Right-clicking the thread and choose *Cancel Operation*. • You can view the call stack for a specific thread. Select the *Create Call Stacks* checkbox, refresh the page, and then select the thread in question.
SQL cache plan	The SQL plan cache is useful for observing overall SQL performance as it provides statistics on compiled queries. Here, you can get insight into frequently executed queries and slow queries with a view to finding potential candidates for optimization. The following information may be useful: • Dominant statements (TOTAL_EXECUTION_TIME) • Long-running statements (AVG_EXECUTION_TIME) • Frequently-executed plans (EXECUTION_COUNT) • Statements with high lock contention (TOTAL_LOCK_WAIT_COUNT) 🔔 Note: The collection of SQL plan cache statistics is enabled by default, but you can disable it on the *SQL Plan Cache* tab by choosing *Configure*.
Expensive statements	Expensive statements are individual SQL queries whose execution time was above a configured threshold. Expensive statements may reduce the performance of the database. 🔔 Note: The expensive statements trace is deactivated by default. You can activate it either on the *Expensive Statements Trace* tab or on the *Trace Configuration* tab. You can also configure the threshold value here. The default threshold value is 1000000 microseconds, that is, 1 second.
Job progress of	Certain operations typically run for a long time and may consume a considerable

long-running operations	amount of resources, for example, <mark>delta merges, compression, delta log replays. By monitoring the progress of these long-running</mark> transactions, you can determine whether or not they are responsible for current high load, see how far along they are and when they will finish.
System load history	The load display gives you a graphical display of general performance KPIs (such as CPU usage, memory consumption, and table unloads) over time. You can compare the performance of different hosts.

Troubleshoot issues detected by analyzing individual queries further or contacting support.

More Information: Troubleshooting

Monitoring Memory Usage

Memory Concepts

As an in-memory database, it is critical for SAP HANA to handle and track its consumption of memory carefully and efficiently. For this purpose, the SAP HANA database pre-allocates and manages its own memory pool and provides a variety of memory usage indicators to allow monitoring.

SAP HANA tracks memory from the perspective of the host. The most important concepts are:

- Physical memory
  The amount of (system) physical memory available on the host
- Allocated memory
  The memory pool reserved by SAP HANA from the operating system
- Used memory
  The amount of memory from this pool that is actually used by the SAP HANA database

The following figure illustrates the above concepts.

Memory Concepts
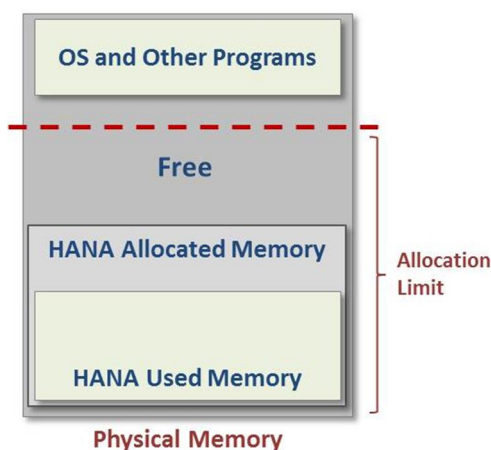
Determining Physical Memory Size

Physical memory (DRAM) is the basis for all memory discussions. On most SAP HANA hosts, it ranges from 256 gigabytes to 2 terabytes. It is used to run the Linux operating system, SAP HANA, and all

other programs that run on the host. There are several ways to determine the amount of physical memory:

Physical Memory	How to Determine
Available physical memory	• Execute the SQL query `select round((USED_PHYSICAL_MEMORY + FREE_PHYSICAL_MEMORY) /1024/1024/1024, 2) as "Physical Memory GB" from PUBLIC.M_HOST_RESOURCE_UTILIZATION;` • Read the value for *Physical Memory Available* on the *Overview* tab of the Administration Editor • Execute Linux command `cat /proc/meminfo	grep MemTotal`
Free physical memory	• Execute the SQL query: `select round(FREE_PHYSICAL_MEMORY/1024/1024/1024, 2) as "Free Physical GB" from PUBLIC.M_HOST_RESOURCE_UTILIZATION;` • Subtract the value for *Memory Used* from the value for *Memory Available* available on the *Overview* tab of the Administration Editor Execute Linux command `awk 'BEGIN {sum = 0}; /^(MemFree|Buffers|Cached):/ {sum = sum + $2}; END {print sum}' /proc/meminfo`

Allocated Memory Pool

The SAP HANA database (across its different processes) reserves a pool of memory before actual use. This pool of allocated memory is pre-allocated from the operating system over time, up to a predefined global allocation limit, and is then efficiently used as needed by the SAP HANA database code. More memory is allocated to the pool as used memory grows. If used memory nears the global allocation limit, the SAP HANA database may run out of memory if it cannot free memory.

The default allocation limit is 90% of available physical memory, but this value is configurable (see Memory Consumption Configuration).

You can see what the global allocation limit of the database is in the Adminstration editor on the *Overview* tab.

> 🔲 Note
> The preallocation of pool memory is the reason why Linux memory indicators (such as top and meminfo) do not accurately reflect the actual SAP HANA used memory size.

In addition to the global allocation limit, each process running on the host has an allocation limit, the process allocation limit. Given that collectively, all process cannot consume more memory than the global allocation limit, each process also has what is called an effective allocation limit. The effective allocation limit of a process specifies how much physical memory a process can in reality consume given the current memory consumption of other processes.

You can see what the current effective allocation limit of a process is in the Administration editor on the *Landscape → Services* tab.

> 🔲 Example

A single-host system has 100 GB physical memory. Both the global allocation limit and the individual process allocation limits are 90% (default values).

This means the following:

• Collectively, all processes of the HANA database can use a maximum of 90 GB.

• Individually, each process can use a maximum of 90 GB.

Therefore, if 2 processes are running and the current memory pool of process 1 is 50 GB, then the effective allocation limit of process 2 is 40 GB. This is because process 1 is already using 50 GB and together they cannot exceed the global allocation limit of 90 GB.

Determining Used Memory Size

Used memory serves several purposes:

• Program code and stack

• Working space and data tables (heap and shared memory)

The program code area contains the SAP HANA database itself while it is running. Different parts of SAP HANA can share the same program code. The stack is needed to do actual computations. The most important part of used memory is the heap and shared area. It is used for working space, temporary data and for storing all data tables, as illustrated in the following figure:

Used Memory
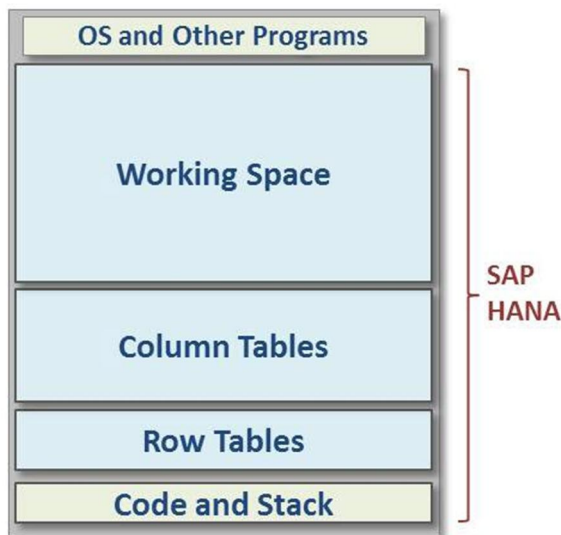
You can use the `M_SERVICE_MEMORY` view to explore the amount of SAP HANA Used Memory as follows:

Category	SQL Query to Execute
Total memory used	`SELECT round(sum(TOTAL_MEMORY_USED_SIZE/1024/1024)) AS "Total Used MB" FROM SYS.M_SERVICE_MEMORY;`
Code and stack size	`SELECT round(sum(CODE_SIZE+STACK_SIZE)/1024/1024) AS "Code+stack MB" FROM SYS.M_SERVICE_MEMORY;`

Total memory consumption of all columnar tables	`SELECT round(sum(MEMORY_SIZE_IN_TOTAL)/1024/1024) AS "Column Tables MB" FROM M_CS_TABLES;`
Total memory consumption of all row tables	`SELECT round(sum(USED_FIXED_PART_SIZE + USED_VARIABLE_PART_SIZE)/1024/1024) AS "Row Tables MB" FROM M_RS_TABLES;`
Total memory consumption of all columnar tables by schema	`SELECT SCHEMA_NAME AS "Schema", round(sum(MEMORY_SIZE_IN_TOTAL) /1024/1024) AS "MB" FROM M_CS_TABLES GROUP BY SCHEMA_NAME ORDER BY "MB" DESC;`

Memory Consumption of Columnar Tables

The SAP HANA database loads columnar tables into memory column by column only upon use. This is sometimes called "lazy loading". This means that columns that are never used are not loaded, which avoids memory waste. When the SAP HANA database runs out of allocatable memory, it may also unload rarely used columns to free up some memory.

Therefore, if it is important to precisely measure the total, or "worst case", amount of memory used for a particular table, it is best to ensure that the table is fully loaded first by executing the following SQL statement: `LOAD` *table_name* `ALL`.

To examine the memory consumption of columnar tables, you can use the `M_CS_TABLES` and `M_CS_COLUMNS` views.

The following examples show how these views can be used to examine the amount of memory consumed by a specific table. You can also see which of its columns are loaded and the compression ratio that was accomplished.

Columnar Table	How to Calculate
List all columnar tables of schema 'SYSTEM'	`SELECT TABLE_NAME AS "Table", round(MEMORY_SIZE_IN_TOTAL/1024/1024, 2) as "MB" FROM M_CS_TABLES WHERE SCHEMA_NAME = 'SYSTEM' ORDER BY "MB" DESC;`
Show column details of table "LineItem" in schema "SYSTEM"	`SELECT COLUMN_NAME AS "Column", LOADED AS "Is Loaded", round(UNCOMPRESSED_SIZE/1024/1024) AS "Uncompressed MB", round(MEMORY_SIZE_IN_MAIN/1024/1024) AS "Main MB", round(MEMORY_SIZE_IN_DELTA/1024/1024) AS "Delta MB", round(MEMORY_SIZE_IN_TOTAL/1024/1024) AS "Total Used MB", round(COMPRESSION_RATIO_IN_PERCENTAGE/100, 2) AS "Compr. Ratio" FROM M_CS_Columns WHERE TABLE_NAME = 'LINEITEM';`

Note that the `M_CS_TABLES` and `M_CS_COLUMNS` views contain a lot of additional information (such as cardinality, main-storage versus delta storage and more). For instance, to explore further try the following query:

```
SELECT * FROM M_CS_COLUMNS WHERE TABLE_NAME = '…' and COLUMN_NAME = '…'
```

Memory Consumption of Row-Ordered Tables

Several system tables are in fact row-ordered tables.

You can use the M_RS_TABLES view to examine the memory consumption of row-ordered tables. For instance, you can execute the following SQL query, which lists *all* row tables of schema 'SYS' by descending size:

```
SELECT SCHEMA_NAME, TABLE_NAME, round((USED_FIXED_PART_SIZE +
USED_VARIABLE_PART_SIZE)/1024/1024, 2) AS "MB Used" FROM M_RS_TABLES WHERE
schema_name = 'SYS' ORDER BY "MB Used" DESC, TABLE_NAME
```

Memory Consumption and SAP HANA Licenses

For more information about memory consumption with regards to SAP HANA licenses, see SAP Note 1704499 – License Memory Audit.

Memory Consumption Configuration

By default, SAP HANA can pre-allocate up to 90% of the available physical memory on the host. There is normally no reason to change the value of this variable, except in the case where a license was purchased for less than the total of the physical memory. In such a case, you should change the global allocation limit to remain in compliance with the license.

Example 1
You have a server with 512GB, but purchased an SAP HANA license for only 384 GB.
You therefore set the global_allocation_limit to 393216 (384 * 1024 MB).

Example 2
You have a distributed HANA system on four hosts with 512GB each, but purchased an SAP HANA license for only 768 GB.
Set the global_allocation_limit to 196608 (192 * 1024 MB on each host).

More information: Setting the Global Allocation Limit Parameter

Configuration

Changing Parameter Values

The properties of a system are defined in the parameters of the configuration files.

A number of configuration files can be displayed and changed in the Administration Editor.

Procedure

1. In the Administration Editor, choose the *Configuration* tab.
   The configuration files that contain the configuration information for the system are displayed.

2. Expand the relevant configuration file.

3. Choose *Change...* in the context menu of the relevant row and enter the new value for the configuration parameter.

Result

After you have changed a parameter, a green circle is displayed next to it and the section in which the parameter was changed is labeled with a gray rhomb.

> � Note:
> To apply your change, you do not have to restart the system. If necessary, the system automatically restarts the relevant components.

For some parameters, you can override the default values per host. Parameters for which you cannot override the system-wide default values contain a minus sign in those columns in which no override is possible.

Resetting Parameter Values

You can reset a parameter value to the system-wide default value.

Procedure

1. In the Administration Editor, choose the *Configuration* tab.
   The configuration files that contain the configuration information for the system are displayed.

2. Expand the relevant configuration file.

3. In the context menu of the parameter, choose *Delete...*

4. Select the level(s) on which you want to reset the parameter.

Setting the Global Allocation Limit Parameter

The *global_allocation_limit* is used to limit the amount of memory that can be used by the database. The value is the maximum allocation limit in MB. A missing entry or a value of *0* results in the system using the default settings (that is, 90% of the physical memory or physical memory minus 1GB in case of small physical memory). This limit is only displayed on the *Configuration* tab.

Procedure

1. In the Administration Editor, choose the *Configuration* tab.

The configuration files that contain the configuration information for the system are displayed.

2. Expand the *global.ini* configuration file and expand the *memorymanager* section.
3. In the context menu, choose *Change* for *global_allocation_limit*.
    Change Configuration Value dialog box for *global_allocation_limit* is displayed.
    There are two parts to the dialog box that enable you to set this parameter for the entire SYSTEM and for an individual HOST. If it is set for SYSTEM, the value is used for each host. For example, if you have 5 hosts and set the limit to 5 GB, the database can use up to 5 GB on each host (25 GB in total). You can additionally set the value for a specific HOST. For that host the specific value is used and the SYSTEM-value is used for all other hosts.
4. Enter the values in the *New Value* fields (for the SYSTEM and HOST, if required) and choose *Save*.

Result

The database memory usage is limited to the amount of memory specified.

Changing the Default SLD Data Supplier Configuration

The System Landscape Directory (SLD) is the central directory of system landscape information relevant for the management of your software lifecycle. Data suppliers collect and send system data to SLD on a regular basis.

For SAP HANA systems, the is the SLD data supplier. It is configured by default to automatically transfer data to the SLD in XML format using the `sldreg` executable on a regular basis. However, if it is necessary to change the default settings, you can do so in the SAP HANA studio by modifying the nameserver.ini file. For example, it may not be necessary to send data to the SLD frequently if your landscape is stable, or you may need to change the default save locations of the configuration and log files.

Prerequisites

You have performed the necessary configuration for the SLD. For more information, see the following:

- SAP Note 1018839 (Registering in the System Landscape Directory Using SLGREG)
- SAP HANA Installation Guide with SAP HANA Unified Installer on SAP Help Portal at
  http://help.sap.com/hana_appliance $\rightarrow$ SAP HANA Installation Guide with SAP HANA Unified Installer $\rightarrow$ Configuring an SAP HANA System to Connect to System Landscape Directory (SLD)

Procedure

1. In the Administration Editor, choose the *Configuration* tab.
2. Right-click the nameserver.ini file and choose *Add Section*.
3. Create the section *sld*.
4. Add those parameters whose default value you want to change.
    The following table lists the possible parameters and their default values.

🗨 Note:

Under normal circumstances, you will not need to change the default values. It should only be necessary, for example, for testing purposes or if requested as part of a support inquiry.

Key	Meaning	Default Value	Note
enable	Activates or deactivates the SLD data supplier.	true	Allowed vales are true, false
Interval	Specifies the frequency (in seconds) with which the `CIM.xml` file is generated. If a newly-generated document is the same as the previous one, it is not sent to the SLD.	300	It does not make sense to enter small positive values or negative values. If you enter 0 or a negative value, data is transferred to the SLD only once. Enter a value without a "1000 separator" (for example, 1899, not 1,899 or 1.899), otherwise it will be interpreted as 0.
force_interval	Specifies how often (in seconds) the `CIM.xml` file must be sent to the SLD, even if the file has not changed.	43200	As above
config_path	Specifies the location of the folder that contains the configuration file `slddest.cfg`. This file is a parameter for the call to sldreg.	/usr/sap/<sid>/SYS/global	Example: /usr/sap/MPW/SYS/global
Xmlpath	Specifies where the file `sldreg.xml` is generated and where the `smlreg.log` log file is written. `smlreg.log` is the log file of sldreg, and both files are parameters for the call to sldreg.	/usr/sap/<sid>/HDB<id>/<currenthost>	Example: /usr/sap/LRH/HDB42/velberlcm1

More information:

SAP Library for SAP NetWeaver on SAP Help Portal at http://help.sap.com under *SAP Netweaver → SAP NetWeaver Platform → SAP NetWeaver 7.3 → Application Help → SAP NetWeaver Library: Function-Oriented View → Solution Lifecycle Management → Configuring, Working with and Administering System Landscape Directory*

Setup Guide Landscape Management Database on SAP Help Portal at http://help.sap.com under *Application Lifecycle Management → SAP Solution Manager → SAP Solution Manager 7.1 → Configuration and Deployment Information → Configuration Guide → 6 Additional Guides*

Note:

> If errors occur in the transfer of data to the SLD, you can check the log file smlreg.log and the nameserver trace (trace topics SLDCollect and SLDSend). The SLD data supplier is traced in the nameserver's regular trace file as part of database tracing.
> More information: Diagnosis Files

Configuring Alerts

Configuring E-Mail Notifications

You can configure the statistics server so that the system notifies you by e-mail about important system alerts.

Procedure

1. In the Administration Editor, choose the *Alerts* tab.
2. Choose *Configure Check Settings*.
   The *Configure Check Settings* dialog box is displayed. The default tab is *Configure E-mail Functions*.
3. Complete the following information:

Information	Description
Sender E-mail Address	This must be a valid e-mail address.
SMTP Server	This must be a valid SMTP server.
SMTP Port	Default is port 25.

4. Optional: Choose *Modify Recipients* and add the e-mail addresses of those users who you want to receive an e-mail notification when all checks produce alerts.
   Note that you can omit this step and only configure e-mail notification for specific checks.

5. Choose *Recipients Configuration* for Specific Checks.

   This opens a new part of the dialog box in which you can add e-mail recipients for specific checks. There is a list of checks for which you can add recipients. These recipients will only receive an e-mail notification when the specified checks produce alerts.

6. Select the checks for which you want to configure e-mail notification and then choose *Add Recipients* to add the e-mail addresses of the users to be notified.

7. Choose *OK* to save the configuration.

Result

Notifications about system alerts are sent to the specified recipients from now on. An e-mail is sent when the rating of an alert changes.

Configuring Check Thresholds

You can configure the thresholds at which the statistics server generates alerts. Each check has a *Low*, *Medium* and *High* priority threshold. For example, for the *Check disk space* option, you could enter *90*, *95* and *100* as the thresholds. This threshold is shown as a percentage of disk space available.

Procedure

1. In the Administration Editor, choose the *Alerts* tab.
2. Choose *Configure Check Settings*.
   The *Configure Check Settings* dialog box is displayed. The default tab is *Configure E-mail Functions*.
3. Choose the *Configure Check Thresholds* tab.

4. Choose the field you want to change and enter the threshold.
5. Choose *OK* when you have finished configuring the check thresholds.

Result

Alerts are generated in line with the configured thresholds. The color of the bar views on the *Overview* tab may change when the thresholds are changed, for example, you change the disk space threshold from *90*, *95* and *100*, to *85*, *90* and *95*. If the disk is on 95% usage, then the bar view would change from yellow to red.

Configuring Start Times on Check Intervals

You can configure the start times for system checks that are performed every 6 hours and every 24 hours. The intervals between checks are pre-configured.

Procedure
1. In the Administration Editor, choose the *Alerts* tab.
2. Choose *Configure Check Settings*.
   The *Configure Check Settings* dialog box is displayed. The default tab is *Configure E-mail Functions*.
3. Choose the *Configure Start Time on Check Intervals* tab.
   There are two sections. One for setting the start time for checks with 6 hour intervals and one for setting the start time for checks with 24 hour intervals. In each section there is a list of the checks that this setting will affect.
4. Set the start time using the buttons on the right of the time field, or type the desired time directly into the time field.
5. Choose *OK*.

Result

The start time for the checks is changed.

Failover Concept

During installation of distributed landscapes, some hosts can be added to the landscape as standby hosts. These are cold standby, which means that all new database processes (nameserver, indexserver, and so on) are running, but they are idle and do not allow SQL connections. In case of failover, they have to open the volume previously assigned to a failed host. This is not called hot standby because failover detection and loading takes some time (1 to *xx* minutes).

Landscape Startup

Up to three hosts can be configured as master nameserver*s*. During landscape start-up, one is elected as the active master. Other hosts will wait until a master is available.
The master nameserver assigns a volume to each starting indexserver or no volume if it is standby. The master indexserver (providing metadata for other indexserver*s*) and statisticsserver are assigned on the same host as the master nameserver.

Nameserver Failover

If the master host fails, one of the remaining master candidates becomes the active master. When the failed host is available again, the master does not failback.

Indexserver Failover

The nameserver processes (which are running on each host in a distributed landscape) are responsible for detecting a failure and executing the failover.

An active indexserver is assigned to one volume. A volume is a collection of directories where data and log area are stored. A standby indexserver is started without a volume and it does not open an SQL port.

In case of failover, the master nameserver assigns a volume to a standby indexserver. If the host with the master nameserver failed, a new master nameserver is elected and the new master nameserver executes additional indexserver failover.

When the failed host is available again, the volume does not fail back. Before failover the *nameserver* waits some time (1-3 minutes) to allow restart of the old server. This prevents unnecessary failover.

Statistics Server Failover

By default the statistics server runs on the same host as the master nameserver. Therefore, a failover of the statistics server only happens at the same time as a failover of the master nameserver.

On the standby host, no statistics server is configured. In case of failover, first the new master nameserver is started. Then the new master nameserver takes care of additional indexserver and statistics server failovers. In order to do this, the new master nameserver configures and starts the statistics server on the new master host. On the failed host, the statistics server configuration is removed.

Failback

There is no automatic failback because this causes downtime while a volume is unassigned.

Failover Group

A failover group can be defined for each host. In case of failover, the nameserver tries to fail over to a host within the same group. This can be used in the following situations:

- Blades and storage are located within different racks
  In case of failover, it should stay in the same rack to get better network performance.
- Hosts have different CPU/memory configuration
  In case of failover, a host with similar configuration should be used.

Configuring Clients for Failover Support

To support failover with our client libraries, you have to specify a list of hostnames separated by a semicolon, instead of a single hostname. The client chooses one of these hosts for connecting. If the selected host is not available, the next host from the list is used. Only if all hosts are not available will a connection error be displayed. We recommend that you specify all hosts that are configured as master nameserver because at least one of these hosts will be active.

If a connection gets lost when a host is no longer available, the client reconnects to one of the hosts specified in the host list. For example:

Client	Example
JDBC	Connect URL: jdbc:sap://host1:30015;host2:30015;host3:30015/
SQLDBC	SQLDBC_Connection *conn = env.createConnection(); SQLDBC_Retcode rc = conn->connect("host1:30015;host2:30015;host3:30015", "", "user", "password");
ODBC	Connect URL: "DRIVER=HDBODBC32;UID=user;PWD=password;SERVERNODE=host1:30015;host2:30015;host3:30015;DATABASE=xxx"

Customizing the Administration Console

There are many options available for customizing the Administration Console of the SAP HANA studio.

1. From the main menu, choose *Window → Preferences → Administration Console*.

2. Make the required settings.

Preferences: Catalog

Option	Description
Show only own database catalog objects	If this option is selected, only the database objects that belong to the database user who is currently logged on are displayed.
Fetch all database catalog objects	By default the SAP HANA studio fetches a limited number of catalog objects when folders such as *Tables* and *Views* are opened. When there are a large number of catalog objects in the database a *Continue* button is displayed. If this option is selected, all catalog objects are loaded in the corresponding folder and no *Continue* button is displayed. This may affect system performance as it may take some time to fetch all database catalog objects.
Number of database catalog objects to display	You can specify the number of catalog objects to be fetched. The default number is 1000.

Preferences: Common

Option	Description
Confirm saving editors	If this option is selected, the system displays a confirmation dialog box when an editor is closed with content that was not saved.
Autosaving of SQL Content • *Save content when HANA Studio is closed* • *Save content every … minutes*	If this option is selected, the content of edited SQL editors is saved automatically when the SAP HANA studio is closed. No dialog requesting the user to save is displayed. Additionally, it is possible to have the content saved at a specified interval. If The SAP HANA studio is closed unexpectedly, the last version can be recovered.

Copy options *Separate data with:* • *Tab separated* • *Align copied values with space* • *Copy cell in editor by using [CTRL] C* • *Copy editor content with column header*	Format for copying content from the table editor.
Representation of null value	Character used to display NULL values.
Database identifier upper case	Names of database objects can only be entered in upper case (all caps).
Default action for database tables	Action that is carried out when double-clicking a database table.
Table Distribution Editor • *Max. Number of Tables Displayed*	Indicates the maximum number of tables that are displayed when you open view table distribution.

Preferences: Global Settings

Option	Description
Update state of databases on startup	The state of all registered databases is determined when the SAP HANA studio starts.
Confirm opening of Merged Diagnosis Files dialog	These options control the appearance of information dialogs on the *Diagnosis Files* tab.
Opening information dialog after deleting files	
Open information dialog after trace files	

Preferences: Result

Option	Description
Limit for LOB columns (Bytes)	Maximum number of bytes that are loaded from the database for one LOB column.
Limit for Zoom (Bytes)	Maximum number of bytes that the Studio should display when you zoom in the LOB column of a results table.
Append exported data to file	When you export a result table to a file, the system attaches the content of this result table to the existing file content.
Display char byte value as hex	Data of the data type CHAR BYTE is displayed as hexadecimal digits. If you do not choose this option, this data is displayed in binary format.
Format values	Specifies whether country-specific formatting is applied (example: numeric values or dates).
Display the duration of fetching a row	You can see in the SQL how long it took to fetch one row of a result set.
Max displayed rows in result	Maximum number of rows fetched from the database and

	displayed in the result editor.
Enable zoom of LOB columns	This option must be enabled if you want to fetch a large amount of (zoom) LOB values in the result editor.

Preferences: SQL

Option	Description
Stop batch SQL statement execution on error	When you execute a list of SQL statements that is separated by comment characters, the system stops the execution of the SQL statements when an error occurs.
Clear SQL editor log before SQL statement execution	The log from the last SQL statement is deleted before the next SQL statement is executed.
Close results before SQL statement execution	When you execute an SQL statement in an SQL editor, all old results windows in that SQL editor are closed.
Display time of statement execution start	You can see in the SQL editor when a statement was executed.
Display the duration of failed statements	You can see in the SQL editor how long a statement took in the SAP HANA studio even when the statement failed.
Connection parameters for SQL window: - Autocommit mode - Isolation level	Connection parameters that the system uses to execute SQL statements from the SQL editor: • Auto-commit mode: ON: The system performs all COMMIT actions automatically. OFF: You have to enter COMMIT statements explicitly. • Isolation level: The isolation level determines how the database system implicitly controls locking and versioning of database objects. • Confirm change of connection: In the SQL editor, you can change the SQL connection you are working on. When changing a connection, cursors might get closed or transactions might get roll backed. This option gives you the opportunity to confirm this before proceeding.
Command separator	Separator for SQL statements in the SQL editor.
Number of tables for table name completion	Number of tables that are displayed in the list when using name completion in the SQL editor.

Preferences: Table Viewer

Option	Description
Show gridlines	These options enable you to format the tables when using the SAP HANA studio.
Alternating colored rows	

Preferences: Templates

Option	Description
The settings always refer to the editor type that is currently open.	

SQL Editor	
Name	Word to be completed when you press the key combination `CTRL + Space`. You can create more than one template with the same name. If more than one template exists for one word, the system displays a list.
Context	Editor in which you can use the template.
Description	-
Auto Insert	If ON, the code assist automatically inserts the template if it is the only proposal available at the cursor position.

Periodic Administration Tasks

Backing Up Systems

More information: SAP HANA Database – Backup and Recovery Guide on SAP Help Portal at http://help.sap.com/hana_appliance.

Managing Tables

Viewing and Modifying Table Distribution

To support the analysis and monitoring of performance issues in a distributed system, a Table Distribution Editor is available in which you can see how tables are distributed across the hosts. In the case of partitioned tables, you can also see how the individual partitions and sub-partitions are distributed, as well as detailed information about the physical distribution, for example, part ID, partition size, and so on. You can move tables and table partitions between the available hosts, for load balancing, for example.

1. Open the Table Distribution Editor by right-clicking any of the following entries in the navigator and then choosing *Show Table Distribution*:
   - Catalog
   - Schema
   - Table

   Note:

   For performance reasons, not all tables of the selected schema are displayed, but only the first 1000 tables. You can change this setting in Preferences. If more tables exist in the selected schema, a message is displayed.
2. If necessary, use the filtering options to refine the list of tables displayed. For example, you can restrict the display to tables on specific hosts only.
3. To view the distribution information of a partitioned table, select the table in the overview list.
   The *Table Partition Details* area is then shown underneath.

   Note:
   You can only see table partition information for tables of type COLUMN as this is the only table type that can be partitioned.

4. To move a table to another host, proceed as follows:
   a. Right-click the table in the overview list and choose *Move Table...*
   b. Specify the host to which you want to move the table.
5. To move a table partition or sub-partition to another host, proceed as follows:
   a. Right-click the partition or sub-partition in the *Table Partition Details* area and choose *Move Partitions...*
      Note that you can select multiple partitions.
   b. Specify the host to which you want to move the partition(s).

More information: SAP Note 1650394 -SAP HANA DB: Partitioning and Distribution of Large Tables

Displaying the Content of Tables

1. In the navigator, right-click the table and choose *Content*.
   The contents of the table are displayed. Note that by default, only the first 1000 rows are displayed. You can change this setting in *Preferences*.
2. To view the full content of a table cell, for example a LOB value, choose *Export Cell* to... → *Zoom...* in the context menu of the cell.

Exporting Table Data

You can export table data to a file system and then import it back into your existing or another database. This may be necessary, for example, if you want to move data from a test system to a productive system, if you want to clone your system, or if you want to provide the data to support so they can replicate a certain scenario.

Column store tables can be exported in binary or CSV format, while row store tables can be exported only in CSV format. Exports in binary format are faster and more compact. However, CVS format is better if you need to use the data in a non-HANA system. It also has the advantage of being human readable.

Procedure

1. In the navigator, right-click the table to be exported in the navigator and choose *Export*.
   You can also select multiple tables.
   The Export wizard is displayed. The tables to be exported are displayed on the right of the window. You can search for additional tables to be exported by typing in the *Type name to find table* box.
2. Choose *Add* to add any tables to the list of tables to be exported.
3. Choose *Next*.
4. Select the file format you want to export the tables into, binary or CSV.
5. Specify whether you want to export the table definition and table data (*Catalog + Data*) or only the table definition (*Catalog Only*). For example, you may want to copy only the table definition in order to create a new table with the same structure.
6. Specify the location to which the file is to be exported.
7. Enter the number of parallel threads to be used for the export.
   The more threads you use, the faster the export will be. This does, however, impact the speed of the database as more threads uses more resources.
8. Choose *Finish*.

Result

The tables are exported to the specified file location.

Importing Table Data

1. In the navigator, right-click *Catalog* and choose *Import*.
2. Specify the location from which to import tables from and choose *Next*.
3. Enter the tables to be imported.

   If importing from a remote host, you must specify the tables to be imported. If importing from a local host, you can select the tables to be imported.
4. In the *Format* column of the *Selected Tables* list, choose the format of the files to be imported and choose *Next*.
5. Choose what information to import (for binary files only).

   If you are importing CSV files, this option is not available.
6. Enter the number of parallel threads to be used for the import.

   The more threads you use, the faster the import will be. This does, however, impact the speed of the database as more threads uses more resources.
7. Choose *Finish*.

Result

The specified tables are imported to your SAP HANA database.

Finding Tables

1. Choose   (*Find Table*) in the navigator toolbar.
2. Enter a search string (at least two characters). Matching tables are displayed immediately.
3. Select the table you were searching for.
4. Choose whether you want to display the table content and/or the table definition.

Creating Tables

1. In the navigator, open the catalog where you want to create the new table.
2. Choose *Create...* in the context menu of the schema to which you want to assign the table.
5. Enter the following information:
   - o Table name
   - o Table type (column or row store)
6. Define the columns of your table as follows:
   a. Enter the name and properties of the first column.
   b. To add further columns, choose *Add Column* in the context menu of the tab.
7. If necessary, add indexes.

   On the *Indexes* tab, choose *Add Index* in the context menu and enter the definition of your index.
8. To apply all your changes, choose *Create Table* in the context menu of the tab.

Creating Views

1. Select a table in the navigator.

2. In the context menu of the table, choose *New → View*.

3. Enter a view name.

4. Drag all relevant tables into the editor area.

   More information: Defining Joins and Views using Visual SQL Builder

5. To create the view, choose *Execute* in the context menu of the editor.

Defining Joins and Views using Visual SQL Builder

As an alternative to the SQL editor, you can use the Visual SQL builder to create joins and views using a graphical user interface.

Procedure

1. Select a table in the navigator.

2. In the context menu of the table, select *New View* or *Generate → Visual SQL*.

   Note that if you choose to creat a new view, you must specify a view name and the schema.

3. Drag and drop tables from the navigator to the editor area.

4. To create a join, drag a column from one table to the column of another table.

Visual SQL Builder: Drag&Drop
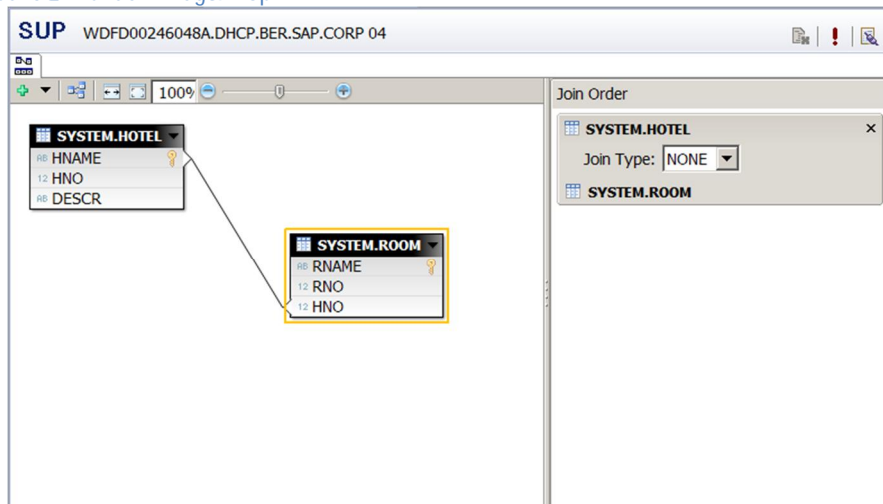
5. Choose the join type in the Join *Order* box.
   If you have defined more than one join, you can define the order in which the joins are executed using drag and drop.

6. Drag and drop the columns to be contained in the result set into the *Columns* area.
   You can specify additional constraints or create synonyms for column names after dragging the relevant columns there.

Visual SQL Builder, Columns
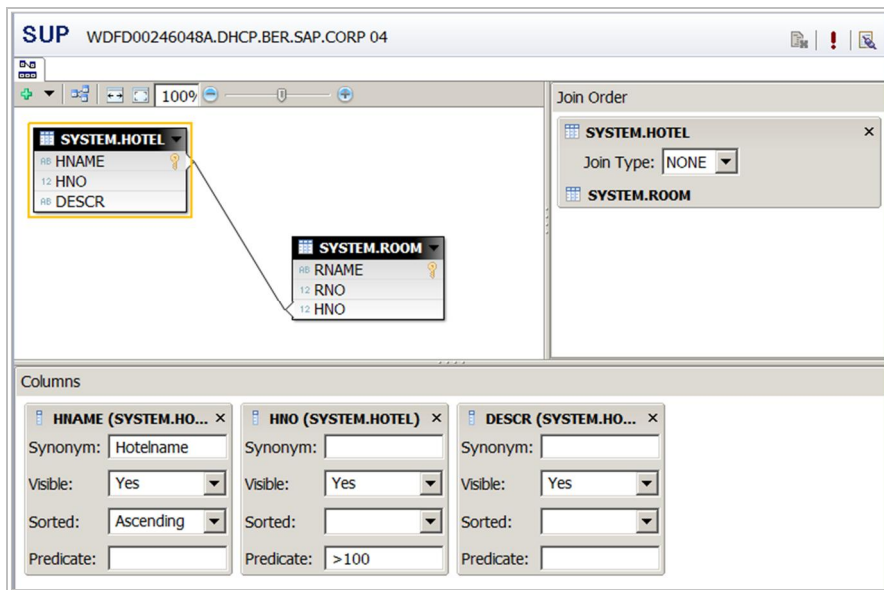
- To preview the data in the join, choose *Data Preview* in the context menu of the editor.
- To show the equivalent SQL statement, choose *Export SQL* in the context menu of the editor.

7. To execute the join, choose *Execute* in the context menu of the editor.

Loading, Unloading, and Merging Table Data

The Load, Unload, and Merge functions can be used on column tables only.

The Load function loads the complete table, including the delta, into the memory. Depending on the size of the table, this may take some time.

The Unload function removes the table, including the delta, from the memory. The next access to this table will be slower as the data has to be reloaded into the memory. Depending on the size of the table, this may take some time.

The Merge function merges the committed entries from the delta into the table.

Procedure

1. Select the column table in the navigator to be loaded, unloaded, or merged.
2. In the context menu of the table, choose *Load*, *Unload* or *Merge* as required.
3. Choose *OK*.

Troubleshooting

The SQL Editor

Many operations in the system require you to use SQL statements. You can enter and execute SQL statements in the SQL editor.

Executing SQL Statements

1. In the navigator, select the system that you want to connect to using SQL and then choose
   (*Open SQL Editor for Current Selection*) in the navigator toolbar.

2. Enter the SQL statement. The following rules apply:
   - You can write SQL syntax elements in either upper or lower case.
   - You can add any number of spaces and line breaks.
   - To force the system to distinguish between upper/lower-case letters in database object names (such as table names), enter the name between double quotation marks: "<database_object_name>"
   - To comment out a line, use - - (double hyphens) at the start of the line
   - To use name completion, press the key combination CTRL + Space. This opens a list from which you can choose: Schema and table names, SQL keywords, user-defined templates.
   - Enter multiple SQL statements, separated by the configured separator character (semicolon ";" by default).

3. To execute the SQL statement, choose *Execute SQL* in the context menu of the SQL editor.

Analyzing SQL Performance

During performance monitoring, you may discover SQL statements that are particularly costly for the database, for example, statements identified by the expensive statements trace. You can analyze such statements further in the SQL Editor using the following features.

Explain Plan

You can evaluate the execution plan that the SAP HANA database follows to execute an SQL statement by entering the statement and then choosing *Explain Plan* in the context menu. You can enter multiple statements, separated by the configured separator character (usually a semicolon), to generate several plan explanations at once. It is also possible to run the same statement on different systems/users by changing the SQL connection. That is, assuming that the tables and views exist in the other systems and you have authorization to access them.

Visualize Plan

To help you understand and analyze the execution plan of an SQL statement, you can generate a graphical view of the plan.

Procedure

1. Enter a query into the SQL editor and choose *Visualize Plan* in the context menu.
   A graphical representation of the query, with estimated performance, is displayed:
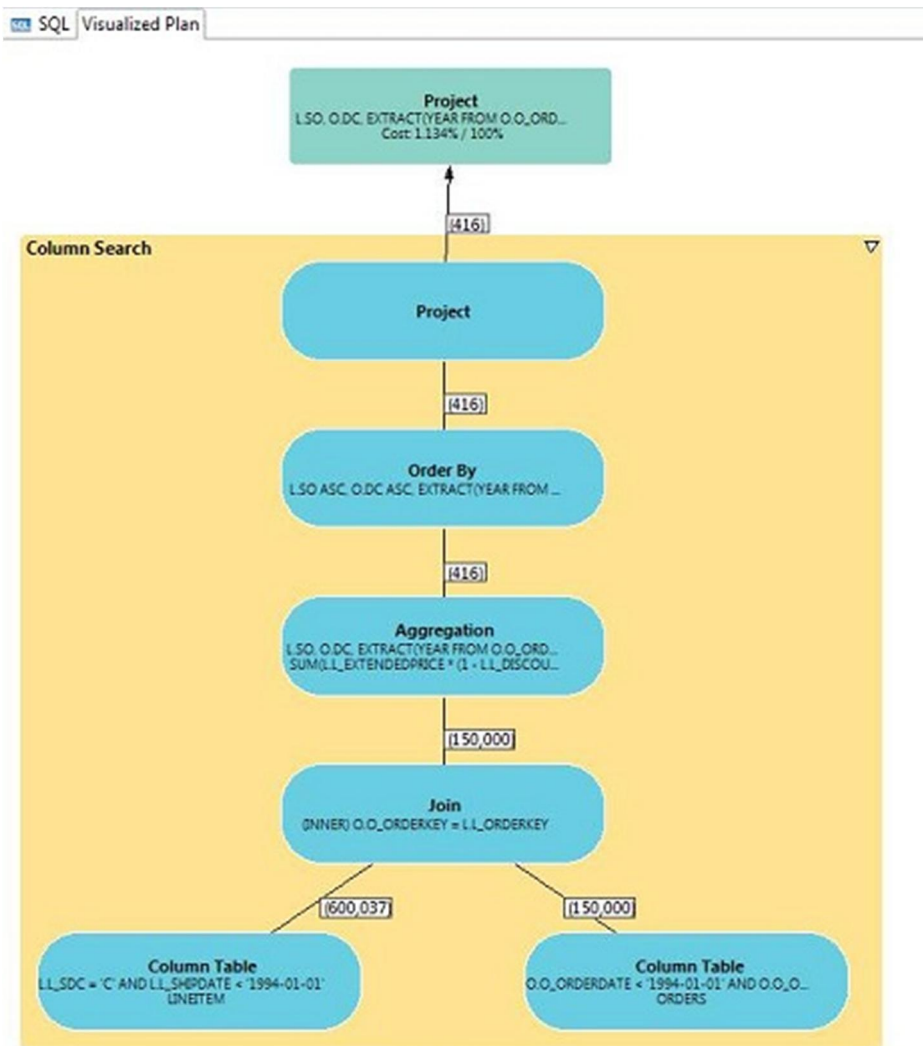
2. Validate the estimated performance by choosing *Execute* in the context menu.
   A similar high-level graphic is generated with execution time information for each of the parts:
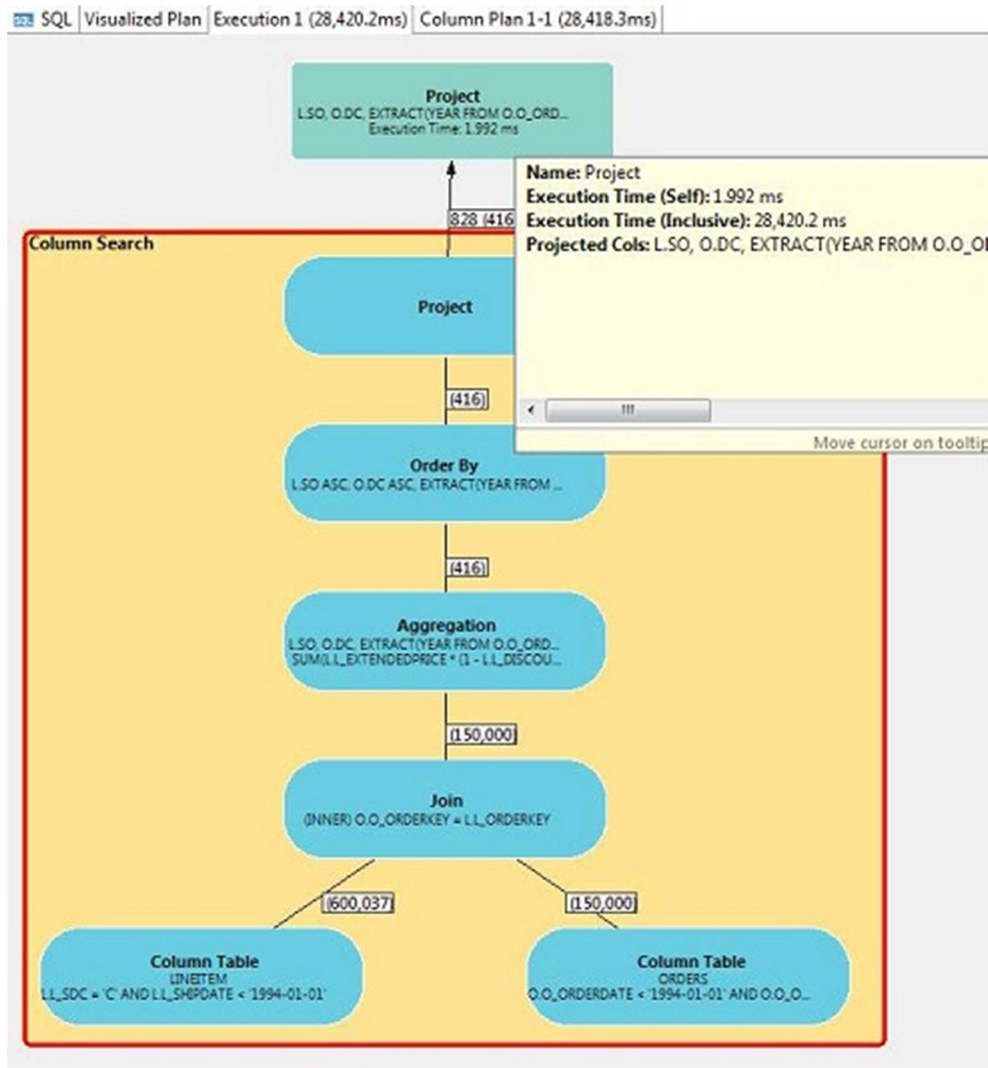
Note that execution time is given as a pair of values: "self" (the execution time of the node), and "Inclusive" (the execution time including the descendent nodes.

3. If the query used the SAP HANA Column Engine, you can view the details of the various database operations by choosing *Visualize Column Plan* in the context menu.
A detailed graphic is displayed:
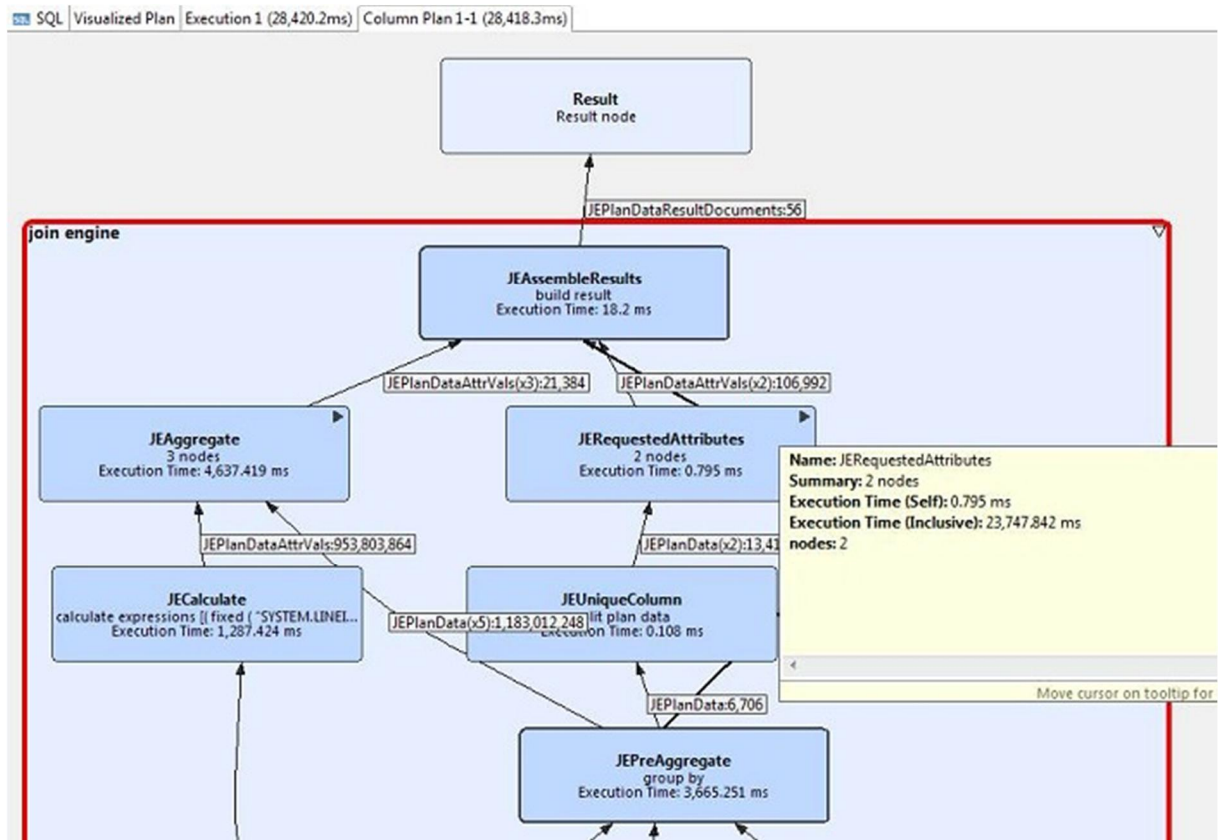
This graphic is a very powerful tool for studying performance of queries on SAP HANA databases. You can explore the graphic further, for example, you can expand, collapse, or rearrange nodes on the screen. You can also save the graphic as an image or XML file, for example, so you can submit it as part of a support query.

Resolving a Disk Full Event

When the disks/storage system on which the database volumes are located run full, the database is suspended, an internal event is triggered, and an alert is generated. In addition to the size and usage information contained on the *Overview* tab of the Administration Editor, a *Disk Full Event* field is displayed. A disk full event must be resolved before the database can resume.

> ⚑ Note:
> You can also view the alert information on the *Alerts* tab.

Procedure

1. Check on the *Volumes* tab (*Show: Storage*) to see whether the database is using all the space or whether additional files are using the space. The storage size and volume size can be compared here.
   More information: Monitoring Disk Space
2. Remove files that are not needed (in case additional files are stored on the SAP HANA storage system) or add additional storage space.
3. On the *Overview* tab, choose the *Disk Full Events* link.
4. Mark the event as handled.

Result

The database resumes.

Diagnosis Files

Diagnosis files hold a mixture of diagnosis, error, and information messages.

In the event of problems with SAP HANA database, you can check these diagnosis for errors. You can see an overview of all files on the *Diagnosis Files* tab of the Administration Editor. We recommend that you monitor disk space that is used for diagnosis files and delete files that are no longer needed.

Displaying Diagnosis Files

To display a file in the list, right-click it and choose *Open*, or double-click the file.

The *Show Start of File* and *Show End of File* buttons help you to navigate particularly large files more easily. You can specify how many lines you want to see when you filter the file in this way.

Merging Diagnosis Files

You can merge the diagnosis files listed on the *Diagnosis Files* tab by choosing *Choose Merge Files....* This feature is helpful during troubleshooting as it allows you to review multiple diagnosis files of different file types at the same time. The merged file is created from the most recent diagnosis files. Once the file has been created, you can use the filtering options and timeframe slider to drill down and analyze further.

> 🔲 Note:
> Merging diagnosis files can take a long time depending on the size and number of files to be merged.

Deleting Diagnosis Files

You can delete one or more files from the list by selecting the file(s) in question and choosing *Delete* in the context menu.

In the case of trace files (files ending in*.trc), it is also possible to delete several files at once, for example all files from specific services. To delete multiple trace files, choose *Delete Trace Files...*

> 🔲 Note:
> If the deletion of selected trace files fails, the content of the files is still deleted.

Downloading Diagnosis Files

To download a diagnosis file for offline analysis, right-click and choose *Download.* You can select multiple files to download.

Configuring Traces

You can activate and configure several traces on the *Trace Configuration* tab of the Administration Editor. Trace data is saved to trace files that can be viewed on the *Diagnosis Files* tab.

The following traces can be configured:

- Performance trace
- SQL trace
- Global database trace

- Database trace
- User-specific trace
- End-to-end trace
- Expensive statements trace

Procedure
1. In the Administration Editor, open the *Trace Configuration* tab.
2. Choose the *Edit Configuration* icon for the trace.
   The *Trace Configuration* dialog appears.
3. Make the required settings.
   The configuration options available in the *Trace Configuration* dialog depend on the trace type.

🔒 Note:
To be able to configure all traces, except the performance trace, you need the system privilege INIFILE ADMIN. For the performance trace, you need the privilege TRACE ADMIN.

Default Trace Status/Configuration

Trace	Default Status/Configuration
Performance trace	Inactive
SQL trace	Inactive
Global database trace	Active with default configuration
Database trace	Active with default configuration
User-specific trace	Not specified
End-to-end trace	Active with default configuration
Expensive statements trace	Inactive

🔒 Note

To restore the default status or configuration of a trace, in the *Trace Configuration* dialog choose *Restore Defaults*.

Configuration Options for Performance Trace
The following configuration options are available for the performance trace:
- You can configure the trace for a single specific database user and a single specific application user.
- You can trace execution plans in addition to the default trace data by choosing the corresponding checkbox.
- You can specify the file name to which the trace data is automatically saved after the performance trace is stopped.
- You can specify the trace duration.
  If a certain scenario is to be traced, ensure that you enter a value greater than the time it takes the scenario to run. If there is no specific scenario to trace but instead general system performance, then enter a reasonable value. After the specified duration, the trace stops automatically.

Configuration Options for SQL Trace

The following configuration options are available for the SQL trace:

- You can activate and deactivate the SQL trace by selecting the corresponding checkbox. The SQL is inactive by default.
- If you have activated the SQL trace, you can choose from the following trace levels:

Trace Level	Note
ERROR	Indicates an error situation that can be recovered. ERROR is the default trace level. ERROR situations are always written to the log.
ERROR_ROLLBACK	Indicates statements that returned errors or that were rolled back
ALL	All statements
ALL_WITH_RESULTS	All statements with results

- You can configure the trace for specific database users and application users.
- You can limit the trace to specific tables and views.
- You can limit the trace to certain statement types.
- You can adapt the flush interval if required.
  During tracing, the messages of a connection are buffered. As soon as the flush interval number of messages is buffered (or if the connection is closed), those messages are written to the trace file.

  The trace data is stored in python files starting with *sqltrace_<servername>.*

More information: SAP HANA Database – SQL Script Guide on SAP Help Portal at http://help.sap.com/hana_appliance.

Other Available Traces

The global database, database, and user-specific traces are written for several services of the system (for example, *indexserver* and *nameserver*) to files *<servicename>.trc*. Some of these traces are always activated by default.

You can activate or deactivate these traces and change what is to be traced in the *Trace Configuration* dialog.

> 🔲 Note:
> Not all trace components are visible by default in *Trace Configuration.* To view all additional components, select check *Show All Components.*

The following trace levels are available:

Trace Level	Note
NONE	Trace is off. FATAL and ERROR situations will still be recorded.
FATAL	Indicates an extreme error situation that cannot be recovered and that would

	lead to a failure or an exit. FATAL errors are always written to the log.
ERROR	Indicates an error situation that can be recovered. Error is the default trace level. ERROR situations are always written to the log.
WARNING	Indicates that you should investigate the situation.
INFO	Information only
DEBUG	Verbose trace information. Trace level DEBUG is intended for debugging.

The expensive statements trace collects SQL statements whose execution time was above a threshold (1000000 microseconds by default). Expensive statements may reduce the performance of the database. You can also monitor expensive statements on the *Performance* tab. The expensive statements trace is Inactive by default.

The end-to-end traces are triggered by applications outside of the SAP HANA database. The default trace levels for SAP HANA database components are normally sufficient and do not need to be changed.

For more information about end-to-end analysis in your landscape, see SAP Library for Solution Manager on SAP Help Portal at http://help.sap.com under *Application Lifecycle Management → SAP Solution Manager → SAP Solution Manager 7.1 → Application Help → SAP Library → Technical Operations → Root Cause Analysis*.

Opening a Support Connection

Support users can log into the system with read-only access in case of troubleshooting situations.

To enable them to do so, you must have completed the following:

- Install the SAPRouter
  More information: SAP Support Portal at http://service.sap.com/saprouter
- Set up a support connection
  More information: SAP Note 1634848 - Set up a support connection
- Configure Telnet connection
  More information: SAP Note 37001 - Telnet link to customer systems
- Configure SAP HANA database connection
  More information: SAP Note 1592925 - SAP HANA database service connections
- Configure TREX/BIA/HANA service connection
  More information: SAP Note 1058533 - TREX/BIA/HANA service connection to customer systems

Create a Database User and grant MONITORING role

The MONITORING role allows read-only access using the Administration Editor. However, this role does not provide any privileges for accessing application data, only for monitoring the system status, statistics server, trace files, and so on. With the MONITORING role, it is also not possible to change the configuration or start and stop a system. You can grant the MONITORING role to a support engineer if SAP support needs to connect to the system. Depending on the issue to be analyzed,

further privileges may be needed to allow sufficient analysis (for example, to access application data or data models).

Collecting System Information for Support

There is a Python script that allows you to collect information from your systems even when no access to the system via SQL is possible. This information can be added to the support message.

Location and Usage

The name of the Python script is fullSystemInfoDump.py and is part of a server installation. It runs from a command line and is located in the directory `$DIR_INSTANCE/exe/python_support` (Linux).

To execute the script `<sid>adm` rights are required.

To start the script out of its location directory, enter:

```
python fullSystemInfoDump.py
```

By default the script creates a zip file with all of the collected support information to the directory `DIR_TEMP/system_dump` where `DIR_TEMP` is the content of the variable with the same name in `sapprofile.ini`. This output directory is shown as console output when the script is running, but it can be looked up by entering:

```
hdbsrvutil -z | grep DIR_TEMP=
```

To change the default directory, an explicit absolute path can be given to the script, for example:

```
python fullSystemInfoDump.py <output_dir>
```

Usage information can be displayed by entering:

```
python fullSystemInfoDump.py -h
```

To collect support information you need an SQL user with rights to select the system tables and views listed in System Tables/Views. For security reasons the user name and password for this SQL user cannot be given as command line parameters to the script. Instead you are prompted for this information:

```
ts1adm@luvm252058a:/usr/sap/TS1/HDB01/exe/python_support> python
fullSystemInfoDump.py

User name: SYSTEM

Password:
```

The password is not displayed on the command line.

If the system can be reached via SQL and the user name and password information is valid, the script starts collecting support information. If user name and/or password are invalid, the script aborts.

If the system cannot be reached via SQL the script only collects information that can be read without SQL access.

The resulting zip file name has the following structure:

```
fullsysteminfodump_<SAPLOCALHOSTFULL>_<SAPSYSTEMNAME>_<YYYY>_<MM>_<DD>_<HH>_<MM>_<SS>.zip
```

`SAPLOCALHOSTFULL` and `SAPSYSTEMNAME` are again taken from `sapprofile.ini`.

Information collected in any case (SQL available and not available)

Protocol file

All information about what has been collected is shown as console output and is written to a file named `protocol.txt` that is stored in the zip file.

Trace Files

From every trace file listed below, the most recent 300 lines are collected and each of them is stored in a file with the same name as the trace file.

```
$DIR_INSTANCE/<SAPLOCALHOST>/trace/daemon_<SAPLOCALHOST>.<...>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/indexserver_alert_<SAPLOCALHOST>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/indexserver_<SAPLOCALHOST>.<...>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/nameserver_alert_<SAPLOCALHOST>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/nameserver_history.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/nameserver_<SAPLOCALHOST>.<...>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/preprocessor_alert_<SAPLOCALHOST>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/preprocessor_<SAPLOCALHOST>.<...>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/statisticsserver_alert_<SAPLOCALHOST>.trc
$DIR_INSTANCE/<SAPLOCALHOST>/trace/statisticsserver_<SAPLOCALHOST>.<...>.trc
```

Configuration Files

All of the following configuration files (ini files) are collected:

```
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/attributes.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/daemon.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/executor.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/extensions.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/filter.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/global.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/indexserver.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/inifiles.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/localclient.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/mimetypemapping.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/nameserver.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/preprocessor.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/scriptserver.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/statisticsserver.ini
$DIR_INSTANCE/<SAPLOCALHOST>/exe/config/validmimetypes.ini
```

Additional Information Collected if SQL is Available

System Tables/Views

All rows of the following system tables/views are exported into a csv file with the name of the table:

```
SYS.M_INIFILE_CONTENTS
SYS.M_LANDSCAPE_HOST_CONFIGURATION
SYS.M_SERVICE_STATISTICS
SYS.M_SYSTEM_OVERVIEW
SYS.M_TABLE_LOCATIONS
_SYS_STATISTICS.STATISTICS_ALERT_INFORMATION
_SYS_STATISTICS.STATISTICS_INTERVAL_INFORMATION
_SYS_STATISTICS.STATISTICS_LASTVALUES
_SYS_STATISTICS.STATISTICS_STATE
_SYS_STATISTICS.STATISTICS_VERSION{}
```

Only the most recent 3000 rows from the following system tables/views are exported into a csv file with the name of the table:

```
_SYS_STATISTICS.GLOBAL_COLUMN_TABLES_SIZE
_SYS_STATISTICS.GLOBAL_CPU_STATISTICS
_SYS_STATISTICS.GLOBAL_INTERNAL_EVENTS
_SYS_STATISTICS.GLOBAL_MEMORY_STATISTICS
_SYS_STATISTICS.GLOBAL_PERSISTENCE_STATISTICS
_SYS_STATISTICS.GLOBAL_TABLES_SIZE
_SYS_STATISTICS.HOST_COLUMN_TABLES_PART_SIZE
_SYS_STATISTICS.HOST_DATA_VOLUME_PAGE_STATISTICS
_SYS_STATISTICS.HOST_MEMORY_STATISTICS
_SYS_STATISTICS.HOST_ONE_DAY_FILE_COUNT
_SYS_STATISTICS.HOST_RESOURCE_UTILIZATION_STATISTICS
_SYS_STATISTICS.HOST_VOLUME_FILES
_SYS_STATISTICS.INDEX_SERVER_HEAP_MEMORY_STATISTICS
_SYS_STATISTICS.STATISTICS_ALERTS
_SYS_STATISTICS.STATISTICS_ALERT_LAST_CHECK_INFORMATION
```

Additional information collected in case SQL is not available

Topology information

All available topology information is exported into a file named `topology.txt`. It contains information about the host topology in a tree-like structure. The keys are grouped using brackets while the corresponding values are referenced by this symbol ==>. For example:

```
[]
  ['host']
    ['host', 'ld8521']
      ['host', 'ld8521', 'role']
        ==> worker
      ['host', 'ld8521', 'group']
        ==> default
      ['host', 'ld8521', 'nameserver']
        ['host', 'ld8521', 'nameserver', '30501']
          ['host', 'ld8521', 'nameserver', '30501', 'activated_at']
            ==> 2011-08-09 16:44:02.684
          ['host', 'ld8521', 'nameserver', '30501', 'active']
            ==> no
          ['host', 'ld8521', 'nameserver', '30501', 'info']
```

```
['host', 'ld8521', 'nameserver', '30501', 'info', 'cpu_manufacturer']
  ==> GenuineIntel
['host', 'ld8521', 'nameserver', '30501', 'info', 'topology_mem_type']
  ==> shared
['host', 'ld8521', 'nameserver', '30501', 'info', 'sap_retrieval_path_devid']
  ==> 29
['host', 'ld8521', 'nameserver', '30501', 'info', 'build_time']
  ==> 2011-07-26 17:15:05
['host', 'ld8521', 'nameserver', '30501', 'info', 'net_realhostname']
  ==> -
['host', 'ld8521', 'nameserver', '30501', 'info', 'build_branch']
  ==> orange_COR
['host', 'ld8521', 'nameserver', '30501', 'info', 'mem_swap']
  ==> 34359730176
['host', 'ld8521', 'nameserver', '30501', 'info', 'mem_phys']
```

Displaying System Information

The *System Information* tab contains the following tables, which are useful for system monitoring:

- Transactions
- Table Locks
- Size of Tables on Disk
- Session Context
- SQL Plan Cache
- Record Locks
- Query Cache
- Overall Workload
- Open Transactions
- Merge Statistics
- Memory of All Row Tables
- Lock Waiting History
- Loaded Memory of Column Tables
- Index Server Memory Usage
- Database Information
- Connections
- Connection Attempts and Status
- Connection Statistics
- Component Memory Usage
- Caches
- Blocked Transactions
- Backup Catalog

For more information about these system tables, see System Tables and Monitoring Views on SAP Help Portal at http://help.sap.com/hana_appliance under *Application Help → References.*

Appendix **A**

SAP HANA HDBSQL

SAP HANA HDBSQL is a command line tool for entering and executing SQL statements, executing database procedures, and querying information about SAP HANA databases. You can use HDBSQL interactively or import commands from a file and execute them in the background. You can access databases on your local computer and on remote computers.

> **Note:**
> The SAP HANA studio has similar functions to HDBSQL, but provides a graphical user interface.
> HDBSQL can be used on all operating systems supported by the database system. It is a component of the SAP HANA software.

Features

- Executing SQL Statements
- Executing Database Procedures
- Requesting Information About the Database Catalog
- Executing Shell Commands
- Executing Commands (command syntax and options)
- Overview of All HDBSQL Call Options
- Overview of All HDBSQL Commands

Logging On to **a** Database

To use the HDBSQL interactively (in session mode), you log on to the database as a database user. This opens a database session.

Prerequisites

The specified user is a database user.

One Step Logon

Procedure

Enter the following command:

```
hdbsql [<options>] -n <database_host> -i <instance_id> -u <database_user> -
p <database_user_password>
```

Property	Description
`<options>`	Call options for HDBSQL. More information: Overview of All HDBSQL Call Options
`<database_host>`	Name or IP address of the database host.
`<database_user>`	Name of the database user.
`<database_user_password>`	Password of the database user.

Example

One step logon to the database on the PARMA computer with instance ID 01 as database user MONA with the password RED.

```
hdbsql -n PARMA -i 1 -u MONA -p RED
```

To log on using a `<user_key>`, enter the following command:

```
hdbsql [<options>] -U <user_key>
```

Two-Step Logon
Procedure

1. Start HDBSQL:
   ```
   hdbsql [<options>]
   ```
2. Log on to the database:
   ```
   \c [<options>] -n <database_host> -i <instance_id> -u
   <database_user>,<database_user_password>
   ```

More information:

- Executing Commands
- Overview of All HDBSQL Commands

Executing Commands

You can use HDBSQL to execute SQL statements, database procedures, and special HDBSQL commands.

Prerequisites

Some commands require you to be logged on to the database.

More information: Logging On to a Database

Executing an Individual Command in Interactive Mode (Session Mode)
Procedure

1. Call HDBSQL:
   ```
   hdbsql [<options>]
   ```

   More information: Overview of All HDBSQL Call Options

2. Enter the command.
   ```
   <command>
   ```

   🔔 Note
   You can also enter commands in multiple line mode or edit commands in an external file.
More information:

- Multiple Line Mode
- Editing Commands in an External File

Example

You start HDBSQL and log on to the HANA database as user MONA with the password RED:

```
hdbsql -n localhost -i 1 -u MONA -p RED
```

You display general information about the database:

```
\s
host         : wdfd00245293a:30015
database     : ORG
user         : SYSTEM
kernel version: 1.50.00.000000
SQLDBC version: libSQLDBCHDB 1.50.00 Build 0000000-0120
autocommit   : ON
```

Executing an Individual Command in Command Mode
Procedure

1. Call HDBSQL and enter the command directly.
   ```
   hdbsql [<options>] <command>
   ```

   Example

   ```
   hdbsql -n localhost -i 1 -u MONA,RED \s
   ```

2. If you want to enter an SQL statement or a database procedure as a command, place the SQL statement or database procedure in quotation marks.

   Example

   ```
   hdbsql -n localhost -i 1 -u MONA,RED "select table_name, table_type
   from tables"
   ```

3. HDBSQL executes the command and then exits.

Executing Several Commands from a Batch File
- If you are in interactive mode, enter the path and name of the batch <file> from which HDBSQL is to import the command as follows:
  ```
  \I <file>
  ```
- If you are working in command mode, enter the path and name of the batch <file> when you log on to the database as follows:
  ```
  hdbsql [<options>] -I <file>
  ```

More information:

- Redirecting Results to a File
- Overview of All HDBSQL Commands

Multiple Line Mode

This mode enables you to enter long commands on several lines. HDBSQL stores multiple line commands in an internal command buffer.

More information: Command Buffer

Prerequisites

You run HDBSQL in multiple line mode. You have the following options for activating multiple line mode:

Call option: `hdbsql [<options>] -m`

HDBSQL command: `\mu ON`

Activities

To start a new line in multiple line mode, press *Enter*.

To execute the command, either close the last line by entering a semicolon and pressing *Enter* or enter the command `\g`.

Example

1. Log on to the SAP HANA database in multiple line mode as user MONA with the password RED:
   ```
   hdbsql -n localhost -i 1 -u MONA,RED
   ```
2. Enter a multiple line SQL statement:
   ```
   select table_name, table_type
   from tables
   ```
3. Execute the SQL statement.
   ```
   \g
   ```

More information:

- Editing Commands in an External File
- Executing Commands

Command Buffer

If you call HDBSQL in multiple line mode, HDBSQL stores all commands in an internal command buffer.

More information: Multiple Line Mode

Activities

- Displaying the contents of the command buffer: `\p`
- Deleting the contents of the command buffer: `\r`
- Editing Commands in an External File
- Executing the command buffer: `\g`

Editing Commands in an External File

If you have entered a long command in HDBSQL, you can make changes to this command at a later stage by editing the command buffer in an external file.

More information: Command Buffer

Prerequisites

You have already executed a command.

More information: Executing Commands.

Procedure

1. To export the contents of the command buffer to an external file, enter the following command:

   `\o [<file>]`
   - Enter the complete file path and `<file>` name.
   - If you do not specify a file, HDBSQL generates a temporary file.

   The system opens the file in an editor. To determine which editor is used, HDBSQL evaluates the environment variables HDBSQL_EDITOR, EDITOR, and VISUAL in succession. If you have not set any of these environment variables, vi is used on Linux and Unix. For information on setting environment variables, see your operating system documentation.

2. Make the desired changes to the file.
3. Save the file in the editor then close file and editor.

Result

You have changed the contents of the command buffer and can now execute the changed command with the command `\g`.

More information:

- Multiple Line Mode
- Batch File

Batch File

HDBSQL can import commands from a batch file and process them in the background.

AUTOCOMMIT mode is activated as default. If you deactivate it, the batch file must contain an explicit COMMIT statement to ensure that HDBSQL executes the SQL statements immediately afterthe batch file has been imported.

Structure

The individual commands are in individual lines and separated by a semicolon.

You can specify the separator used in the batch file between two commands using the `-c` `<separator>` call option. The default value is `;`.

More information: Overview of All HDBSQL Call Options

Example

```
CREATE TABLE city
(zip NCHAR (5) PRIMARY KEY,
name NCHAR(20) ,
state NCHAR(2) );
CREATE TABLE customer
(cno INTEGER PRIMARY KEY,
title NCHAR (7),
firstname NCHAR (10) ,
name NCHAR (10),
zip NCHAR (5),
address NCHAR (25));
\dt customer;
COMMIT
```
In this example, AUTOCOMMIT mode is deactivated.

Redirecting Results to **a** File
 You redirect the result of one or more HDBSQL commands to a `<file>`.

Prerequisites
You are logged on to a database.

More information: Logging On to a Database

Procedure

1. Enter the following command:

   `\o <file>`

   🔹 Note
   Enter the full path of the file.

2. Enter the command whose result is to be redirected to the `<file>`.

   `<command>`

   To enter multiple commands in succession, press *Enter* after each command.

3. To stop redirection to a file, enter `\o`.

Example

1. Log on to the SAP HANA database as user MONA with the password RED:

```
hdbsql -n localhost -i 1 -u MONA,RED
```

2. Create the file c:\tmp\redirected.txt to which HDBSQL is to redirect the result:

```
\o c:\tmp\redirected.txt
```

3. Enter the following command:

```
\ds
```

4. Enter another command (SQL statement).

```
select * from HOTEL.CUSTOMER
```

5. Stop redirection to the file.

```
\o
```

The `redirected.txt` file now has the following content:

```
| Schema | Owner name      |
| ------ | --------------- |
| MDX_TE | SYSTEM          |
| SECURI | SECURITY1       |
| SOP_PL | SYSTEM          |
| SYS    | SYS             |
| SYSTEM | SYSTEM          |
| _SYS_B | _SYS_REPO       |
| _SYS_B | _SYS_REPO       |
| _SYS_R | _SYS_REPO       |
| _SYS_S | _SYS_STATISTICS |
```

```
| CNO  | TITLE   | FIRSTNAME | NAME     | ZIP   | ADDRESS|
| ------ | ------- | ---------- | ---------- | ----- | -------|
| 3200 | Company | ?       | Datasoft | 90018 | 486 Maple Str.|
| 3400 | Mrs     | Mary     | Griffith | 20005 | 3401 Elder Lane|
| 3500 | Mr      | Martin   | Randolph | 60615 | 340 MAIN STREET, #7|
| 3600 | Mrs     | Sally    | Smith    | 75243 | 250 Curtis Street|
| 3700 | Mr      | Mike     | Jackson  | 45211 | 133 BROADWAY APT. 1|
| 3900 | Mr      | George   | Howe     | 75243 | 111 B Parkway, #23|
| 4000 | Mr      | Frank    | Miller   | 95054 | 27 5th Str., 76|
| 4400 | Mr      | Antony   | Jenkins  | 20903 | 55 A Parkway, #15|
...
```

More information: Executing Commands

Executing SQL Statements

You execute an SQL statement in HDBSQL in interactive mode (session mode).

> **Note**
>
> For information about the other options for executing SQL statements in HDBSQL, see
> Executing Commands.

Prerequisites

You are logged on to the database.

More information: Logging On to a Database

Procedure

Enter the SQL statement.

```
<sql_statement>
```

Example

1. Log on to the SAP HANA database as user MONA with the password RED and choose SQL mode INTERNAL:

   ```
   hdbsql -n localhost -i 1 -u MONA,RED
   ```

2. Display the columns CNO, TITLE, FIRSTNAME, NAME, and ZIP of table HOTEL.CUSTOMER:

   ```
   select CNO,TITLE,FIRSTNAME,NAME,ZIP from HOTEL.CUSTOMER

   CNO | TITLE | FIRSTNAME | NAME | ZIP
   ----+-------+-----------+------+------
   3000 | Mrs | Jenny | Porter | 10580
   3100 | Mr | Peter | Brown | 48226
   3200 | Company | ? | Datasoft | 90018
   3300 | Mrs | Rose | Brian | 75243
   3400 | Mrs | Mary | Griffith | 20005
   3500 | Mr | Martin | Randolph | 60615
   3600 | Mrs | Sally | Smith | 75243
   3700 | Mr | Mike | Jackson | 45211
   3800 | Mrs | Rita | Doe | 97213
   3900 | Mr | George | Howe | 75243
   4000 | Mr | Frank | Miller | 95054
   4100 | Mrs | Susan | Baker | 90018
   4200 | Mr | Joseph | Peters | 92714
   4300 | Company | ? | TOOLware | 20019
   4400 | Mr | Antony | Jenkins | 20903
   (15 rows selected) * Ok
   ```

Requesting Information About the Database Catalog

You use an HDBSQL command to request information about the database catalog of a database in interactive mode.

> **Note**
> For information about the other options for executing HDBSQL commands, see Executing Commands.

Prerequisites

You are logged on to the database.

More information: Logging On to a Database

Procedure

Enter one of the HDBSQL commands listed below.

HDBSQL returns information about the database objects that correspond to the specified `[PATTERN]` or `[NAME]` and to which you have access. If you do not specify a pattern, the system displays information about all the database objects to which you have access.

HDBSQL Commands: Requesting Information About the Database Catalog		
Database Object	HDBSQL Command	Result
Column	`\dc [PATTERN]`	• Column name • Data Type • Column length • Null value permitted or not • Position of column in primary key of table (if applicable)
Index	`\de [PATTERN]`	• Index name • Columns contained in index • Position of column in index • Specifies whether index is UNIQUE • Sort sequence
Database Procedure	`\dp [PATTERN]`	• Schema Name • Name of the database procedure • Package to which database procedure is assigned
Schema	`\ds [NAME]`	• Schema Name • Owner
Table	`\dt [PATTERN]`	• Schema Name • Table Name • Table type
Database users	`\du [NAME]`	• Name of the database user • User properties
View	`\dv [PATTERN]`	• Schema Name • View name • View types

The following syntax applies to the `[PATTERN]`:

Property	Description
PATTERN	[SCHEMA.][OBJECT_NAME]
SCHEMA	Schema of the database objects about which you want to request information
OBJECT_NAME	Name of the database object

You can use the following placeholders:

- For one character: _
- For any number of characters: %

Example

Requesting information on the columns in the `HOTEL.CUSTOMER` table:

```
\dc HOTEL.CUSTOMER

Table "HOTEL.CUSTOMER"
Column Name | Type | Length | Nullable | KEYPOS
------------+------+--------+----------+-------
ADDRESS | CHAR ASCII | 25 | NO |
CNO | FIXED | 4 | NO | 1
FIRSTNAME | CHAR ASCII | 10 | YES |
NAME | CHAR ASCII | 10 | NO |
TITLE | CHAR ASCII | 7 | YES |
ZIP | CHAR ASCII | 5 | YES |
(6 rows selected)
```

Exiting HDBSQL
To exit the interactive operating mode of HDBSQL, use the following command.

```
exit | quit | \q
```

Overview of All HDBSQL Call Options
You can call the HDBSQL program with the following options:

```
hdbsql [<options>]
```

Call Options: Database Session	
Option	Description
-i <instance_id>	Instance ID of the database
-e	Encrypted data transmission
-n <database_computer>[:<port>]	Name of the computer on which the database is installed and port number
-r	Enforces execution of SQL statements as statements rather than as prepared statements
-u <database_user >	User name for logging on to the database
-p <database_user_password>	Password for logging on to the database
-U <user_store_key>	Use credentials from user store

`-S <sql mode>`	SQL mode, one of "INTERNAL" or "SAPR3".
`-z`	Switches AUTOCOMMIT mode off
`-r`	suppress usage of prepared statements

Call Options: Input and Output	
Option	Description
`-c <separator>`	When importing commands from a file, HDBSQL uses the `<separator>` to separate the individual commands. The default value is `;`.
`-I <file>`	Imports commands from the batch file `<file>`
`-m`	Activates multiple line mode for entering HDBSQL commands
`-o <file>`	Writes the results to the `<file>`
`-x`	Suppresses additional output such as the number of selected rows in a result set

Call Options: Formatting the Output	
Option	Description
`-A`	Returns the result set in an aligned format.
`-a`	Suppresses the output of the column names in the result set.
`-C`	Suppresses escape output format.
`-b <maximum_length>`	Defines the maximum number of characters for output of LOB values. Default value: 10 characters
`-f`	HDBSQL returns all SQL statements before sending them to the database instance.
`-F <separator>`	Specifies which string HDBSQL uses as a separator between the individual columns of the result set Default value: |
`-g <null_value>`	Specifies the character for null values in the result set Default value: ?
`-p <prefix>`	Specifies which string is to be output before each row of the result set Default value: |
`-P <suffix>`	Specifies which string is to be output after each row of the result set Default value: |
`-Q`	Outputs each column of the result set in a new row
`-j`	Switches the page by page scroll output off.

Call Options: Other	
Option	Description
`-h`	Displays the help
`-t`	Outputs debug information
`-T <file>`	Activates the SQLDBC trace SQLDBC writes the trace data to the `<file>`
`-v`	Displays version information about the HDBSQL program

Call Options: SSL Options	
Option	Description
`-sslprovider`	SSL provider [sapcrypto|mscrypto]
`-sslkeystore`	SSL key store name

`-ssltruststore`	SSL trust store name
`-ssltrustcert`	Skip certificate validation
`-sslhostnameincert`	Hostname used for certificate validation
`-sslcreatecert`	Create self signed certificate

Overview of All HDBSQL Commands

The following table shows all HDBSQL commands that you can enter in interactive operation.

> 🔲 Note
>
> Instead of an HDBSQL command, you can also enter an SQL statement or a database procedure.

Overview of all HDBSQL Commands	
Command	Description
`\?` `\h[elp]`	Displays all HDBSQL commands
`\a[utocommit] [ON|OFF]`	Switches AUTOCOMMIT mode on or off
`\al[ign] [ON|OFF]`	Switches formatted output of the results of SQL statements on or off
`\es[cape] [ON|OFF]`	Switches the escape output format on or off.
`\c[onnect]`	Logs a user onto the database.
`\dc [PATTERN]`	Lists all table columns that correspond to the `PATTERN`. HDBSQL lists only those tables to which the current user has access.
`\de [PATTERN]`	Lists all the indexes of database objects that correspond to the `PATTERN`
`\di[sconnect]`	Logs the user off from the database
`\dp [PATTERN]`	Lists all database procedures that correspond to the `PATTERN`
`\ds [NAME]`	Lists all schemas that correspond to the `NAME` pattern
`\dt [PATTERN]`	Lists all tables that correspond to the `PATTERN`
`\du [NAME]`	Lists all database users that correspond to the `NAME` pattern
`\dv [PATTERN]`	Lists all views that correspond to the `PATTERN`
`\e[dit][<file>]`	Writes the command buffer to the `<file>` where you can edit it with an editor
`\f[ieldsep] <separator>`	Uses the `<separator>` character to separate the individual fields of the result
`\g`	Executes the commands in the command buffer and returns the results
`\i[nput] <file>`	Imports commands from the batch file `<file>`
`\m[ode] <INTERNAL|SAPR3>`	Changes the SQL mode
`\mu[ltiline] ON | OFF`	Switches multiple line mode on | off
`\o[utput] <file>`	Redirects the result to a file
`\pa[ger]`	Displays results consecutively (not page by page)
`\p[rint]`	Displays the current command buffer
`\q[uit]`	Exits HDBSQL
`\r[eset]`	Deletes the current command buffer
`\ro[wsep] <separator>`	Uses the `<separator>` character to separate the individual rows of the result
`\s[tatus]`	Displays general information about the database