PRODUCT DOCUMENTATION

Pivotal ADS

Version 1.1

Administrator Guide

Rev: A06

Use of Open Source

Revised November 2013

Pivotal ADS Administrator Guide 1.1.3 - Contents

Section II: References

Preface

This guide provides information for system administrators and database superusers responsible for administering a HAWQ system.

- About This Guide
- Document Conventions
- Getting Support

About Pivotal, Inc.

Greenplum is currently transitioning to a new corporate identity (Pivotal, Inc.). We estimate that this transition will be completed in 2013. During this transition, there will be some legacy instances of our former corporate identity (Greenplum) appearing in our products and documentation. If you have any questions or concerns, please do not hesitate to contact us through our web site: `http://www.greenplum.com/support-transition`.

About This Guide

This guide provides information and instructions for configuring, maintaining and using a HAWQ system. This guide is intended for system and database administrators responsible for managing a HAWQ system.

This guide assumes knowledge of Linux/UNIX system administration, database management systems, database administration, and structured query language (SQL).

Because HAWQ is based on PostgreSQL 8.2.15, this guide assumes some familiarity with PostgreSQL. Links and cross-references to PostgreSQL documentation are provided throughout this guide for features that are similar to those in HAWQ.

This guide contains the following main sections:

- Section I, "Introduction to HAWQ" explains the distributed architecture of HAWQ.
- Section II, "References" contains reference documentation for SQL commands, command-line utilities, client programs, and configuration parameters.

Document Conventions

The following conventions are used throughout the HAWQ documentation to help you identify certain types of information.

- Text Conventions
- Command Syntax Conventions

Text Conventions

Table 0.1 Text Conventions

Text Convention	Usage	Examples
bold	Button, menu, tab, page, and field names in GUI applications	Click **Cancel** to exit the page without saving your changes.
italics	New terms where they are defined Database objects, such as schema, table, or columns names	The *master instance* is the `postgres` process that accepts client connections. Catalog information for HAWQ resides in the *pg_catalog* schema.
`monospace`	File names and path names Programs and executables Command names and syntax Parameter names	Edit the `postgresql.conf` file. Use `gpstart` to start HAWQ.
`monospace italics`	Variable information within file paths and file names Variable information within command syntax	`/home/gpadmin/`*`config_file`* `COPY` *`tablename`* `FROM '`*`filename`*`'`
`monospace bold`	Used to call attention to a particular part of a command, parameter, or code snippet.	Change the host name, port, and database name in the JDBC connection URL: `jdbc:postgresql://`**`host:5432`**`/`**`mydb`**
`UPPERCASE`	Environment variables SQL commands Keyboard keys	Make sure that the Java `/bin` directory is in your `$PATH`. `SELECT * FROM` *`my_table`*`;` Press `CTRL+C` to escape.

Command Syntax Conventions

Table 0.2 Command Syntax Conventions

Text Convention	Usage	Examples
`{ }`	Within command syntax, curly braces group related command options. Do not type the curly braces.	`FROM { 'filename' | STDIN }`
`[ ]`	Within command syntax, square brackets denote optional arguments. Do not type the brackets.	`TRUNCATE [ TABLE ] name`
`...`	Within command syntax, an ellipsis denotes repetition of a command, variable, or option. Do not type the ellipsis.	`DROP TABLE name [, ...]`
`|`	Within command syntax, the pipe symbol denotes an "OR" relationship. Do not type the pipe symbol.	`VACUUM [ FULL | FREEZE ]`

`$ system_command`
`# root_system_command`
`=> gpdb_command`
`=# su_gpdb_command`
	Denotes a command prompt - do not type the prompt symbol. `$` and `#` denote terminal command prompts. `=>` and `=#` denote HAWQ interactive program command prompts (`psql` or `gpssh`, for example).	`$ createdb mydatabase`
		`# chown gpadmin -R /datadir`
		`=> SELECT * FROM mytable;`
		`=# SELECT * FROM pg_database;`

Getting Support

Pivotal support, product, and licensing information can be obtained as follows.

Product information and Technical Support

For technical support, documentation, release notes, software updates, or for information about Pivotal products, licensing, and services, go to www.gopivotal.com. Additionally you can still obtain product and support information from the EMC Support Site at: http://support.emc.com.

Section I: Introduction to HAWQ

HAWQ is a parallel SQL query engine that combines the merits of the Greenplum Database Massively Parallel Processing (MPP) relational database engine and the Hadoop parallel processing framework. MPP (known as a *shared nothing* architecture) refers to systems with two or more processors that carry out an operation - each processor with its own memory, operating system and disks.Hadoop provides scalable architecture based on commodity hardware, flexible programming language and low-level parallel data processing framework (suitable for unstructured data processing and data mining). HAWQ combines both systems to provide large-scale analytics processing for big data.

HAWQ supports SQL and native querying capability against various data sources in different popular formats. It provides linear scalable storage solution for managing terabytes or petabytes of data at low cost. Industry performance benchmarks show that HAWQ is faster than competing products with HDFS storage, such as Hive.

HAWQ is essentially several PostgreSQL database instances acting together as one cohesive database management system. It is based on PostgreSQL 8.2.15, and in most cases is similar to PostgreSQL with regards to SQL support, features, configuration options, and end-user functionality. Database users interact with HAWQ as they would a regular PostgreSQL DBMS.

Different from Greenplum, HAWQ leverages HDFS as its storage system. This provides high scalability and high fault-tolerance.

PostgreSQL has been modified or supplemented to support HAWQ's parallel structure. For example, the system catalog, query planner, optimizer, query executor, and transaction manager components have been modified and enhanced to execute queries in parallel across all the PostgreSQL database instances. The HAWQ *interconnect* (the networking layer) enables communication between the distinct PostgreSQL instances and allows the system to behave as one logical database.

To learn more about HAWQ, refer to the following topic:

About the HAWQ Architecture

1. About the HAWQ Architecture

HAWQ is designed as a MPP SQL processing engine optimized for analytics with full transaction support. HAWQ breaks complex queries into small tasks and distributes them to MPP query processing units for execution. The query planner, dynamic pipeline, the leading edge interconnect and the specific query executor optimization for distributed storage work seamlessly to support highest level of performance and scalability.

Figure 1.1 illustrates the high-level concepts of the HAWQ architecture.

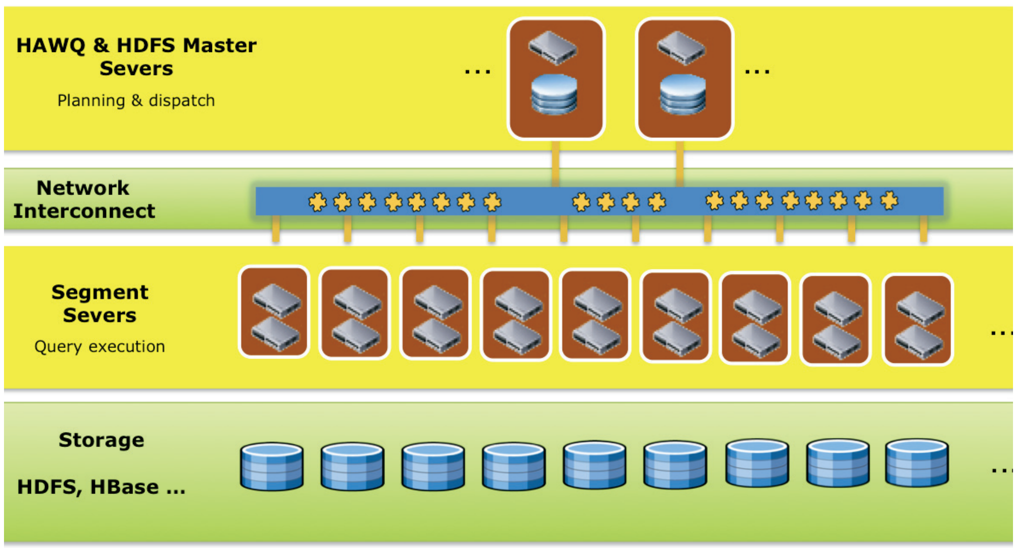


Figure 1.1 High-level HAWQ Architecture

HAWQ's basic unit of parallelism is the segment instance. Multiple segment instances on commodity servers work together to form a single parallel query processing system. A query submitted to HAWQ is optimized, broken into smaller components, and dispatched to segments that work together to deliver a single result set. All relational operations—such as table scans, joins, aggregations, and sorts—execute in parallel across the segments simultaneously. Data from upstream components in the dynamic pipeline are transmitted to downstream components through the scalable User Datagram Protocol (UDP) interconnect.

Based on Hadoop's distributed storage, HAWQ has no single point of failure and supports fully-automatic online recovery. System states are continuously monitored, therefore if a segment fails it is automatically removed from the cluster. During this process, the system continues serving customer queries, and the segments can be added back to the system when necessary.

This section describes all of the components that comprise a HAWQ system, and how they work together:

- About the HAWQ Master
- About the HAWQ Segment
- About the HAWQ Storage

About the HAWQ Master

The HAWQ *master* is the entry point to the system. It is the database process that accepts client connections and processes the SQL commands issued.

End-users interact with HAWQ (through the master) as they would with a typical PostgreSQL database. They can connect to the database using client programs such as `psql` or application programming interfaces (APIs) such as JDBC or ODBC.

The master is where the *global system catalog* resides. The global system catalog is the set of system tables that contain metadata about the HAWQ system itself. The master does not contain any user data; data resides only on *HDFS*. The master authenticates client connections, processes incoming SQL commands, distributes workload among segments, coordinates the results returned by each segment, and presents the final results to the client program.

About the HAWQ Segment

In HAWQ, the *segments* are the units which process the individual data modules simultaneously.

Segments are are stateless, and therefore different from master:

- Does not store the metadata for each database and table
- Does not store data on the local file system. This is different from the HAWQ.

The master dispatches the `SQL` request to the segments along with the related metadata information to process. The metadata contains the HDFS url for the required table. The segment accesses the corresponding data using this URL.

About the HAWQ Storage

HAWQ stores all table data, except the system table, in HDFS. When a user creates a table, the metadata is stored on the master's local file system and the table content is stored in HDFS.

About the HAWQ Interconnect

The *interconnect* is the networking layer of HAWQ. When a user connects to a database and issues a query, processes are created on each segment to handle the query. The *interconnect* refers to the inter-process communication between the segments, as well as the network infrastructure on which this communication relies. The interconnect uses standard Ethernet switching fabric.

By default, the interconnect uses UDP (User Datagram Protocol) to send messages over the network. The Greenplum software performs the additional packet verification beyond what is provided by UDP. This means the reliability is equivalent to Transmission Control Protocol (TCP), and the performance and scalability exceeds TCP. If the interconnect used TCP, HAWQ would have a scalability limit of 1000 segment instances. With UDP as the current default protocol for the interconnect, this limit is not applicable.

About Redundancy and Failover in HAWQ

HAWQ provides deployment options that protect the system from having a single point of failure. This section explains the redundancy components of HAWQ.

- About Master Mirroring
- About Segment Failover
- About Interconnect Redundancy

About Master Mirroring

You can also optionally deploy a *backup* or *mirror* of the master instance on a separate host from the master node. A backup master host serves as a *warm standby* in the event that the primary master host becomes unoperational. The standby master is kept up to date by a transaction log replication process, which runs on the standby master host and synchronizes the data between the primary and standby master hosts.

You can also optionally deploy a *backup* or *mirror* of the master instance on a separate host from the master node. A backup master host serves as a *warm standby* in the event that the primary master host becomes unoperational. The standby master is kept up to date by a transaction log replication process, which runs on the standby master host and synchronizes the data between the primary and standby master hosts.

Since the master does not contain any user data, only the system catalog tables need to be synchronized between the primary and backup copies. When these tables are updated, changes are automatically copied over to the standby master to ensure synchronization with the primary master..

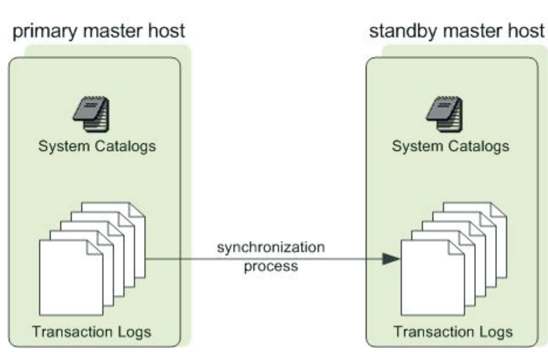


Figure 1.2 Master Mirroring in HAWQ

About Segment Failover

In HAWQ, the segments are stateless. This ensures faster recovery and better availability.

When a segment is down, the existing sessions are automtically reassigned to the remaining segments. If a new session is created during segment downtime, it succeeds on the remaining segments.

When the segments are operational agina, the Fault Tolerance Service verifies their state, returning the segment number to normal. All the sessions are automatically reconfigured to use the fullcomputing power.

About Interconnect Redundancy

The *interconnect* refers to the inter-process communication between the segments and the network infrastructure on which this communication relies. You can achieve a highly available interconnect by deploying dual Gigabit Ethernet switches on your network and redundant Gigabit connections to the HAWQ host (master and segment) servers.

2. About Query Processing

Users issue queries to Greenplum Database as they would to any database management system (DBMS). They connect to the database instance on the Greenplum master host using a client application such as `psql` and submit SQL statements.

HAWQ 1.1.1.0 now offers the new ORCA query planner and optimizer. This chapter describes the following information:

- Understanding Query Planning and Dispatch
- Understanding Query Plans
- Understanding Parallel Query Execution

Understanding Query Planning and Dispatch

This section decribes the following:

- Planning and Dispatch
- ORCA

Planning and Dispatch

The master receives, parses, and optimizes the query. The resulting query plan is either *parallel* or *targeted*. The master dispatches parallel query plans to all segments, as shown in Figure 2.1. The master dispatches targeted query plans to a single segment, as shown in Figure 2.2. Each segment is responsible for executing local database operations on its own set of data.

Most database operations—such as table scans, joins, aggregations, and sorts—execute across all segments in parallel. Each operation is performed on a segment database independent of the data stored in the other segment databases.

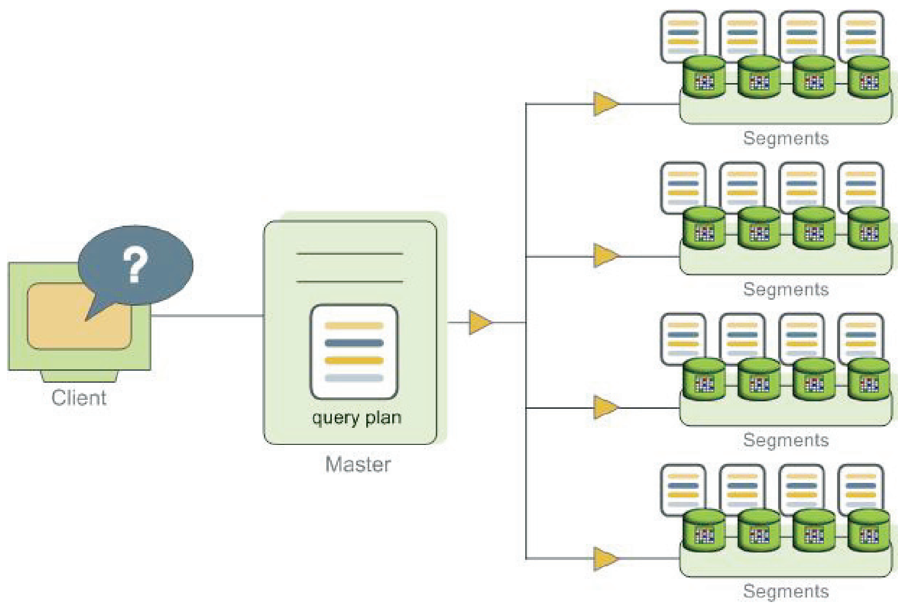


Figure 2.1 Dispatching the Parallel Query Plan

Certain queries may access only data on a single segment, such as single-row `INSERT`, `UPDATE`, `DELETE`, or `SELECT` operations or queries that filter on the table distribution key column(s). In queries such as these, the query plan is not dispatched to all segments, but is targeted at the segment that contains the affected or relevant row(s).

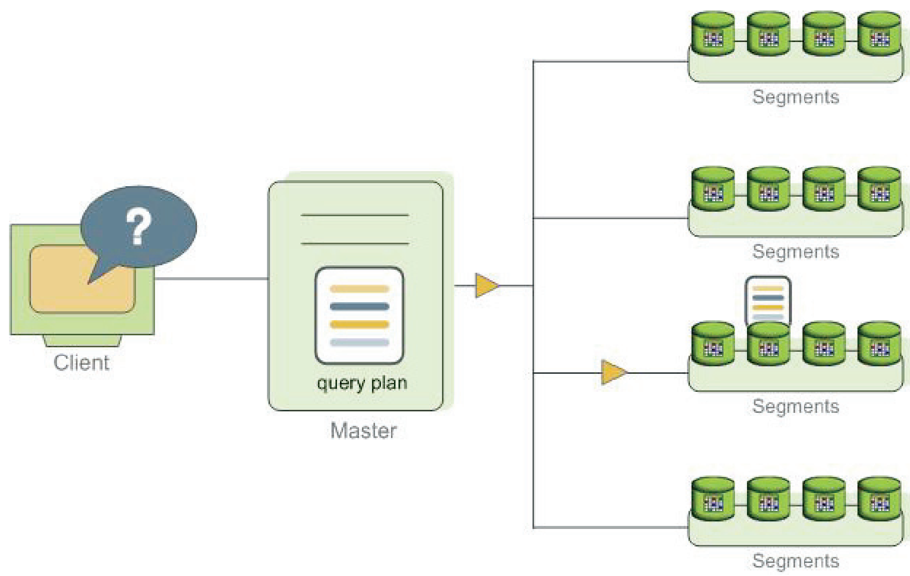
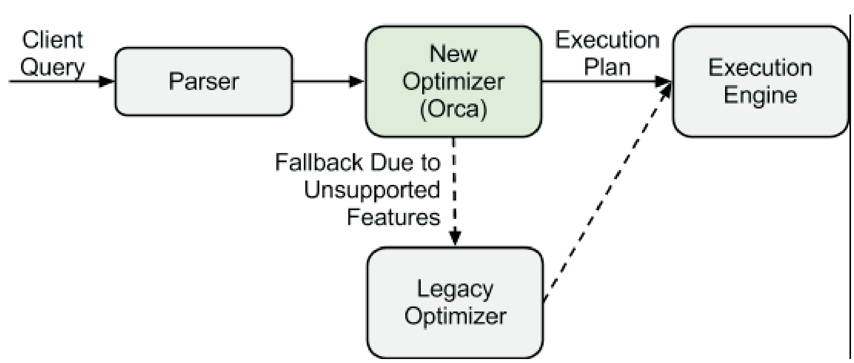


Figure 2.2 Dispatching a Targeted Query Plan

ORCA

ORCA is the new query optimizer built in to HAWQ 1.1.1.0. It extends the planning and optimization capabilities of HAWQ. ORCA is extensible, verifiable, and achieves better optimization using multi-core architectures. ORCA also betters performance tuning.

The following figure shows how ORCA fits into the query planning architecture:



You can inspect the log to determine whether ORCA or the existing planner produced the plan. If you see the log message, "Optimizer produced plan", then ORCA generated the plan for your query. If the exising planner generated the plan, the log message reads "Planner produced plan". To turn off logging, see optimizer_log.

Understanding Query Plans

A *query plan* is the set of operations the database will perform to produce the answer to a query. Each *node* or step in the plan represents a database operation such as a table scan, join, aggregation, or sort. Plans are read and executed from bottom to top.

In addition to common database operations such as tables scans, joins, and so on, Greenplum Database has an additional operation type called *motion*. A motion operation involves moving tuples between the segments during query processing. Note that not every query requires a motion. For example, a targeted query plan does not require data to move across the interconnect.

To achieve maximum parallelism during query execution, the database divides the work of the query plan into *slices*. A slice is a portion of the plan that segments can work on independently. A query plan is sliced wherever a motion operation occurs in the plan, with one slice on each side of the motion.

For example, consider the following simple query involving a join between two tables:

```
SELECT customer, amount
FROM sales JOIN customer USING (cust_id)
WHERE dateCol = '04-30-2008';
```

Figure 2.3 shows the query plan. Each segment receives a copy of the query plan and works on it in parallel.

The query plan for this example has a *redistribute motion* that moves tuples between the segments to complete the join. The redistribute motion is necessary because the `customer` table is distributed across the segments by `cust_id`, but the `sales` table is distributed across the segments by `sale_id`. To perform the join, the `sales` tuples must be redistributed by `cust_id`. The plan is sliced on either side of the redistribute motion, creating *slice 1* and *slice 2*.

This query plan has another type of motion operation called a *gather motion*. A gather motion is when the segments send results back up to the master for presentation to the client. Because a query plan is always sliced wherever a motion occurs, this plan also has an implicit slice at the very top of the plan (*slice 3*). Not all query plans involve a gather motion. For example, a `CREATE TABLE x AS SELECT...` statement would not have a gather motion because tuples are sent to the newly created table, not to the master.

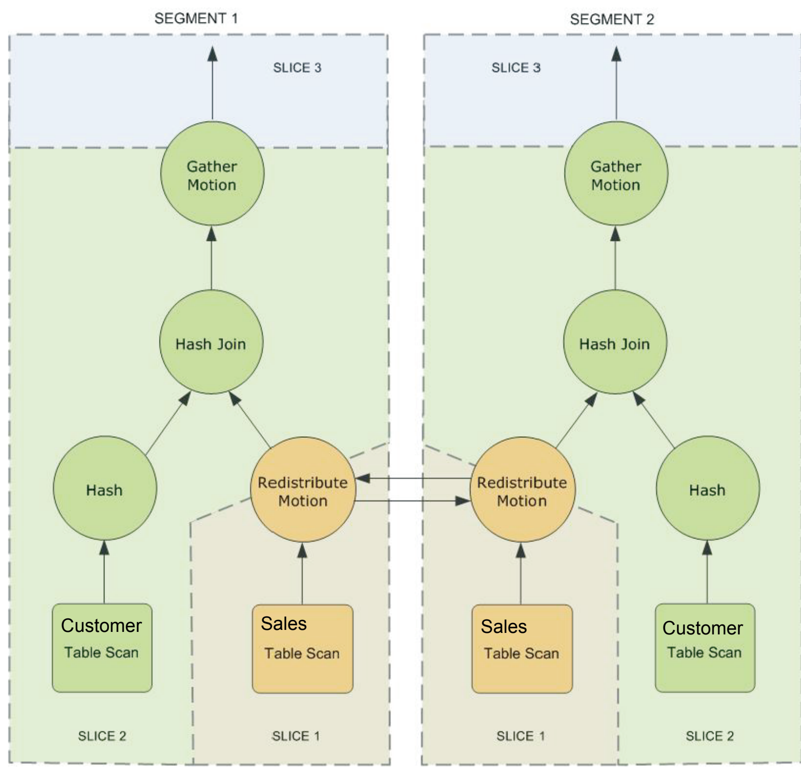


Figure 2.3 Query Slice Plan

Understanding Parallel Query Execution

The database creates a number of database processes to handle the work of a query. On the master, the query worker process is called the *query dispatcher* (QD). The QD is responsible for creating and dispatching the query plan. It also accumulates and presents the final results. On the segments, a query worker process is called a *query executor* (QE). A QE is responsible for completing its portion of work and communicating its intermediate results to the other worker processes.

There is at least one worker process assigned to each *slice* of the query plan. A worker process works on its assigned portion of the query plan independently. During query execution, each segment will have a number of processes working on the query in parallel.

Related processes that are working on the same slice of the query plan but on different segments are called *gangs*. As a portion of work is completed, tuples flow up the query plan from one gang of processes to the next. This inter-process communication between the segments is referred to as the *interconnect* component of Greenplum Database.

Figure 2.4 shows the query worker processes on the master and two segment instances for the query plan illustrated in Figure 2.3.

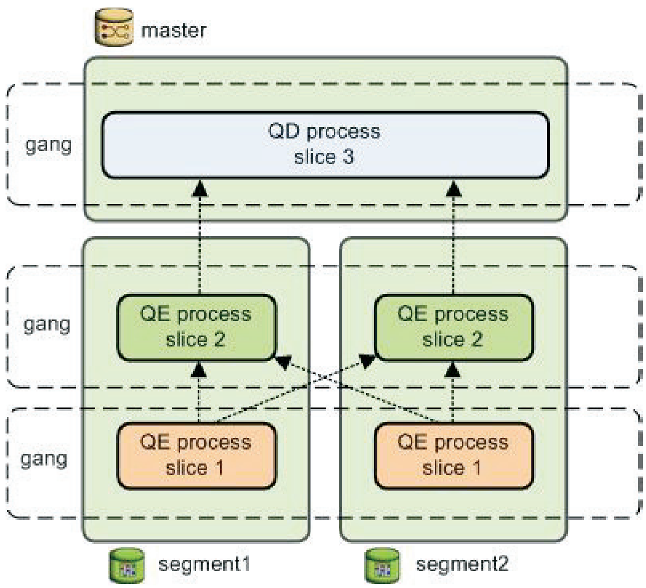


Figure 2.4 Query Worker Processes

Using Functions and Operators

- Using Functions in HAWQ
- User-Defined Functions
- Built-in Functions and Operators
- Window Functions
- Advanced Analytic Functions

Using Functions in HAWQ

Table 2.1 Functions in HAWQ

Function Type	Greenplum Support	Description	Comments
IMMUTABLE	Yes	Relies only on information directly in its argument list. Given the same argument values, always returns the same result.	
STABLE	Yes, in most cases	Within a single table scan, returns the same result for same argument values, but results change across SQL statements.	Results depend on database lookups or parameter values. `current_timestamp` family of functions is `STABLE`; values do not change within an execution.
VOLATILE	Restricted	Function values can change within a single table scan. For example: `random()`, `currval()`, `timeofday()`.	Any function with side effects is volatile, even if its result is predictable. For example: `setval()`.

Data is divided up across segments — each segment is a distinct PostgreSQL database. To prevent inconsistent or unexpected results, do not execute functions classified as `VOLATILE` at the segment level if they contain SQL commands or modify the database in any way. For example, functions such as `setval()` are not allowed to execute on distributed data because they can cause inconsistent data between segment instances.

To ensure data consistency, you can safely use `VOLATILE` and `STABLE` functions in statements that are evaluated on and run from the master. For example, the following statements run on the master (statements without a `FROM` clause):

```
SELECT setval('myseq', 201);
SELECT foo();
```

If a statement has a `FROM` clause containing a distributed table and the function in the `FROM` clause returns a set of rows, the statement can run on the segments:

```
SELECT * from foo();
```

Important: HAWQ does not support the following:

- Nested functions
- Set returning functions
- User defined aggregates
- Functions that return a table reference (`rangeFuncs`) or functions that use the `refCursor` datatype.

User-Defined Functions

HAWQ supports user-defined functions. See Extending SQL in the PostgreSQL documentation for more information.

Use the `CREATE FUNCTION` command to register user-defined functions that are used as described in "Using Functions in HAWQ" on page 15. By default, user-defined functions are declared as `VOLATILE`, so if your user-defined function is `IMMUTABLE` or `STABLE`, you must specify the correct volatility level when you register your function.

When you create user-defined functions, avoid using fatal errors or destructive calls. HAWQ may respond to such errors with a sudden shutdown or restart.

In HAWQ, the shared library files for user-created functions must reside in the same library path location on every host in the HAWQ array (masters, segments, and mirrors).

Built-in Functions and Operators

The following table lists the categories of built-in functions and operators supported by PostgreSQL. All functions and operators are supported in HAWQ as in PostgreSQL with the exception of `STABLE` and `VOLATILE` functions, which are subject to the restrictions noted in "Using Functions in HAWQ" on page 15. See the Functions and Operators section of the PostgreSQL documentation for more information about these built-in functions and operators.

Table 2.2 Built-in functions and operators

Operator/Function Category	VOLATILE Functions	STABLE Functions	Restrictions
Logical Operators			
Comparison Operators			
Mathematical Functions and Operators	random setseed		
String Functions and Operators	*All built-in conversion functions*	convert pg_client_encoding	
Binary String Functions and Operators			
Bit String Functions and Operators			
Pattern Matching			
Data Type Formatting Functions		to_char to_timestamp	

Table 2.2 Built-in functions and operators

Operator/Function Category	VOLATILE Functions	STABLE Functions	Restrictions
Date/Time Functions and Operators	timeofday	age current_date current_time current_timestamp localtime localtimestamp now	
Geometric Functions and Operators			
Network Address Functions and Operators			
Sequence Manipulation Functions	currval lastval nextval setval		
Conditional Expressions			
Array Functions and Operators		*All array functions*	
Aggregate Functions			
Subquery Expressions			
Row and Array Comparisons			
Set Returning Functions	generate_series		
System Information Functions		*All session information functions* *All access privilege inquiry functions* *All schema visibility inquiry functions* *All system catalog information functions* *All comment information functions*	

Table 2.2 Built-in functions and operators

Operator/Function Category	VOLATILE Functions	STABLE Functions	Restrictions
System Administration Functions	set_config pg_cancel_backend pg_reload_conf pg_rotate_logfile pg_start_backup pg_stop_backup pg_size_pretty pg_ls_dir pg_read_file pg_stat_file	current_setting *All database object size functions*	
XML Functions		xmlagg(xml) xmlexists(text, xml) xml_is_well_formed(text) xml_is_well_formed_document(text) xml_is_well_formed_content(text) xpath(text, xml) xpath(text, xml, text[]) xpath_exists(text, xml) xpath_exists(text, xml, text[]) xml(text) text(xml) xmlcomment(xml) xmlconcat2(xml, xml)	

Window Functions

The following built-in window functions are extensions to the PostgreSQL database. All window functions are *immutable*..

Table 2.3 Window functions

Function	Return Type	Full Syntax	Description
`cume_dist()`	`double precision`	`CUME_DIST() OVER ( [PARTITION BY` *expr*`] ORDER BY` *expr* `)`	Calculates the cumulative distribution of a value in a group of values. Rows with equal values always evaluate to the same cumulative distribution value.
`dense_rank()`	`bigint`	`DENSE_RANK () OVER ( [PARTITION BY` *expr*`] ORDER BY` *expr*`)`	Computes the rank of a row in an ordered group of rows without skipping rank values. Rows with equal values are given the same rank value.
`first_value(`*expr*`)`	same as input *expr* type	`FIRST_VALUE(`*expr*`) OVER ( [PARTITION BY` *expr*`] ORDER BY` *expr* `[ROWS|RANGE` *frame_expr*`] )`	Returns the first value in an ordered set of values.

Table 2.3 Window functions

Function	Return Type	Full Syntax	Description
lag(*expr* [,*offset*] [,*default*])	same as input *expr* type	LAG(*expr* [,*offset*] [,*default*]) OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Provides access to more than one row of the same table without doing a self join. Given a series of rows returned from a query and a position of the cursor, LAG provides access to a row at a given physical offset prior to that position. The default offset is 1. *default* sets the value that is returned if the offset goes beyond the scope of the window. If *default* is not specified, the default value is null.
last_value(*expr*)	same as input *expr* type	LAST_VALUE(*expr*) OVER ([PARTITION BY *expr*] ORDER BY *expr* [ROWS|RANGE *frame_expr*])	Returns the last value in an ordered set of values.
lead(*expr* [,*offset*] [,*default*])	same as input *expr* type	LEAD(*expr* [,*offset*] [,*default*]) OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Provides access to more than one row of the same table without doing a self join. Given a series of rows returned from a query and a position of the cursor, lead provides access to a row at a given physical offset after that position. If *offset* is not specified, the default offset is 1. *default* sets the value that is returned if the offset goes beyond the scope of the window. If *default* is not specified, the default value is null.
ntile(*expr*)	bigint	NTILE(*expr*) OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Divides an ordered data set into a number of buckets (as defined by *expr*) and assigns a bucket number to each row.
percent_rank()	double precision	PERCENT_RANK () OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Calculates the rank of a hypothetical row *R* minus 1, divided by 1 less than the number of rows being evaluated (within a window partition).
rank()	bigint	RANK () OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Calculates the rank of a row in an ordered group of values. Rows with equal values for the ranking criteria receive the same rank. The number of tied rows are added to the rank number to calculate the next rank value. Ranks may not be consecutive numbers in this case.
row_number()	bigint	ROW_NUMBER () OVER ([PARTITION BY *expr*] ORDER BY *expr*)	Assigns a unique number to each row to which it is applied (either each row in a window partition or each row of the query).

Advanced Analytic Functions

The following built-in advanced analytic functions are extensions of the PostgreSQL database. Analytic functions are *immutable*..

Table 2.4 Advanced Analytic Functions

Function	Return Type	Full Syntax	Description
`matrix_add( array[], array[])`	`smallint[], int[], bigint[], float[]`	`matrix_add( array[[1,1],[2,2]], array[[3,4],[5,6]])`	Adds two two-dimensional matrices. The matrices must be conformable.
`matrix_multiply(array [], array[])`	`smallint[]int[], bigint[], float[]`	`matrix_multiply( array[[2,0,0],[0,2,0],[0,0,2]], array[[3,0,3],[0,3,0],[0,0,3]] )`	Multiplies two, three-dimensional arrays. The matrices must be conformable.
`matrix_multiply(array [], `*`expr`*`)`	`int[], float[]`	`matrix_multiply( array[[1,1,1], [2,2,2], [3,3,3]], 2)`	Multiplies a two-dimensional array and a scalar numeric value.
`matrix_transpose(array [])`	Same as input `array` type.	`matrix_transpose( array [[1,1,1],[2,2,2]])`	Transposes a two-dimensional array.
`pinv(array [])`	`smallint[]int[], bigint[], float[]`	`pinv(array[[2.5,0,0],[0,1,0],[0,0,.5]])`	Calculates the Moore-Penrose pseudoinverse of a matrix.
`unnest (array[])`	set of `anyelement`	`unnest( array['one', 'row', 'per', 'item'])`	Transforms a one dimensional array into rows. Returns a set of `anyelement`, a polymorphic pseudotype in PostgreSQL.

Table 2.5 Advanced Aggregate Functions

Function	Return Type	Full Syntax	Description

`MEDIAN (expr)`	`timestamp, timestampz, interval, float`	`MEDIAN (_expression_)`
		Example:
		`SELECT department_id, MEDIAN(salary)`
		`FROM employees`
		`GROUP BY department_id;`
			Can take a two-dimensional array as input. Treats such arrays as matrices.

`PERCENTILE_CONT (expr) WITHIN GROUP (ORDER BY expr [DESC/ASC])`	`timestamp, timestampz, interval, float`	`PERCENTILE_CONT(_percentage_) WITHIN GROUP (ORDER BY _expression_)`
		Example:
		`SELECT department_id,`
		`PERCENTILE_CONT (0.5) WITHIN GROUP (ORDER BY salary DESC)`
		`“Median_cont”;`
		`FROM employees GROUP BY department_id;`
			Performs an inverse distirbution function that assumes a continuous distribution model. It takes a percentile value and a sort specification and returns the same datatype as the numeric datatype of the argument. This returned value is a computed result after performing linear interpolation. Null are ignored in this calculation.

`PERCENTILE_DESC (expr) WITHIN GROUP (ORDER BY expr [DESC/ASC])`	`timestamp, timestampz, interval, float`	`PERCENTILE_DESC(_percentage_) WITHIN GROUP (ORDER BY _expression_)`
		Example:
		`SELECT department_id,`
		`PERCENTILE_DESC (0.5) WITHIN GROUP (ORDER BY salary DESC)`
		`“Median_desc”;`
		`FROM employees GROUP BY department_id;`
			Performs an inverse distirbution function that assumes a discrete distribution model. It takes a percentile value and a sort specification. This returned value is an element from the set. Null are ignored in this calculation.

`sum(array[])`	`smallint[] int[], bigint[], float[]`	`sum(array[[1,2],[3,4]])` **Example:** CREATE TABLE mymatrix (myvalue int[]); INSERT INTO mymatrix VALUES (array[[1,2],[3,4]]); INSERT INTO mymatrix VALUES (array[[0,1],[1,0]]); SELECT sum(myvalue) FROM mymatrix; sum --------------- {{1,3},{4,4}}	Performs matrix summation. Can take as input a two-dimensional array that is treated as a matrix.
`pivot_sum (label[], label, *expr*)`	`int[], bigint[], float[]`	`pivot_sum( array['A1','A2'], attr, value)`	A pivot aggregation using sum to resolve duplicate entries.

Table 2.5 Advanced Aggregate Functions

Function	Return Type	Full Syntax	Description
`mregr_coef(` *`expr`*`, array[])`	`float[]`	`mregr_coef(y, array[1, x1, x2])`	The four `mregr_*` aggregates perform linear regressions using the ordinary-least-squares method. `mregr_coef` calculates the regression coefficients. The size of the return array for `mregr_coef` is the same as the size of the input array of independent variables, since the return array contains the coefficient for each independent variable.
`mregr_r2 (`*`expr`*`, array[])`	`float`	`mregr_r2(y, array[1, x1, x2])`	The four `mregr_*` aggregates perform linear regressions using the ordinary-least-squares method. `mregr_r2` calculates the r-squared error value for the regression.
`mregr_pvalues(`*`expr`*`, array[])`	`float[]`	`mregr_pvalues(y, array[1, x1, x2])`	The four `mregr_*` aggregates perform linear regressions using the ordinary-least-squares method. `mregr_pvalues` calculates the p-values for the regression.
`mregr_tstats(`*`expr`*`, array[])`	`float[]`	`mregr_tstats(y, array[1, x1, x2])`	The four `mregr_*` aggregates perform linear regressions using the ordinary-least-squares method. `mregr_tstats` calculates the t-statistics for the regression.
`nb_classify (text[], bigint, bigint[], bigint[])`	`text`	`nb_classify(classes, attr_count, class_count, class_total)`	Classify rows using a Naive Bayes Classifier. This aggregate uses a baseline of training data to predict the classification of new rows and returns the class with the largest likelihood of appearing in the new rows.
`nb_probabilities(text[], bigint, bigint[], bigint[])`	`text`	`nb_probabilities(classes, attr_count, class_count, class_total)`	Determine probability for each class using a Naive Bayes Classifier. This aggregate uses a baseline of training data to predict the classification of new rows and returns the probabilities that each class will appear in new rows.

Advanced Analytic Function Examples

These examples illustrate selected advanced analytic functions in queries on simplified example data. They are for the multiple linear regression aggregate functions and for Naive Bayes Classification with `nb_classify`.

Linear Regression Aggregates Example

The following example uses the four linear regression aggregates `mregr_coef`, `mregr_r2`, `mregr_pvalues`, and `mregr_tstats` in a query on the example table `regr_example`. In this example query, all the aggregates take the dependent variable as the first parameter and an array of independent variables as the second parameter.

```
SELECT mregr_coef(y, array[1, x1, x2]),
       mregr_r2(y, array[1, x1, x2]),
       mregr_pvalues(y, array[1, x1, x2]),
       mregr_tstats(y, array[1, x1, x2])
from regr_example;
```

Table `regr_example`:

```
 id | y  | x1 | x2
----+----+----+----
  1 |  5 |  2 |  1
  2 | 10 |  4 |  2
  3 |  6 |  3 |  1
  4 |  8|   3 |  1
```

Running the example query against this table yields one row of data with the following values:

`mregr_coef`:

`{-7.105427357601e-15,2.00000000000003,0.999999999999943}`

`mregr_r2`:

`0.86440677966103`

`mregr_pvalues`:

`{0.999999999999999,0.454371051656992,0.783653104061216}`

`mregr_tstats`:

`{-2.24693341988919e-15,1.15470053837932,0.35355339059327}`

HAWQ returns `NaN` (not a number) if the results of any of these agregates are undefined. This can happen if there is a very small amount of data.

Note: The intercept is computed by setting one of the independent variables to `1`, as shown in the preceding example.

Naive Bayes Classification Examples

The aggregates `nb_classify and nb_probabilities` are used within a larger four-step classification process that involves the creation of tables and views for training data. The following two examples show all the steps. The first example shows a small data set with arbitrary values, and the second example is the Greenplum implementation of a popular Naive Bayes example based on weather conditions.

Overview

The following describes the Naive Bayes classification procedure. In the examples, the value names become the values of the field *attr*:

1. Unpivot the data.

   If the data is not denormalized, create a view with the identification and classification that unpivots all the values. If the data is already in denormalized form, you do not need to unpivot the data.

2. Create a training table.

   The training table shifts the view of the data to the values of the field *attr*.

3. Create a summary view of the training data.

4. Aggregate the data with `nb_classify`, `nb_probabilities`,or both.

Naive Bayes Example 1 – Small Table

This example begins with the normalized data in the example table `class_example` and proceeds through four discrete steps:

Table `class_example`:

```
 id | class | a1 | a2 | a3
----+-------+----+----+----
  1 | C1    |  1 |  2 |  3
  2 | C1    |  1 |  4 |  3
  3 | C2    |  0 |  2 |  2
  4 | C1    |  1 |  2 |  1
  5 | C2    |  1 |  2 |  2
  6 | C2    |  0 |  1 |  3
```

1. Unpivot the data

   For use as training data, the data in `class_example` must be unpivoted because the data is in denormalized form. The terms in single quotation marks define the values to use for the new field *attr*. By convention, these values are the same as the field names in the normalized table. In this example, these values are capitalized to highlight where they are created in the command.

   ```
   CREATE view class_example_unpivot AS
   SELECT id, class, unnest(array['A1', 'A2', 'A3']) as attr,
   unnest(array[a1,a2,a3]) as value FROM class_example;
   ```

   The unpivoted view shows the normalized data. It is not necessary to use this view. Use the command `SELECT * from class_example_unpivot` to see the denormalized data:

   ```
    id | class | attr | value
   ----+-------+------+-------
     2 | C1    | A1   |     1
     2 | C1    | A2   |     2
     2 | C1    | A3   |     1
     4 | C2    | A1   |     1
     4 | C2    | A2   |     2
     4 | C2    | A3   |     2
     6 | C2    | A1   |     0
     6 | C2    | A2   |     1
     6 | C2    | A3   |     3
   ```

```
  1 | C1     | A1    |      1
  1 | C1     | A2    |      2
  1 | C1     | A3    |      3
  3 | C1     | A1    |      1
  3 | C1     | A2    |      4
  3 | C1     | A3    |      3
  5 | C2     | A1    |      0
  5 | C2     | A2    |      2
  5 | C2     | A3    |      2
(18 rows)
```

2. Create a training table from the unpivoted data.

   The terms in single quotation marks define the values to sum. The terms in the array passed into `pivot_sum` must match the number and names of classifications in the original data. In the example, C1 and C2:

```
CREATE table class_example_nb_training AS
SELECT attr, value, pivot_sum(array['C1', 'C2'], class, 1)
as class_count
FROM   class_example_unpivot
GROUP BY attr, value
DISTRIBUTED by (attr);
```

   The following is the resulting training table:

```
 attr | value | class_count
------+-------+-------------
 A3   |     1 | {1,0}
 A3   |     3 | {2,1}
 A1   |     1 | {3,1}
 A1   |     0 | {0,2}
 A3   |     2 | {0,2}
 A2   |     2 | {2,2}
 A2   |     4 | {1,0}
 A2   |     1 | {0,1}
(8 rows)
```

3. Create a summary view of the training data.

```
CREATE VIEW class_example_nb_classify_functions AS
SELECT attr, value, class_count, array['C1', 'C2'] as classes,
sum(class_count) over (wa)::integer[] as class_total,
count(distinct value) over (wa) as attr_count
FROM class_example_nb_training
WINDOW wa as (partition by attr);
```

   The following is the resulting training table:

```
attr| value | class_count| classes | class_total |attr_count
-----+-------+------------+---------+------------+---------
 A2  |     2 | {2,2}      | {C1,C2} | {3,3}       |         3
```

```
 A2   |      4 | {1,0}       | {C1,C2} | {3,3}       |          3
 A2   |      1 | {0,1}       | {C1,C2} | {3,3}       |          3
 A1   |      0 | {0,2}       | {C1,C2} | {3,3}       |          2
 A1   |      1 | {3,1}       | {C1,C2} | {3,3}       |          2
 A3   |      2 | {0,2}       | {C1,C2} | {3,3}       |          3
 A3   |      3 | {2,1}       | {C1,C2} | {3,3}       |          3
 A3   |      1 | {1,0}       | {C1,C2} | {3,3}       |          3
(8 rows)
```

4. Classify rows with `nb_classify` and display the probability with `nb_probabilities`.

After you prepare the view, the training data is ready for use as a baseline for determining the class of incoming rows. The following query predicts whether rows are of class `C1` or `C2` by using the `nb_classify` aggregate:

```
SELECT nb_classify(classes, attr_count, class_count,
class_total) as class
FROM class_example_nb_classify_functions
where (attr = 'A1' and value = 0) or (attr = 'A2' and value =
2) or (attr = 'A3' and value = 1);
```

Running the example query against this simple table yields one row of data displaying these values:

This query yields the expected single-row result of `C1`.

```
class
-------
C2
(1 row)
```

Display the probabilities for each class with `nb_probabilities`.

Once the view is prepared, the system can use the training data as a baseline for determining the class of incoming rows. The following query predicts whether rows are of class `C1` or `C2` by using the `nb_probabilities` aggregate:

```
SELECT nb_probabilities(classes, attr_count, class_count,
class_total) as probability
FROM class_example_nb_classify_functions
where (attr = 'A1' and value = 0) or (attr = 'A2' and value =
2) or (attr = 'A3' and value = 1);
```

Running the example query against this simple table yields one row of data displaying the probabilities for each class:

This query yields the expected single-row result showing two probabilities, the first for `C1`,and the second for `C2`.

```
probability
-------------
 {0.4,0.6}
(1 row)
```

You can display the classification and the probabilities with the following query.

```
SELECT nb_classify(classes, attr_count, class_count,
```

```
class_total) as class, nb_probabilities(classes, attr_count,
class_count, class_total) as probability FROM
class_example_nb_classify where (attr = 'A1' and value = 0)
or (attr = 'A2' and value = 2) or (attr = 'A3' and value =
1);
```

This query produces the following result:

```
 class | probability
-------+-------------
  C2   | {0.4,0.6}
(1 row)
```

Actual data in production scenarios is more extensive than this example data and yields better results. Accuracy of classification with `nb_classify and nb_probabilities` improves significantly with larger sets of training data.

Naive Bayes Example 2 – Weather and Outdoor Sports

This example calculates the probabilities of whether the user will play an outdoor sport, such as golf or tennis, based on weather conditions. The table `weather_example` contains the example values. The identification field for the table is *day*. There are two classifications held in the field *play*: `Yes` or `No`. There are four weather attributes, *outlook*, *temperature*, *humidity*, and *wind*. The data is normalized.

```
 day | play | outlook  | temperature | humidity |  wind
-----+------+----------+-------------+----------+--------
   2 | No   | Sunny    | Hot         | High     | Strong
   4 | Yes  | Rain     | Mild        | High     | Weak
   6 | No   | Rain     | Cool        | Normal   | Strong
   8 | No   | Sunny    | Mild        | High     | Weak
  10 | Yes  | Rain     | Mild        | Normal   | Weak
  12 | Yes  | Overcast | Mild        | High     | Strong
  14 | No   | Rain     | Mild        | High     | Strong
   1 | No   | Sunny    | Hot         | High     | Weak
   3 | Yes  | Overcast | Hot         | High     | Weak
   5 | Yes  | Rain     | Cool        | Normal   | Weak
   7 | Yes  | Overcast | Cool        | Normal   | Strong
   9 | Yes  | Sunny    | Cool        | Normal   | Weak
  11 | Yes  | Sunny    | Mild        | Normal   | Strong
  13 | Yes  | Overcast | Hot         | Normal   | Weak
(14 rows)
```

Because this data is normalized, all four Naive Bayes steps are required.

1. Unpivot the data.

   ```
   CREATE view weather_example_unpivot AS SELECT day, play,
   unnest(array['outlook','temperature', 'humidity','wind']) as
   attr, unnest(array[outlook,temperature,humidity,wind]) as
   value FROM weather_example;
   ```

   Note the use of quotation marks in the command.

The `SELECT * from weather_example_unpivot` displays the denormalized data and contains the following 56 rows.

```
 day | play |    attr     |  value
-----+------+-------------+----------
   2 | No   | outlook     | Sunny
   2 | No   | temperature | Hot
   2 | No   | humidity    | High
   2 | No   | wind        | Strong
   4 | Yes  | outlook     | Rain
   4 | Yes  | temperature | Mild
   4 | Yes  | humidity    | High
   4 | Yes  | wind        | Weak
   6 | No   | outlook     | Rain
   6 | No   | temperature | Cool
   6 | No   | humidity    | Normal
   6 | No   | wind        | Strong
   8 | No   | outlook     | Sunny
   8 | No   | temperature | Mild
   8 | No   | humidity    | High
   8 | No   | wind        | Weak
  10 | Yes  | outlook     | Rain
  10 | Yes  | temperature | Mild
  10 | Yes  | humidity    | Normal
10 | Yes  | wind        | Weak
  12 | Yes  | outlook     | Overcast
  12 | Yes  | temperature | Mild
  12 | Yes  | humidity    | High
  12 | Yes  | wind        | Strong
  14 | No   | outlook     | Rain
  14 | No   | temperature | Mild
  14 | No   | humidity    | High
  14 | No   | wind        | Strong
   1 | No   | outlook     | Sunny
   1 | No   | temperature | Hot
   1 | No   | humidity    | High
   1 | No   | wind        | Weak
   3 | Yes  | outlook     | Overcast
   3 | Yes  | temperature | Hot
   3 | Yes  | humidity    | High
   3 | Yes  | wind        | Weak
   5 | Yes  | outlook     | Rain
   5 | Yes  | temperature | Cool
   5 | Yes  | humidity    | Normal
   5 | Yes  | wind        | Weak
   7 | Yes  | outlook     | Overcast
```

```
   7 | Yes   | temperature | Cool
   7 | Yes   | humidity    | Normal
   7 | Yes   | wind        | Strong
   9 | Yes   | outlook     | Sunny
   9 | Yes   | temperature | Cool
   9 | Yes   | humidity    | Normal
   9 | Yes   | wind        | Weak
  11 | Yes   | outlook     | Sunny
  11 | Yes   | temperature | Mild
  11 | Yes   | humidity    | Normal
  11 | Yes   | wind        | Strong
  13 | Yes   | outlook     | Overcast
  13 | Yes   | temperature | Hot
  13 | Yes   | humidity    | Normal
  13 | Yes   | wind        | Weak
(56 rows)
```

2. Create a training table.

```
CREATE table weather_example_nb_training AS SELECT attr,
value, pivot_sum(array['Yes','No'], play, 1) as class_count
FROM weather_example_unpivot GROUP BY attr, value
DISTRIBUTED by (attr);
```

The `SELECT * from weather_example_nb_training` displays the training data and contains the following 10 rows.

```
    attr     |  value   | class_count
-------------+----------+-------------
 outlook     | Rain     | {3,2}
 humidity    | High     | {3,4}
 outlook     | Overcast | {4,0}
 humidity    | Normal   | {6,1}
 outlook     | Sunny    | {2,3}
 wind        | Strong   | {3,3}
 temperature | Hot      | {2,2}
 temperature | Cool     | {3,1}
 temperature | Mild     | {4,2}
 wind        | Weak     | {6,2}
(10 rows)
```

3. Create a summary view of the training data.

```
CREATE VIEW weather_example_nb_classify_functions AS SELECT
attr, value, class_count, array['Yes','No'] as
classes,sum(class_count) over (wa)::integer[] as
class_total,count(distinct value) over (wa) as attr_count
FROM weather_example_nb_training WINDOW wa as (partition by
attr);
```

The `SELECT * from weather_example_nb_classify_function` displays the training data and contains the following 10 rows.

```
attr        |  value   | class_count| classes | class_total| attr_count
------------+-------- +------------+---------+------------+-----------
temperature | Mild     | {4,2}      | {Yes,No}| {9,5}      |          3
temperature | Cool     | {3,1}      | {Yes,No}| {9,5}      |          3
temperature | Hot      | {2,2}      | {Yes,No}| {9,5}      |          3
wind        | Weak     | {6,2}      | {Yes,No}| {9,5}      |          2
wind        | Strong   | {3,3}      | {Yes,No}| {9,5}      |          2
humidity    | High     | {3,4}      | {Yes,No}| {9,5}      |          2
humidity    | Normal   | {6,1}      | {Yes,No}| {9,5}      |          2
outlook     | Sunny    | {2,3}      | {Yes,No}| {9,5}      |          3
outlook     | Overcast| {4,0}      | {Yes,No}| {9,5}      |          3
outlook     | Rain     | {3,2}      | {Yes,No}| {9,5}      |          3
(10 rows)
```

4. Aggregate the data with `nb_classify`, `nb_probabilities`,or both.

Decide what to classify. To classify only one record with the following values:

```
temperature | wind | humidity | outlook
------------+------+----------+---------
 Cool       | Weak | High     | Overcast
```

Use the following command to aggregate the data. The result gives the classification `Yes` or `No` and the probability of playing outdoor sports under this particular set of conditions.

```
SELECT nb_classify(classes, attr_count, class_count,
   class_total) as class,
          nb_probabilities(classes, attr_count, class_count,
   class_total) as probability
   FROM weather_example_nb_classify_functions where
     (attr = 'temperature' and value = 'Cool') or
     (attr = 'wind'        and value = 'Weak') or
     (attr = 'humidity'    and value = 'High') or
     (attr = 'outlook'     and value = 'Overcast');
```

The result is a single row.

```
class |              probability
-------+--------------------------------------
 Yes   | {0.858103353920726,0.141896646079274}
(1 row)
```

To classify a group of records, load them into a table. In this example, the table `t1` contains the following records:

```
 day | outlook   | temperature | humidity |  wind
-----+-----------+-------------+----------+--------
  15 | Sunny     | Mild        | High     | Strong
```

```
  16 | Rain     | Cool          | Normal    | Strong
  17 | Overcast | Hot           | Normal    | Weak
  18 | Rain     | Hot           | High      | Weak
(4 rows)
```

The following command aggregates the data against this table. The result gives the classification `Yes` or `No` and the probability of playing outdoor sports for each set of conditions in the table `t1`. Both the `nb_classify` and `nb_probabilities` aggregates are used.

```
SELECT t1.day,
       t1.temperature, t1.wind, t1.humidity, t1.outlook,
       nb_classify(classes, attr_count, class_count,
class_total) as class,
       nb_probabilities(classes, attr_count, class_count,
class_total) as probability
FROM t1, weather_example_nb_classify_functions
WHERE
  (attr = 'temperature' and value = t1.temperature) or
  (attr = 'wind'        and value = t1.wind) or
  (attr = 'humidity'    and value = t1.humidity) or
  (attr = 'outlook'     and value = t1.outlook)
GROUP BY t1.day, t1.temperature, t1.wind, t1.humidity,
t1.outlook;
```

The result is a four rows, one for each record in `t1`.

```
day| temp| wind   | humidity | outlook  | class |  probability
---+-----+--------+----------+----------+-------+--------------
15 | Mild| Strong | High     | Sunny    | No    | {0.244694132334582,0.755305867665418}
16 | Cool| Strong | Normal   | Rain     | Yes   | {0.751471997809119,0.248528002190881}
18 | Hot | Weak   | High     | Rain     | No    | {0.446387538890131,0.553612461109869}
17 | Hot | Weak   | Normal   | Overcast | Yes   | {0.9297192642788,0.0702807357212004}
(4 rows)
```

3. Configuring Client Authentication

When HAWQ is first initialized, the system contains one predefined *superuser* role. This role will have the same name as the operating system user who initialized the Greenplum Database system. This role is referred to as `gpadmin`. By default, the system is configured to only allow local connections to the database from the `gpadmin` role. If you want to allow any other roles to connect, or if you want to allow connections from remote hosts, you have to configure HAWQ to allow such connections. This chapter explains how to configure client connections and authentication to Greenplum Database.

- Allowing Connections to HAWQ
- Limiting Concurrent Connections

Allowing Connections to HAWQ

Client access and authentication is controlled by the standard PostgreSQL host-based authentication file, pg_hba.conf. In HAWQ, the `pg_hba.conf` file of the master instance controls client access and authentication to your Greenplum system. Greenplum segments have `pg_hba.conf` files that are configured to allowonly client connections from the master host and never accept client connections. Do not alter the `pg_hba.conf` file on your segments.

See The pg_hba.conf File in the PostgreSQL documentation for more information.

The general format of the `pg_hba.conf` file is a set of records, one per line. Greenplum ignores blank lines and any text after the `#` comment character. A record consists of a number of fields that are separated by spaces and/or tabs. Fields can contain white space if the field value is quoted. Records cannot be continued across lines. Each remote client access record has the following format:

```
host   database   role   CIDR-address   authentication-method
```

Each UNIX-domain socket access record has the following format:

```
local   database   role   authentication-method
```

The following table describes meaning of each field.

Table 3.1 pg_hba.conf Fields

Field	Description
local	Matches connection attempts using UNIX-domain sockets. Without a record of this type, UNIX-domain socket connections are disallowed.
host	Matches connection attempts made using TCP/IP. Remote TCP/IP connections will not be possible unless the server is started with an appropriate value for the listen_addresses server configuration parameter.
hostssl	Matches connection attempts made using TCP/IP, but only when the connection is made with SSL encryption. SSL must be enabled at server start time by setting the ssl configuration parameter

Table 3.1 pg_hba.conf Fields

Field	Description
hostnossl	Matches connection attempts made over TCP/IP that do not use SSL.
database	Specifies which database names this record matches. The value `all` specifies that it matches all databases. Multiple database names can be supplied by separating them with commas. A separate file containing database names can be specified by preceding the file name with @.
role	Specifies which database role names this record matches. The value `all` specifies that it matches all roles. If the specified role is a group and you want all members of that group to be included, precede the role name with a +. Multiple role names can be supplied by separating them with commas. A separate file containing role names can be specified by preceding the file name with @.
CIDR-address	Specifies the client machine IP address range that this record matches. It contains an IP address in standard dotted decimal notation and a CIDR mask length. IP addresses can only be specified numerically, not as domain or host names. The mask length indicates the number of high-order bits of the client IP address that must match. Bits to the right of this must be zero in the given IP address. There must not be any white space between the IP address, the /, and the CIDR mask length. Typical examples of a CIDR-address are 172.20.143.89/32 for a single host, or 172.20.143.0/24 for a small network, or 10.6.0.0/16 for a larger one. To specify a single host, use a CIDR mask of 32 for IPv4 or 128 for IPv6. In a network address, do not omit trailing zeroes.
IP-address IP-mask	These fields can be used as an alternative to the CIDR-address notation. Instead of specifying the mask length, the actual mask is specified in a separate column. For example, 255.0.0.0 represents an IPv4 CIDR mask length of 8, and 255.255.255.255 represents a CIDR mask length of 32. These fields only apply to host, hostssl, and hostnossl records.
authentication-method	Specifies the authentication method to use when connecting. HAWQ supports the authentication methods supported by Postgre 9.0.

Editing the pg_hba.conf File

This example shows how to edit the `pg_hba.conf` file of the master to allow remote client access to all databases from all roles using encrypted password authentication.

Note: For a more secure system, consider removing all connections that use trust authentication from your master `pg_hba.conf`. Trust authentication means the role is granted access without any authentication, therefore bypassing all security. Replace trust entries with ident authentication if your system has an ident service available.

Editing pg_hba.conf

1. Open the file `$MASTER_DATA_DIRECTORY/pg_hba.conf` in a text editor.

2. Add a line to the file for each type of connection you want to allow. Records are read sequentially, so the order of the records is significant. Typically, earlier records will have tight connection match parameters and weaker authentication methods, while later records will have looser match parameters and stronger authentication methods. For example:

```
# allow the gpadmin user local access to all databases
# using ident authentication
local   all   gpadmin   ident        sameuser
host    all   gpadmin   127.0.0.1/32 ident
host    all   gpadmin   ::1/128      ident
# allow the 'dba' role access to any database from any
# host with IP address 192.168.x.x and use md5 encrypted
# passwords to authenticate the user
# Note that to use SHA-256 encryption, replace md5 with
# password in the line below
host    all   dba   192.168.0.0/32  md5
# allow all roles access to any database from any
# host and use ldap to authenticate the user. Greenplum role
# names must match the LDAP common name.
host    all   all   192.168.0.0/32  ldap ldapserver=usldap1
ldapport=1389 ldapprefix="cn="
ldapsuffix=",ou=People,dc=company,dc=com"
```

3. Save and close the file.

4. Reload the `pg_hba.conf` configuration file for your changes to take effect:

```
$ gpstop -u
```

Note: Note that you can also control database access by setting object privileges as described in "Managing Object Privileges" on page 33. The `pg_hba.conf` file just controls who can initiate a database session and how those connections are authenticated.

Limiting Concurrent Connections

To limit the number of active concurrent sessions to your HAWQ system, you can configure the `max_connections` server configuration parameter. This is a *local* parameter, meaning that you must set it in the `postgresql.conf` file of the master, the standby master, and each segment instance (primary and mirror). The value of `max_connections` on segments must be 5-10 times the value on the master.

When you set `max_connections`, you must also set the dependent parameter `max_prepared_transactions`. This value must be at least as large as the value of `max_connections` on the master, and segment instances should be set to the same value as the master.

For example:

In `$MASTER_DATA_DIRECTORY/postgresql.conf` (including standby master):

```
max_connections=100
max_prepared_transactions=100
```

In *SEGMENT_DATA_DIRECTORY*/postgresql.conf for all segment instances:

```
max_connections=500
max_prepared_transactions=100
```

To change the number of allowed connections

1. Stop your HAWQ system:

   `$ gpstop`

2. On your master host, edit `$MASTER_DATA_DIRECTORY/postgresql.conf` and change the following two parameters:

   `max_connections` (the number of active user sessions you want to allow plus the number of `superuser_reserved_connections`)

   `max_prepared_transactions` (must be greater than or equal to `max_connections`)

3. On each segment instance, edit *SEGMENT_DATA_DIRECTORY*/`postgresql.conf` and and change the following two parameters:

   `max_connections` (must be 5-10 times the value on the master)

   `max_prepared_transactions` (must be equal to the value on the master)

4. Restart your HAWQ system:

   `$ gpstart`

Note: Raising the values of these parameters may cause HAWQ to request more shared memory. To mitigate this effect, consider decreasing other memory-related parameters such as `gp_cached_segworkers_threshold`.

Encrypting Client/Server Connections

HAWQ has native support for SSL connections between the client and the master server. SSL connections prevent third parties from snooping on the packets, and also prevent man-in-the-middle attacks. SSL should be used whenever the client connection goes through an insecure link, and must be used whenever client certificate authentication is used.

To enable SSL requires that OpenSSL be installed on both the client and the master server systems. HAWQ can be started with SSL enabled by setting the server configuration parameter `ssl=on` in the master `postgresql.conf`. When starting in SSL mode, the server will look for the files `server.key` (server private key) and `server.crt` (server certificate) in the master data directory. These files must be set up correctly before an SSL-enabled Greenplum system can start.

Important: Do not protect the private key with a passphrase. The server does not prompt for a passphrase for the private key, and the database startup fails with an error if one is required.

A self-signed certificate can be used for testing, but a certificate signed by a certificate authority (CA) should be used in production, so the client can verify the identity of the server. Either a global or local CA can be used. If all the clients are local to the organization, a local CA is recommended.

Creating a Self-signed Certificate without a Passphrase for Testing Only

To create a quick self-signed certificate for the server for testing, use the following OpenSSL command:

```
# openssl req -new -text -out server.req
```

Fill out the information that openssl asks for. Be sure to enter the local host name as *Common Name*. The challenge password can be left blank.

The program will generate a key that is passphrase protected, and does not accept a passphrase that is less than four characters long.

To use this certificate with HAWQ, remove the passphrase with the following commands:

```
# openssl rsa -in privkey.pem -out server.key
# rm privkey.pem
```

Enter the old passphrase when prompted to unlock the existing key.

Then, enter the following command to turn the certificate into a self-signed certificate and to copy the key and certificate to a location where the server will look for them.

```
# openssl req -x509 -in server.req -text -key server.key -out server.crt
```

Finally, change the permissions on the key with the following command. The server will reject the file if the permissions are less restrictive than these.

```
# chmod og-rwx server.key
```

For more details on how to create your server private key and certificate, refer to the OpenSSL documentation.

4. HAWQ InputFormat for MapReduce

This chapter describes the document format and schema for defining HAWQ MapReduce jobs.

MapReduce is a programming model developed by Google for processing and generating large data sets on an array of commodity servers. You can use the HAWQ InputFormat option to enable MapReduce jobs to access HAWQ data stored in HDFS.

To use HAWQ InputFormat, you only need to provide the URL of the database you want to conect to and the table name you want to access. HAWQ InputFormat only fetches the metadata of the database and table with interest which is much less than the table data itself. After getting the metadata, the HAWQ InputFormat figures out where and how the table data is stored in HDFS. It reads and parses those HDFS files and processes the parsed table tuples directly inside a Map task.

Supported Data Types

HAWQ InputFormat supports the following data types:

Table 4.1 HAWQ InputFormat data types

SQL/HAWQ	JDBC/JAVA	setXXX	getXXX
DECIMAL/NUMERIC	java.math.BigDecimal	setBigDecimal	getBigDecimal
FLOAT8/DOUBLE PRECISION	double	setDouble	getDouble
INT8/BIGINT	long	setLong	getLong
INTEGER/INT4/INT	int	setInt	getInt
FLOAT4/REAL	float	setFloat	getFloat
SMALLINT/INT2	short	setShort	getShort
BOOL/BOOLEAN	boolean	setBoolean	getBoolean
VARCHAR/CHAR/TEXT	String	setString	getString
DATE	java.sql.Date	setDate	getDate
TIME/TIMETZ	java.sql.Time	setTime	getTime
TIMESTAMP/TIMSTAMPTZ	java.sql.Timestamp	setTimestamp	getTimestamp
ARRAY	java.sq.Array	setArray	getArray
BIT/VARBIT	com.pivotal.hawq. mapreduce.datatype. HAWQVarbit	setVarbit	getVarbit
BYTEA	byte[]	setBytes	getBytes

Table 4.1 HAWQ InputFormat data types

SQL/HAWQ	JDBC/JAVA	setXXX	getXXX
INTERVAL	com.pivotal.hawq. mapreduce.datatype. HAWQInterval	setInterval	getInterval
POINT	com.pivotal.hawq. mapreduce.datatype. HAWQPoint	setPoint	getPoint
LSEG	com.pivotal.hawq. mapreduce.datatype. HAWQLseg	setLseg	getLseg
BOX	com.pivotal.hawq. mapreduce.datatype. HAWQBox	setBox	getBox
CIRCLE	com.pivotal.hawq. mapreduce.datatype. HAWQCircle	setCircle	getCircle
PATH	com.pivotal.hawq. mapreduce.datatype. HAWQPath	setPath	getPath
POLYGON	com.pivotal.hawq. mapreduce.datatype. HAWQPolygon	setPolygon	getPolygon
MACADDR	com.pivotal.hawq. mapreduce.datatype. HAWQMacaddr	setMacaddr	getMacaddr
INET	com.pivotal.hawq. mapreduce.datatype. HAWQInet	setInet	getInet
CIDR	com.pivotal.hawq. mapreduce.datatype. HAWQCIDR	setCIDR	getCidr

Note: The SQL standard defines a different binary string type, called BLOB or BINARY LARGE OBJECT. The corresponding data type in Postgres is bytea. The SQL standard also defines the CLOB type, that corresponds to the Postgres type, TEXT.

HAWQ InputFormat Example

The following example shows how you can use the HAWQ InputFormat to access HAWQ table data from MapReduce jobs.

```
package com.mycompany.app;
```

```
import com.pivotal.hawq.mapreduce.HAWQException;
import com.pivotal.hawq.mapreduce.HAWQInputFormat;
import com.pivotal.hawq.mapreduce.HAWQRecord;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.conf.Configured;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
import org.apache.hadoop.util.Tool;
import org.apache.hadoop.util.ToolRunner;
import org.apache.hadoop.io.IntWritable;

import java.io.IOException;
public class HAWQInputFormatDemoDriver extends Configured
implements Tool {

   // CREATE TABLE employees (
   // id INTEGER NOT NULL PRIMARY KEY,
   // name VARCHAR(32) NOT NULL);
   public static class DemoMapper extends
         Mapper<Void, HAWQRecord, IntWritable, Text> {
      int id = 0;
      String name = null;

      public void map(Void key, HAWQRecord value, Context
      context)
            throws IOException, InterruptedException {
         try {
            id = value.getInt(1);
            name = value.getString(2);
         } catch (HAWQException hawqE) {
            throw new IOException(hawqE.getMessage());
         }
         context.write(new IntWritable(id), new Text(name));
      }
   }
```

```
private static int printUsage() {
    System.out.println("HAWQInputFormatDemoDriver
    <database_url> <table_name> <output_path> [username]
    [password]");
    ToolRunner.printGenericCommandUsage(System.out);
    return 2;
}

public int run(String[] args) throws Exception {
    if (args.length < 3) {
      return printUsage();
    }

    Job job = new Job(getConf());
    job.setJobName("hawq-inputformat-demo");
    job.setJarByClass(HAWQInputFormatDemoDriver.class);
    job.setMapperClass(DemoMapper.class);
    job.setMapOutputValueClass(Text.class);
    job.setOutputValueClass(Text.class);
    String db_url = args[0];
    String table_name = args[1];
    String output_path = args[2];
    String user_name = null;
    if (args.length > 3) {
      user_name = args[3];
    }
    String password = null;
    if (args.length > 4) {
      password = args[4];
    }

    job.setInputFormatClass(HAWQInputFormat.class);
    HAWQInputFormat.setInput(job.getConfiguration(), db_url,
    user_name, password, table_name);

    FileOutputFormat.setOutputPath(job, new
    Path(output_path));
    job.setNumReduceTasks(0);
    int res = job.waitForCompletion(true) ? 0 : 1;
    return res;
}
```

```
    public static void main(String[] args) throws Exception {
        int res = ToolRunner.run(new Configuration(),
            new HAWQInputFormatDemoDriver(), args);
        System.exit(res);
    }
}
```

To compile and run the example:

1. Add the following dependencies into the project for compilation:
   a. HAWQInputFormat jars:
   - hawq-mapreduce-common.jar
   - hawq-mapreduce-ao.jar
   - hawq-mapreduce-tool.jar

   Find these jars in the $GPHOME/lib/postgresql/hawq-mr-io/ directory.

   b. Required 3rd party jars:
   - postgresql-jdbc.jar
   - snakeyaml.jar

   Find these jars under the $GPHOME/lib/postgresql/hawq-mr-io/lib.

   c. Hadoop Mapreduce related jars: Find these jars under the install directory of your Hadoop distribution.
2. Check that you have installed HAWQ, HDFS and Yarn.
3. Create sample table:
   a. Login to HAWQ:
   ```
   psql -d postgres
   ```
   b. Create the sample table:
   ```
   CREATE TABLE employees (
   id INTEGER NOT NULL PRIMARY KEY,
   name TEXT NOT NULL);
   ```
   c. Insert one tuple:
   ```
   INSERT INTO employees VALUES (1, 'Paul');
   ```
4. Use the following shell script snippet showing to run the Mapreduce job
   ```
   # Suppose all five needed jars are under ./lib
   export
   LIBJARS=lib/hawq-mapreduce-common.jar,lib/hawq-mapreduce-ao.
   jar,lib/hawq-mapreduce-tool.jar,lib/postgresql-9.2-1003-jdbc
   4.jar,lib/snakeyaml-1.12.jar
   export
   HADOOP_CLASSPATH=lib/hawq-mapreduce-common.jar:lib/hawq-mapr
   educe-ao.jar:lib/hawq-mapreduce-tool.jar:lib/postgresql-9.2-
   1003-jdbc4.jar:lib/snakeyaml-1.12.jar
   ```

```
# Suppose the built application jar is my-app.jar
hadoop jar my-app.jar
com.mycompany.app.HAWQInputFormatDemoDriver -libjars
${LIBJARS} localhost:5432/postgres employees /tmp/employees
```

5. Use the following command to check the result of the Mapreduce job

```
hadoop fs -cat /tmp/employees/*
```

The output looks as follows:

```
1 Paul
```

Acessing HAWQ Data

You can access HAWQ data using the following interfaces:

- **HAWQInputFormat.setInput API**: Use this when HAWQ is running.
- **Metadata Export Tool**: Use this when HAWQ is not running.

HAWQInputFormat.setInput

```
/**
   * Initializes the map-part of the job with the appropriate
   input settings
   * through connecting to Database.
   *
   * @param conf
   * The map-reduce job configuration
   * @param db_url
   * The database URL to connect to
   * @param username
   * The username for setting up a connection to the database
   * @param password
   * The password for setting up a connection to the database
   * @param tableName
   * The name of the table to access to
   * @throws Exception
   */
public static void setInput(Configuration conf, String db_url,
   String username, String password, String tableName)
   throws Exception;
```

Metadata Export Tool

Use the metadata export tool, `gpextract`, to export the metadata of the target table into a local `YAML`file:

```
gpextract [-h hostname] [-p port] [-U username] [-d
database] [-o output_file] [-W] <tablename>
```

Using the extracted metadata, access HAWQ data through the following interface:

```
/**
   * Initializes the map-part of the job with the appropriate
   input settings through reading metadata file stored in local
   filesystem.
   *
   * To get metadata file, please use gpextract first
   *
   * @param conf
   * The map-reduce job configuration
   * @param pathStr
   * The metadata file path in local filesystem. e.g.
   * /home/gpadmin/metadata/postgres_test
   * @throws Exception
   */
public static void setInput(Configuration conf, String pathStr)
   throws Exception;
```

5. Kerberos Authentication

On the versions of Red Hat Enterprise Linux that are supported by HAWQ, you can use a Kerberos authentication system to control access to HAWQ. HAWQ supports GSSAPI with Kerberos authentication. GSSAPI provides automatic authentication (single sign-on) for systems that support it. If Kerberos authentication is not available when a role attempts to log into HAWQ the login fails.

You specify which HAWQ users require Kerberos authentication in the HAWQ configuration file `pg_hba.conf`. Whether you specify Kerberos authentication or another type of authentication for a HAWQ user, authorization to access HAWQ databases and database objects such as schemas and tables is controlled by the settings specified in the `pg_hba.conf` file and the privileges given to HAWQ users and roles within the database. For information about managing authorization privileges, see the *HAWQ Database Administrator Guide*.

This chapter describes how to configure a Kerberos authentication system and HAWQ to authenticate a HAWQ administrator. It contains the following topics:

- Enabling Kerberos authentication for HAWQ
- Requirements for using Kerberos with HAWQ
- Installing and Configuring a Kerberos KDC Server
- Creating HAWQ Roles in the KDC Database
- Installing and Configuring the Kerberos Client
- Setting up HAWQ with Kerberos for PSQL
- Setting up HAWQ with Kerberos for JDBC
- Sample Kerberos Configuration File

For more information about Kerberos, see http://web.mit.edu/kerberos/.

Enabling Kerberos authentication for HAWQ

The following tasks are required to use Kerberos with HAWQ:

1. Set up a Kerberos Key Distribution Center (KDC) server.

   In a Kerberos database on the KDC server, set up a Kerberos realm and principals on the server. For HAWQ, a principal is a HAWQ role that utilizes Kerberos authentication. In the Kerberos database, a realm groups together the Kerberos principals that are the HAWQ roles.

2. Create a Kerberos keytab file for HAWQ.

   To access HAWQ, you create a service key known only by Kerberos and HAWQ. On the Kerberos server, the service key is stored in the Kerberos database.

On the HAWQ master, the service key is stored in key tables, which are files known as keytabs. The service keys are usually stored in the keytab file `/etc/krb5.keytab`. This service key is the equivalent of the service's password, and must be kept secure. Data which is meant to be read only by the service is encrypted using this key.

3. Install the Kerberos client packages and the keytab file on HAWQ master.
4. Create a Kerberos ticket for `gpadmin` on HAWQ master node using the keytab file. The ticket contains the Kerberos authentication credentials that grant access to the HAWQ.

With Kerberos authentication configured on the HAWQ, you can use to use Kerberos for PSQL and JDBC.

Setting up HAWQ with Kerberos for PSQL

Setting up HAWQ with Kerberos for JDBC

Requirements for using Kerberos with HAWQ

The following items are required for using Kerberos with HAWQ:

- Kerberos Key Distribution Center (KDC) server that uses the krb5-server library.
- Kerberos packages for version 5
  - krb5-libs
  - krb5-workstation
- HAWQ capable of supporting Kerberos
- A configuration that allows the Kerberos server and the HAWQ master to communicate with each other.
- Red Hat Enterprise Linux 6.x requires Java 1.7.0_17 or later.
- Red Hat Enterprise Linux 5.x requires Java 1.6.0_21 or later.
- Red Hat Enterprise Linux 4.x requires Java 1.6.0_21 or later.

Notes

The dates and times on the Kerberos server and clients must be synchronized. Authentication fails if the time difference between the Kerberos server and a client too large. The maximum time difference is configurable, 5 minutes is the default.

The Kerberos server and client must be configured so that they can ping each other using their host names.

The Kerberos authentication itself is secure, but the data sent over the database connection is transmitted in clear text unless SSL is used.

Installing and Configuring a Kerberos KDC Server

The following steps install and configure a Kerberos Key Distribution Center (KDC) server:

1. Install the Kerberos packages for the Kerberos server:
   krb5-libs
   krb5-server
   krb5-workstation

2. Edit the `/etc/krb5.conf` configuration file. See "krb5.conf Configuration File" on page 50 for sample configuration file parameters.

   When you create a KDC database, the parameters in the `/etc/krb5.conf` file specify that the realm KRB.GREENPLUM.COM is created. You use this realm when you create the Kerberos principals that are HAWQ roles.

   If you have an existing Kerberos server you might need to edit the `kdc.conf` file. See the Kerberos documentation for information the `kdc.conf` file.

3. To create a Kerberos KDC database, run the `kdb5_util`. For example:

   ```
   kdb5_util create -s
   ```

   The create option creates the database to store keys for the Kerberos realms that are managed by this KDC server. The `-s` option creates a stash file. Without the stash file, every time the KDC server starts it requests a password.

4. The Kerberos utility `kadmin` uses Kerberos to authenticate to the server. Before using `kadmin`, add an administrative user to KDC database with `kadmin.local`. `kadmin.local` is local to the server and does not use Kerberos authentication. To add the user `gpadmin` as an administrative user to the KDC database, run the following command:

   ```
   kadmin.local -q "addprinc gpadmin/admin"
   ```

   Note: Most users do not need administrative access to the Kerberos server. They can use kadmin to manage their own principals (for example, to change their own password). For information about `kadmin`, see the Kerberos documentation.

5. If needed, edit the `/var/kerberos/krb5kdc/kadm5.acl` file to grant the appropriate permissions to `gpadmin`.

6. Start the Kerberos daemons with the following commands:

   ```
   /sbin/service krb5kdc start
   /sbin/service kadmin start
   ```

   If you want to start Kerberos automatically upon restart, run the following commands:

   ```
   /sbin/chkconfig krb5kdc on
   /sbin/chkconfig kadmin on
   ```

Creating HAWQ Roles in the KDC Database

After you have set up a Kerberos KDC and have created a realm for HAWQ, you add principals to the realm.

1. Create principals in the Kerberos database with `kadmin.local`.

   Using `kadmin.local` in interactive mode, the following commands add users:

   ```
   addprinc gpadmin/kerberos-gpdb@KRB.GREENPLUM.COM
   addprinc postgres/master.test.com@KRB.GREENPLUM.COM
   ```

The first `addprinc` command creates a HAWQ user as a principal. In this example, the principal is `gpadmin/kerberos-gpdb`. See "Setting up HAWQ with Kerberos for PSQL" on page 48 for information on modifying the file `pg_hba.conf` so The HAWQ user `gpadmin/kerberos-gpdb` uses Kerberos authentication to access HAWQ from the master host.

The second `addprinc` command creates the postgres process as principal in the Kerberos KDC. This principal is required when using Kerberos authentication with HAWQ. The syntax for the principal is `postgres/`*`GPDB_master_host`*. The *`GPDB_master_host`* is the host name of the HAWQ master.

2. Create a Kerberos keytab file with `kadmin.local`. The following example creates a keytab file `gpdb-kerberos.keytab` with authentication information for the two principals.

```
xst -k gpdb-kerberos.keytab
   gpadmin/kerberos-gpdb@KRB.GREENPLUM.COM
   postgres/master.test.com@KRB.GREENPLUM.COM
```

You use the keytab file `gpdb-kerberos.keytab` on the HAWQ master.

Installing and Configuring the Kerberos Client

Install the Kerberos client libraries on the HAWQ master and configure the Kerberos client:

1. Install the Kerberos packages on the HAWQ master.
   krb5-libs
   krb5-workstation

2. Ensure that the `/etc/krb5.conf` file is the same as the one that is on the Kerberos server.

3. Copy the `gpdb-kerberos.keytab` that was generated on the Kerberos server to HAWQ master.

4. Remove any existing tickets with the Kerberos utility `kdestroy`. As root, run the utility.

```
# kdestroy
```

5. Use the Kerberos utility `kinit` to request a ticket using the keytab file on the HAWQ master for `gpadmin/kerberos-gpdb@KRB.GREENPLUM.COM`. The `-t` option specifies the keytab file on the HAWQ master.

```
# kinit -k -t gpdb-kerberos.keytab
gpadmin/kerberos-gpdb@KRB.GREENPLUM.COM
```

Use the Kerberos utility `klist` to display the contents of the Kerberos ticket cache on the HAWQ master. The following is example `klist` output:

```
# klist

Ticket cache: FILE:/tmp/krb5cc_108061

Default principal: gpadmin/kerberos-gpdb@KRB.GREENPLUM.COM

Valid starting     Expires            Service principal
```

```
03/28/13 14:50:26  03/29/13 14:50:26   krbtgt/KRB.GREENPLUM.COM
    @KRB.GREENPLUM.COM

    renew until 03/28/13 14:50:26
```

Setting up HAWQ with Kerberos for PSQL

After you have set up Kerberos on the HAWQ master, you can configure HAWQ to use Kerberos. For information on setting up the HAWQ master, see "Installing and Configuring the Kerberos Client" on page 47.

1. Create a HAWQ administrator role in the database template1 for the Kerberos principal that is used as the database administrator. The following example uses `gpamin/kerberos-gpdb`.

   ```
   psql template1 -c 'create role "gpadmin/kerberos-gpdb" login
   superuser;'
   ```

   Note: The role you create in the database template1 will be available in any new HAWQ database that you create.

2. Modify `postgresql.conf` to specify the location of the keytab file. For example, adding this line to the `postgresql.conf` specifies the folder `/home/gpadmin` as the location of the keytab file `gpdb-kerberos.keytab`.

   ```
   krb_server_keyfile = '/home/gpadmin/gpdb-kerberos.keytab'
   ```

3. Modify the HAWQ file `pg_hba.conf` to enable Kerberos support. Then restart HAWQ (`gpstop -ar`). For example, adding the following line to `pg_hba.conf` adds GSSAPI and Kerberos support. The value for `krb_realm` is the Kerberos realm that is used for authentication to HAWQ.

```
host all all 0.0.0.0/0 gss include_realm=0 krb_realm=KRB.GREENPLUM.COM
```

   For information about the `pg_hba.conf` file, see the Postgres documentation: http://www.postgresql.org/docs/8.4/static/auth-pg-hba-conf.html

4. Create a ticket using `kinit` and show the tickets in the Kerberos ticket cache with `klist`.

5. As a test, login into the database as the gpadmin role with the Kerberos credentials `gpadmin/kerberos-gpdb`:

   ```
   psql -U "gpadmin/kerberos-gpdb" -h master.test template1
   ```

Notes

- A username map can be defined in the `pg_ident.conf` file and specified in the `pg_hba.conf` file to simplify logging into HAWQ. For example, this `psql` command logs into the default HAWQ on `mdw.proddb` as the Kerberos principal `adminuser/mdw.proddb`:

  ```
  $ psql -U "adminuser/mdw.proddb" -h mdw.proddb
  ```

  If the default user is `adminuser`, the `pg_ident.conf` file and the `pg_hba.conf` file can be configured so that the `adminuser` can log into the database as the Kerberos principal `adminuser/mdw.proddb` without specifying the `-U` option:

```
$ psql -h mdw.proddb
```

The following username map is defined in the HAWQ file `$MASTER_DATA_DIRECTORY/pg_ident.conf`:

```
# MAPNAME    SYSTEM-USERNAME        GP-USERNAME
mymap        /^(.*)mdw\.proddb$      adminuser
```

The map can be specified in the `pg_hba.conf` file as part of the line that enables Kerberos support:

```
host all all 0.0.0.0/0 krb5 include_realm=0 krb_realm=proddb
   map=mymap
```

For more information on specifying username maps see the Postgres documentation:
http://www.postgresql.org/docs/8.4/static/auth-username-maps.html

- If a Kerberos principal is not a HAWQ user, a message is similar to the following is displayed from the `psql` command line when the user attempts to log into the database:

  ```
  psql: krb5_sendauth: Bad response
  ```

  The principal must be added as a HAWQ user.

Setting up HAWQ with Kerberos for JDBC

You can configure HAWQ to use Kerberos to run user-defined Java functions.

1. Ensure that a Kerberos is installed and configured on the HAWQ master. See "Installing and Configuring the Kerberos Client" on page 47.

2. Create the file `.java.login.config` in the folder `/home/gpadmin` and add the following text to the file:

   ```
   pgjdbc {
     com.sun.security.auth.module.Krb5LoginModule required
     doNotPrompt=true
     useTicketCache=true
     debug=true
     client=true;
   };
   ```

3. Create a Java application that connects to HAWQ using Kerberos authentication.

   The this example database connection URL uses a PostgreSQL JDBC driver and specifies parameters for Kerberos authentication.

   ```
   jdbc:postgresql://mdw:5432/mytest?kerberosServerName=
   postgres&jaasApplicationName=pgjdbc&user=
   gpadmin/kerberos-gpdb
   ```

   The parameter names and values specified depend on how the Java application performs Kerberos authentication.

4. Test the Kerberos login by running a sample Java application from HAWQ.

Sample Kerberos Configuration File

This sample `krb5.conf` Kerberos configuration file is used in the example that configures HAWQ to use Kerberos authentication.

krb5.conf Configuration File

```
[logging]
 default = FILE:/var/log/krb5libs.log
 kdc = FILE:/var/log/krb5kdc.log
 admin_server = FILE:/var/log/kadmind.log


[libdefaults]
 default_realm = KRB.GREENPLUM.COM
 dns_lookup_realm = false
 dns_lookup_kdc = false
 ticket_lifetime = 24h
 renew_lifetime = 7d
 forwardable = yes
 default_tgs_enctypes = aes128-cts des3-hmac-sha1 des-cbc-crc
des-cbc-md5

 default_tkt_enctypes = aes128-cts des3-hmac-sha1 des-cbc-crc
des-cbc-md5

 permitted_enctypes = aes128-cts des3-hmac-sha1 des-cbc-crc
des-cbc-md5


[realms]
 KRB.GREENPLUM.COM = {
  kdc = kerberos-gpdb:88
  admin_server = kerberos-gpdb:749
  default_domain = kerberos-gpdb
 }


[domain_realm]
 .kerberos-gpdb = KRB.GREENPLUM.COM
 kerberos-gpdb = KRB.GREENPLUM.COM


[appdefaults]
 pam = {
    debug = false
    ticket_lifetime = 36000
    renew_lifetime = 36000
    forwardable = true
```

```
    krb4_convert = false
}
```

Section II: References

This section contains the following references:

- SQL Command Reference
- Management Utility Reference
- Client Utility Reference
- Server Configuration Parameters
- HAWQ Environment Variables
- HAWQ Data Types
- Pivotal Extension Framework
- MADlib References

A. SQL Command Reference

This appendix provides references for the SQL commands available in Greenplum Database:

- ABORT
- ALTER ROLE
- ALTER TABLE
- ALTER USER
- ANALYZE
- BEGIN
- CHECKPOINT
- CLOSE
- COMMIT
- COPY
- CREATE DATABASE
- CREATE EXTERNAL TABLE
- CREATE GROUP
- CREATE RESOURCE QUEUE
- CREATE ROLE
- CREATE SCHEMA
- CREATE SEQUENCE
- CREATE TABLE
- CREATE TABLE AS
- CREATE USER
- CREATE VIEW
- DEALLOCATE
- DECLARE
- DROP DATABASE
- DROP EXTERNAL TABLE
- DROP FILESPACE
- DROP GROUP
- DROP OWNED
- DROP RESOURCE QUEUE
- DROP ROLE
- DROP SCHEMA
- DROP SEQUENCE
- DROP TABLE
- DROP TABLESPACE
- DROP USER
- DROP VIEW
- END
- EXECUTE
- EXPLAIN
- FETCH
- GRANT
- INSERT
- PREPARE
- REASSIGN OWNED
- RELEASE SAVEPOINT
- RESET
- REVOKE
- ROLLBACK
- ROLLBACK TO SAVEPOINT
- SAVEPOINT
- SELECT
- SELECT INTO
- SET
- SET ROLE
- SET SESSION AUTHORIZATION
- SHOW
- TRUNCATE
- VACUUM

SQL Syntax Summary

ABORT

Aborts the current transaction.

```
ABORT [WORK | TRANSACTION]
```

ALTER ROLE

Changes a database role (user or group).

```
ALTER ROLE name RENAME TO newname

ALTER ROLE name SET config_parameter {TO | =} {value | DEFAULT}

ALTER ROLE name RESET config_parameter

ALTER ROLE name RESOURCE QUEUE {queue_name | NONE}

ALTER ROLE name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEEXTTABLE | NOCREATEEXTTABLE
      [ ( attribute='value'[, ...] ) ]
           where attributes and values are:
           type='readable'|'writable'
           protocol='gpfdist'|'http'
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | CONNECTION LIMIT connlimit
    | [ENCRYPTED | UNENCRYPTED] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | [ DENY deny_point ]
    | [ DENY BETWEEN deny_point AND deny_point]
    | [ DROP DENY FOR deny_point ]
```

ALTER TABLE

Changes the definition of a table.

```
ALTER TABLE [ONLY] name RENAME [COLUMN] column TO new_column

ALTER TABLE name RENAME TO new_name

ALTER TABLE name SET SCHEMA new_schema

ALTER TABLE [ONLY] name SET
     DISTRIBUTED BY (column, [ ... ] )
   | DISTRIBUTED RANDOMLY
   | WITH (REORGANIZE=true|false)


ALTER TABLE [ONLY] name action [, ... ]

ALTER TABLE name
   [ ALTER PARTITION { partition_name | FOR (RANK(number))
                     | FOR (value) } partition_action [...] ]
   partition_action
```

where *action* is one of:

```
  ADD [COLUMN] column_name type
      [ ENCODING ( storage_directive [,…] ) ]
      [column_constraint [ ... ]]
  DROP [COLUMN] column [RESTRICT | CASCADE]
  ALTER [COLUMN] column TYPE type [USING expression]
  ALTER [COLUMN] column SET DEFAULT expression
  ALTER [COLUMN] column DROP DEFAULT
  ALTER [COLUMN] column { SET | DROP } NOT NULL
  ALTER [COLUMN] column SET STATISTICS integer
  ADD table_constraint
  DROP CONSTRAINT constraint_name [RESTRICT | CASCADE]
  SET WITHOUT OIDS
  INHERIT parent_table
  NO INHERIT parent_table
  OWNER TO new_owner
  ALTER DEFAULT PARTITION
  DROP DEFAULT PARTITION [IF EXISTS]
  DROP PARTITION [IF EXISTS] { partition_name |
      FOR (RANK(number)) | FOR (value) } [CASCADE]
  TRUNCATE DEFAULT PARTITION
  TRUNCATE PARTITION { partition_name | FOR (RANK(number)) |
      FOR (value) }
  RENAME DEFAULT PARTITION TO new_partition_name
  RENAME PARTITION { partition_name | FOR (RANK(number)) |
      FOR (value) } TO new_partition_name
  ADD DEFAULT PARTITION name [ ( subpartition_spec ) ]
  ADD PARTITION [name] partition_element
      [ ( subpartition_spec ) ]
  EXCHANGE PARTITION { partition_name | FOR (RANK(number)) |
       FOR (value) } WITH TABLE table_name
        [ WITH | WITHOUT VALIDATION ]
  EXCHANGE DEFAULT PARTITION WITH TABLE table_name
   [ WITH | WITHOUT VALIDATION ]
  SET SUBPARTITION TEMPLATE (subpartition_spec)
  SPLIT DEFAULT PARTITION
    {  AT (list_value)
     | START([datatype] range_value) [INCLUSIVE | EXCLUSIVE]
        END([datatype] range_value) [INCLUSIVE | EXCLUSIVE] }
    [ INTO ( PARTITION new_partition_name,
```

```
            PARTITION default_partition_name ) ]
  SPLIT PARTITION { partition_name | FOR (RANK(number)) |
     FOR (value) } AT (value)
    [ INTO (PARTITION partition_name, PARTITION partition_name)]
```

where *partition_element* is:

```
    VALUES (list_value [,...] )
  | START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
  | END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[ TABLESPACE tablespace ]
```

where *subpartition_spec* is:

```
subpartition_element [, ...]
```

and *subpartition_element* is:

```
   DEFAULT SUBPARTITION subpartition_name
  | [SUBPARTITION subpartition_name] VALUES (list_value [,...] )
  | [SUBPARTITION subpartition_name]
     START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
     [ EVERY ( [number | datatype] 'interval_value') ]
  | [SUBPARTITION subpartition_name]
     END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
     [ EVERY ( [number | datatype] 'interval_value') ]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[ TABLESPACE tablespace ]
```

where *storage_parameter* is:

```
   APPENDONLY={TRUE}
   BLOCKSIZE={8192-2097152}
   ORIENTATION={COLUMN|ROW}
   COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
   COMPRESSLEVEL={0-9}
   FILLFACTOR={10-100}
   OIDS[=TRUE|FALSE]
```

where *storage_directive* is:

```
   COMPRESSTYPE={ZLIB | QUICKLZ | RLE_TYPE | NONE}
 | COMPRESSLEVEL={0-9}
 | BLOCKSIZE={8192-2097152}
```

Where *column_reference_storage_directive* is:

```
COLUMN column_name ENCODING ( storage_directive [, … ] ), …  |
DEFAULT COLUMN ENCODING ( storage_directive [, … ] )
```

ALTER USER

Changes the definition of a database role (user).

```
ALTER USER name RENAME TO newname
ALTER USER name SET config_parameter {TO | =} {value | DEFAULT}
ALTER USER name RESET config_parameter
ALTER USER name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
```

ANALYZE

Collects statistics about a database.

```
ANALYZE [VERBOSE] [table [ (column [, ...] ) ]]
```

BEGIN

Starts a transaction block.

```
BEGIN [WORK | TRANSACTION] [SERIALIZABLE | REPEATABLE READ | READ COMMITTED | READ
UNCOMMITTED] [READ WRITE | READ ONLY]
```

CHECKPOINT

Forces a transaction log checkpoint.

```
CHECKPOINT
```

CLOSE

Closes a cursor.

```
CLOSE cursor_name
```

COMMIT

Commits the current transaction.

```
COMMIT [WORK | TRANSACTION]
```

COPY

Copies data between a file and a table.

```
COPY table [(column [, ...])] FROM {'file' | STDIN}
     [ [WITH]
       [OIDS]
       [HEADER]
       [DELIMITER [ AS ] 'delimiter']
       [NULL [ AS ] 'null string']
       [ESCAPE [ AS ] 'escape' | 'OFF']
       [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
       [CSV [QUOTE [ AS ] 'quote']
            [FORCE NOT NULL column [, ...]]
       [FILL MISSING FIELDS]
COPY {table [(column [, ...])] | (query)} TO {'file' | STDOUT}
      [ [WITH]
        [OIDS]
        [HEADER]
        [DELIMITER [ AS ] 'delimiter']
        [NULL [ AS ] 'null string']
        [ESCAPE [ AS ] 'escape' | 'OFF']
        [CSV [QUOTE [ AS ] 'quote']
             [FORCE QUOTE column [, ...]] ]
```

CREATE EXTERNAL TABLE

Defines a new external table.

```
CREATE [READABLE] EXTERNAL TABLE table_name
     ( column_name data_type [, ...] | LIKE other_table )
      LOCATION ('file://seghost[:port]/path/file' [, ...])
         | ('gpfdist://filehost[:port]/file_pattern[#transform]'
```

```
          [, ...])
      FORMAT 'TEXT'
            [( [HEADER]
               [DELIMITER [AS] 'delimiter' | 'OFF']
               [NULL [AS] 'null string']
               [ESCAPE [AS] 'escape' | 'OFF']
               [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
               [FILL MISSING FIELDS] )]
           | 'CSV'
            [( [HEADER]
               [QUOTE [AS] 'quote']
               [DELIMITER [AS] 'delimiter']
               [NULL [AS] 'null string']
               [FORCE NOT NULL column [, ...]]
               [ESCAPE [AS] 'escape']
               [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
               [FILL MISSING FIELDS] )]
     [ ENCODING 'encoding' ]

CREATE [READABLE] EXTERNAL WEB TABLE table_name
     ( column_name data_type [, ...] | LIKE other_table )
      LOCATION ('http://webhost[:port]/path/file' [, ...])
    | EXECUTE 'command' [ON ALL
                          | MASTER
                          | number_of_segments
                          | HOST ['segment_hostname']
                          | SEGMENT segment_id ]
      FORMAT 'TEXT'
            [( [HEADER]
               [DELIMITER [AS] 'delimiter' | 'OFF']
               [NULL [AS] 'null string']
               [ESCAPE [AS] 'escape' | 'OFF']
               [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
               [FILL MISSING FIELDS] )]
           | 'CSV'
            [( [HEADER]
               [QUOTE [AS] 'quote']
               [DELIMITER [AS] 'delimiter']
               [NULL [AS] 'null string']
               [FORCE NOT NULL column [, ...]]
               [ESCAPE [AS] 'escape']
               [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
               [FILL MISSING FIELDS] )]
     [ ENCODING 'encoding' ]

CREATE WRITABLE EXTERNAL TABLE table_name
    ( column_name data_type [, ...] | LIKE other_table )
     LOCATION('gpfdist://outputhost[:port]/filename[#transform]'
```

```
                [, ...])
        FORMAT 'TEXT'
                  [( [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [ESCAPE [AS] 'escape' | 'OFF'] )]
             | 'CSV'
                  [([QUOTE [AS] 'quote']
                  [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [FORCE QUOTE column [, ...]] ]
                  [ESCAPE [AS] 'escape'] )]
    [ ENCODING 'write_encoding' ]
    [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]
CREATE WRITABLE EXTERNAL WEB TABLE table_name
    ( column_name data_type [, ...] | LIKE other_table )
    EXECUTE 'command' [ON ALL]
    FORMAT 'TEXT'
                  [( [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [ESCAPE [AS] 'escape' | 'OFF'] )]
             | 'CSV'
                  [([QUOTE [AS] 'quote']
                  [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [FORCE QUOTE column [, ...]] ]
                  [ESCAPE [AS] 'escape'] )]
    [ ENCODING 'write_encoding' ]
    [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]
```

CREATE GROUP

Defines a new database role.

```
CREATE GROUP name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | IN GROUP rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | USER rolename [, ...]
    | SYSID uid
```

CREATE DATABASE

Creates a new database.

```
CREATE DATABASE name [ [WITH] [OWNER [=] dbowner]
                     [TEMPLATE [=] template]
                     [ENCODING [=] encoding]
                     [TABLESPACE [=] tablespace]
                     [CONNECTION LIMIT [=] connlimit ] ]
```

CREATE RESOURCE QUEUE

Defines a new resource queue.

```
CREATE RESOURCE QUEUE name WITH (queue_attribute=value [, ... ])
```

where *queue_attribute* is:

```
   ACTIVE_STATEMENTS=integer
        [ MAX_COST=float [COST_OVERCOMMIT={TRUE|FALSE}] ]
        [ MIN_COST=float ]
        [ PRIORITY={MIN|LOW|MEDIUM|HIGH|MAX} ]
        [ MEMORY_LIMIT='memory_units' ]
|  MAX_COST=float [ COST_OVERCOMMIT={TRUE|FALSE} ]
        [ ACTIVE_STATEMENTS=integer ]
        [ MIN_COST=float ]
        [ PRIORITY={MIN|LOW|MEDIUM|HIGH|MAX} ]
        [ MEMORY_LIMIT='memory_units' ]
```

CREATE ROLE

Defines a new database role (user or group).

```
CREATE ROLE name [[WITH] option [ ... ]]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEEXTTABLE | NOCREATEEXTTABLE
      [ ( attribute='value'[, ...] ) ]
           where attributes and values are:
           type='readable'|'writable'
           protocol='gpfdist'|'http'
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | CONNECTION LIMIT connlimit
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | RESOURCE QUEUE queue_name
    | [ DENY deny_point ]
    | [ DENY BETWEEN deny_point AND deny_point]
```

CREATE SCHEMA

Defines a new schema.

```
CREATE SCHEMA schema_name [AUTHORIZATION username] [schema_element [ ... ]]
CREATE SCHEMA AUTHORIZATION rolename [schema_element [ ... ]]
```

CREATE SEQUENCE

Defines a new sequence generator.

```
CREATE [TEMPORARY | TEMP] SEQUENCE name
       [INCREMENT [BY] value]
       [MINVALUE minvalue | NO MINVALUE]
       [MAXVALUE maxvalue | NO MAXVALUE]
       [START [ WITH ] start]
       [CACHE cache]
       [[NO] CYCLE]
       [OWNED BY { table.column | NONE }]
```

CREATE TABLE

Defines a new table.

```
CREATE [[GLOBAL | LOCAL] {TEMPORARY | TEMP}] TABLE table_name (
[ { column_name data_type [ DEFAULT default_expr ]    [column_constraint [ ... ]
[ ENCODING ( storage_directive [,...] ) ]
]
   | table_constraint
   | LIKE other_table [{INCLUDING | EXCLUDING}
                      {DEFAULTS | CONSTRAINTS}] ...}
   [, ... ] ]
   [column_reference_storage_directive [, …] ]
   )
   [ INHERITS ( parent_table [, ... ] ) ]
   [ WITH ( storage_parameter=value [, ... ] )
   [ ON COMMIT {PRESERVE ROWS | DELETE ROWS | DROP} ]
   [ TABLESPACE tablespace ]
   [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]
   [ PARTITION BY partition_type (column)
       [ SUBPARTITION BY partition_type (column) ]
          [ SUBPARTITION TEMPLATE ( template_spec ) ]
       [...]
    ( partition_spec )
        | [ SUBPARTITION BY partition_type (column) ]
          [...]
    ( partition_spec
      [ ( subpartition_spec
           [(...)]
         ) ]
    )
```

where *storage_parameter* is:

```
   APPENDONLY={TRUE}
   BLOCKSIZE={8192-2097152}
   ORIENTATION={COLUMN|ROW}
   COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
   COMPRESSLEVEL={0-9}
   FILLFACTOR={10-100}
   OIDS[=TRUE|FALSE]
```

where *column_constraint* is:

```
   [CONSTRAINT constraint_name]
   NOT NULL | NULL
   | CHECK ( expression )
```

and *table_constraint* is:

```
   [CONSTRAINT constraint_name]
   CHECK ( expression )
```

where *partition_type* is:

```
    LIST
  | RANGE
```

where *partition_specification* is:

```
partition_element [, ...]
```

and *partition_element* is:

```
   DEFAULT PARTITION name

  | [PARTITION name] VALUES (list_value [,...] )

  | [PARTITION name]
     START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
```

```
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
     [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
  | [PARTITION name]
     END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
     [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[column_reference_storage_directive [, …] ]
[ TABLESPACE tablespace ]
```

where *subpartition_spec* or *template_spec* is:

```
subpartition_element [, ...]
```

and *subpartition_element* is:

```
   DEFAULT SUBPARTITION name
  | [SUBPARTITION name] VALUES (list_value [,...] )
  | [SUBPARTITION name]
     START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
     [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
  | [SUBPARTITION name]
     END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
     [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[column_reference_storage_directive [, …] ]
[ TABLESPACE tablespace ]
```

where *storage_parameter* is:

```
   APPENDONLY={TRUE}
   BLOCKSIZE={8192-2097152}
   ORIENTATION={COLUMN|ROW}
   COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
   COMPRESSLEVEL={0-9}
   FILLFACTOR={10-100}
   OIDS[=TRUE|FALSE]
```

where *storage_directive* is:

```
   COMPRESSTYPE={ZLIB | QUICKLZ | RLE_TYPE | NONE}
 | COMPRESSLEVEL={0-9}
 | BLOCKSIZE={8192-2097152}
```

Where *column_reference_storage_directive* is:

```
COLUMN column_name ENCODING (storage_directive [, ... ] ), ...
 |
DEFAULT COLUMN ENCODING (storage_directive [, ... ] )
```

CREATE TABLE AS

Defines a new table from the results of a query.

```
CREATE [ [GLOBAL | LOCAL] {TEMPORARY | TEMP} ] TABLE table_name
   [(column_name [, ...] )]
   [ WITH ( storage_parameter=value [, ... ] ) ]
   [ON COMMIT {PRESERVE ROWS | DELETE ROWS | DROP}]
   [TABLESPACE tablespace]
   AS query
   [DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY]
```

where *storage_parameter* is:

```
   APPENDONLY={TRUE}
   BLOCKSIZE={8192-2097152}
   ORIENTATION={COLUMN|ROW}
   COMPRESSTYPE={ZLIB|QUICKLZ}
   COMPRESSLEVEL={1-9 | 1}
   FILLFACTOR={10-100}
   OIDS[=TRUE|FALSE]
```

CREATE USER

Defines a new database role with the `LOGIN` privilege by default.

```
CREATE USER name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | IN GROUP rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | USER rolename [, ...]
    | SYSID uid
    | RESOURCE QUEUE queue_name
```

CREATE VIEW

Defines a new view.

```
CREATE [OR REPLACE] [TEMP | TEMPORARY] VIEW name
       [ ( column_name [, ...] ) ]
       AS query
```

DEALLOCATE

Deallocates a prepared statement.

```
DEALLOCATE [PREPARE] name
```

DECLARE

Defines a cursor.

```
DECLARE name [BINARY] [INSENSITIVE] [NO SCROLL] CURSOR
             [{WITH | WITHOUT} HOLD]
             FOR query [FOR READ ONLY]
```

DROP DATABASE

Removes a database.

```
DROP DATABASE [IF EXISTS] name
```

DROP EXTERNAL TABLE

Removes an external table definition.

```
DROP EXTERNAL [WEB] TABLE [IF EXISTS] name [CASCADE | RESTRICT]
```

DROP FILESPACE

Removes a filespace.

```
DROP FILESPACE [IF EXISTS] filespacename
```

DROP GROUP

Removes a database role.

```
DROP GROUP [IF EXISTS] name [, ...]
```

DROP OWNED

Removes database objects owned by a database role.

```
DROP OWNED BY name [, ...] [CASCADE | RESTRICT]
```

DROP RESOURCE QUEUE

Removes a resource queue.

```
DROP RESOURCE QUEUE queue_name
```

DROP ROLE

Removes a database role.

```
DROP ROLE [IF EXISTS] name [, ...]
```

DROP SCHEMA

Removes a schema.

```
DROP SCHEMA [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

DROP SEQUENCE

Removes a sequence.

```
DROP SEQUENCE [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

DROP TABLE

Removes a table.

```
DROP TABLE [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

DROP TABLESPACE

Removes a tablespace.

```
DROP TABLESPACE [IF EXISTS] tablespacename
```

DROP USER

Removes a database role.

```
DROP USER [IF EXISTS] name [, ...]
```

DROP VIEW

Removes a view.

```
DROP VIEW [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

END

Commits the current transaction.

```
END [WORK | TRANSACTION]
```

EXECUTE

Executes a prepared SQL statement.

```
EXECUTE name [ (parameter [, ...] ) ]
```

EXPLAIN

Shows the query plan of a statement.

```
EXPLAIN [ANALYZE] [VERBOSE] statement
```

FETCH

Retrieves rows from a query using a cursor.

```
FETCH [ forward_direction { FROM | IN } ] cursorname
```

where forward_direction can be empty or one of:

```
    NEXT
    FIRST
    LAST
    ABSOLUTE count
    RELATIVE count
    count
    ALL
    FORWARD
    FORWARD count
    FORWARD ALL
```

GRANT

Defines access privileges.

```
GRANT { {SELECT | INSERT | UPDATE | DELETE | REFERENCES | TRIGGER} [,...] | ALL [PRIV-
```

```
ILEGES] }
    ON [TABLE] tablename [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { {USAGE | SELECT | UPDATE} [,...] | ALL [PRIVILEGES] }
    ON SEQUENCE sequencename [, ...]
    TO { rolename | PUBLIC } [, ...] [WITH GRANT OPTION]

GRANT { {CREATE | CONNECT | TEMPORARY | TEMP} [,...] | ALL [PRIVILEGES] }
    ON DATABASE dbname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { EXECUTE | ALL [PRIVILEGES] }
    ON FUNCTION funcname ( [ [argmode] [argname] argtype [, ...] ] ) [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { USAGE | ALL [PRIVILEGES] }
    ON LANGUAGE langname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { {CREATE | USAGE} [,...] | ALL [PRIVILEGES] }
    ON SCHEMA schemaname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { CREATE | ALL [PRIVILEGES] }
    ON TABLESPACE tablespacename [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT parent_role [, ...]
    TO member_role [, ...] [WITH ADMIN OPTION]

GRANT { SELECT | INSERT | ALL [PRIVILEGES] }

    ON PROTOCOL protocolname

    TO username
```

INSERT

Creates new rows in a table.

```
INSERT INTO table [( column [, ...] )]
   {DEFAULT VALUES | VALUES ( {expression | DEFAULT} [, ...] ) [, ...] | query}
```

PREPARE

Prepare a statement for execution.

```
PREPARE name [ (datatype [, ...] ) ] AS statement
```

REASSIGN OWNED

Changes the ownership of database objects owned by a database role.

```
REASSIGN OWNED BY old_role [, ...] TO new_role
```

RELEASE SAVEPOINT

Destroys a previously defined savepoint.

```
RELEASE [SAVEPOINT] savepoint_name
```

RESET

Restores the value of a system configuration parameter to the default value.

```
RESET configuration_parameter

RESET ALL
```

REVOKE

Removes access privileges.

```
REVOKE [GRANT OPTION FOR] { {SELECT | INSERT | UPDATE | DELETE
       | REFERENCES | TRIGGER} [,...] | ALL [PRIVILEGES] }
       ON [TABLE] tablename [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { {USAGE | SELECT | UPDATE} [,...]
       | ALL [PRIVILEGES] }
       ON SEQUENCE sequencename [, ...]
       FROM { rolename | PUBLIC } [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { {CREATE | CONNECT
       | TEMPORARY | TEMP} [,...] | ALL [PRIVILEGES] }
       ON DATABASE dbname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] {EXECUTE | ALL [PRIVILEGES]}
       ON FUNCTION funcname ( [[argmode] [argname] argtype
                              [, ...]] ) [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] {USAGE | ALL [PRIVILEGES]}
       ON LANGUAGE langname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [ CASCADE | RESTRICT ]

REVOKE [GRANT OPTION FOR] { {CREATE | USAGE} [,...]
       | ALL [PRIVILEGES] }
       ON SCHEMA schemaname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { CREATE | ALL [PRIVILEGES] }
       ON TABLESPACE tablespacename [, ...]
       FROM { rolename | PUBLIC } [, ...]
       [CASCADE | RESTRICT]

REVOKE [ADMIN OPTION FOR] parent_role [, ...]
       FROM member_role [, ...]
       [CASCADE | RESTRICT]
```

ROLLBACK

Aborts the current transaction.

```
ROLLBACK [WORK | TRANSACTION]
```

ROLLBACK TO SAVEPOINT

Rolls back the current transaction to a savepoint.

```
ROLLBACK [WORK | TRANSACTION] TO [SAVEPOINT] savepoint_name
```

SAVEPOINT

Defines a new savepoint within the current transaction.

```
SAVEPOINT savepoint_name
```

SELECT

Retrieves rows from a table or view.

```
SELECT [ALL | DISTINCT [ON (expression [, ...])]]
  * | expression [[AS] output_name] [, ...]
  [FROM from_item [, ...]]
  [WHERE condition]
  [GROUP BY grouping_element [, ...]]
  [HAVING condition [, ...]]
  [WINDOW window_name AS (window_specification)]
  [{UNION | INTERSECT | EXCEPT} [ALL] select]
  [ORDER BY expression [ASC | DESC | USING operator] [, ...]]
  [LIMIT {count | ALL}]
  [OFFSET start]
```

where *grouping_element* can be one of:

```
  ()
  expression
  ROLLUP (expression [,...])
  CUBE (expression [,...])
  GROUPING SETS ((grouping_element [, ...]))
```

where *window_specification* can be:

```
  [window_name]
  [PARTITION BY expression [, ...]]
  [ORDER BY expression [ASC | DESC | USING operator] [, ...]
     [{RANGE | ROWS}
          { UNBOUNDED PRECEDING
          | expression PRECEDING
          | CURRENT ROW
          | BETWEEN window_frame_bound AND window_frame_bound }]]
```

where *window_frame_bound* can be one of:

```
    UNBOUNDED PRECEDING
    expression PRECEDING
    CURRENT ROW
    expression FOLLOWING
    UNBOUNDED FOLLOWING
```

where *from_item* can be one of:

```
[ONLY] table_name [[AS] alias [( column_alias [, ...] )]]
(select) [AS] alias [( column_alias [, ...] )]
function_name ( [argument [, ...]] ) [AS] alias
             [( column_alias [, ...]
                | column_definition [, ...] )]
function_name ( [argument [, ...]] ) AS
              ( column_definition [, ...] )
from_item [NATURAL] join_type from_item
          [ON join_condition | USING ( join_column [, ...] )]
```

SELECT INTO

Defines a new table from the results of a query.

```
SELECT [ALL | DISTINCT [ON ( expression [, ...] )]]
    * | expression [AS output_name] [, ...]
    INTO [TEMPORARY | TEMP] [TABLE] new_table
    [FROM from_item [, ...]]
    [WHERE condition]
    [GROUP BY expression [, ...]]
    [HAVING condition [, ...]]
    [{UNION | INTERSECT | EXCEPT} [ALL] select]
    [ORDER BY expression [ASC | DESC | USING operator] [, ...]]
    [LIMIT {count | ALL}]
    [OFFSET start]
[...]]
```

SET

Changes the value of a HAWQ configuration parameter.

```
SET [SESSION | LOCAL] configuration_parameter {TO | =} value | 'value' | DEFAULT}

SET [SESSION | LOCAL] TIME ZONE {timezone | LOCAL | DEFAULT}
```

SET ROLE

Sets the current role identifier of the current session.

```
SET [SESSION | LOCAL] ROLE rolename

SET [SESSION | LOCAL] ROLE NONE

RESET ROLE
```

SET SESSION AUTHORIZATION

Sets the session role identifier and the current role identifier of the current session.

```
SET [SESSION | LOCAL] SESSION AUTHORIZATION rolename

SET [SESSION | LOCAL] SESSION AUTHORIZATION DEFAULT

RESET SESSION AUTHORIZATION
```

SHOW

Shows the value of a system configuration parameter.

```
SHOW configuration_parameter

SHOW ALL
```

TRUNCATE

Empties a table of all rows.

```
TRUNCATE [TABLE] name [, ...] [CASCADE | RESTRICT]
```

VACUUM

Garbage-collects and optionally analyzes a database.

```
VACUUM [FULL] [FREEZE] [VERBOSE] [table]

VACUUM [FULL] [FREEZE] [VERBOSE] ANALYZE
              [table [(column [, ...] )]]
```

ABORT

Aborts the current transaction.

Synopsis

```
ABORT [WORK | TRANSACTION]
```

Description

`ABORT` rolls back the current transaction and causes all the updates made by the transaction to be discarded. This command is identical in behavior to the standard SQL command `ROLLBACK`, and is present only for historical reasons.

Parameters

WORK
TRANSACTION

Optional key words. They have no effect.

Notes

Use `COMMIT` to successfully terminate a transaction.

Issuing `ABORT` when not inside a transaction does no harm, but it will provoke a warning message.

Compatibility

This command is a HAWQ extension present for historical reasons. `ROLLBACK` is the equivalent standard SQL command.

See Also

`BEGIN`, `COMMIT`, `ROLLBACK`

ALTER ROLE

Changes a database role (user or group).

Synopsis

```
ALTER ROLE name RENAME TO newname

ALTER ROLE name SET config_parameter {TO | =} {value | DEFAULT}

ALTER ROLE name RESET config_parameter

ALTER ROLE name RESOURCE QUEUE {queue_name | NONE}

ALTER ROLE name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEEXTTABLE | NOCREATEEXTTABLE
      [ ( attribute='value'[, ...] ) ]
           where attributes and values are:
           type='readable'|'writable'
           protocol='gpfdist'|'http'
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | CONNECTION LIMIT connlimit
    | [ENCRYPTED | UNENCRYPTED] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | [ DENY deny_point ]
    | [ DENY BETWEEN deny_point AND deny_point]
    | [ DROP DENY FOR deny_point ]
```

Description

`ALTER ROLE` changes the attributes of a HAWQ role. There are several variants of this command:

- **`RENAME`** — Changes the name of the role. Database superusers can rename any role. Roles having `CREATEROLE` privilege can rename non-superuser roles. The current session user cannot be renamed (connect as a different user to rename a role). Because MD5-encrypted passwords use the role name as cryptographic salt, renaming a role clears its password if the password is MD5-encrypted.

- **SET | RESET** — changes a role's session default for a specified configuration parameter. Whenever the role subsequently starts a new session, the specified value becomes the session default, overriding whatever setting is present in server configuration file (`postgresql.conf`). For a role without `LOGIN` privilege, session defaults have no effect. Ordinary roles can change their own session defaults. Superusers can change anyone's session defaults. Roles having `CREATEROLE` privilege can change defaults for non-superuser roles. See "Server Configuration Parameters" on page 368 for more information on all user-settable configuration parameters.
- **RESOURCE QUEUE** — Assigns the role to a workload management resource queue. The role would then be subject to the limits assigned to the resource queue when issuing queries. Specify `NONE` to assign the role to the default resource queue. A role can only belong to one resource queue. For a role without `LOGIN` privilege, resource queues have no effect. See `CREATE RESOURCE QUEUE` for more information.
- **WITH option** — Changes many of the role attributes that can be specified in `CREATE ROLE`. Attributes not mentioned in the command retain their previous settings. Database superusers can change any of these settings for any role. Roles having `CREATEROLE` privilege can change any of these settings, but only for non-superuser roles. Ordinary roles can only change their own password.

Parameters

name

The name of the role whose attributes are to be altered.

newname

The new name of the role.

config_parameter=value

Set this role's session default for the specified configuration parameter to the given value. If value is `DEFAULT` or if `RESET` is used, the role-specific variable setting is removed, so the role will inherit the system-wide default setting in new sessions. Use `RESET ALL` to clear all role-specific settings. See `SET` and "Server Configuration Parameters" on page 368 for more information on user-settable configuration parameters.

queue_name

The name of the resource queue to which the user-level role is to be assigned. Only roles with `LOGIN` privilege can be assigned to a resource queue. To unassign a role from a resource queue and put it in the default resource queue, specify `NONE`. A role can only belong to one resource queue.

SUPERUSER | NOSUPERUSER
CREATEDB | NOCREATEDB

CREATEROLE | NOCREATEROLE
CREATEEXTTABLE | NOCREATEEXTTABLE [(*attribute*='*value*')]

If CREATEEXTTABLE is specified, the role being defined is allowed to create external tables. The default type is readable and the default protocol is gpfdist if not specified. NOCREATEEXTTABLE (the default) denies the role the ability to create external tables. Note that external tables that use the file or execute protocols can only be created by superusers.

INHERIT | NOINHERIT
LOGIN | NOLOGIN
CONNECTION LIMIT *connlimit*
PASSWORD *password*
ENCRYPTED | UNENCRYPTED
VALID UNTIL '*timestamp*'

These clauses alter role attributes originally set by CREATE ROLE.

DENY *deny_point*
DENY BETWEEN *deny_point* AND *deny_point*

The DENY and DENY BETWEEN keywords set time-based constraints that are enforced at login. DENY sets a day or a day and time to deny access. DENY BETWEEN sets an interval during which access is denied. Both use the parameter *deny_point* that has following format:

```
DAY day [ TIME 'time' ]
```

The two parts of the deny_point parameter use the following formats:

For day:

{'Sunday' | 'Monday' | 'Tuesday' |'Wednesday' | 'Thursday' | 'Friday' | 'Saturday' | 0-6 }

For time:

{ 00-23 : 00-59 | 01-12 : 00-59 { AM | PM }}

The DENY BETWEEN clause uses two *deny_point* parameters.

```
DENY BETWEEN deny_point AND deny_point
```

DROP DENY FOR *deny_point*

The DROP DENY FOR clause removes a time-based constraint from the role. It uses the *deny_point* parameter described above.

Notes

Use GRANT and REVOKE for adding and removing role memberships.

Caution must be exercised when specifying an unencrypted password with this command. The password will be transmitted to the server in clear text, and it might also be logged in the client's command history or the server log. The psql command-line client contains a meta-command \password that can be used to safely change a role's password.

It is also possible to tie a session default to a specific database rather than to a role. Role-specific settings override database-specific ones if there is a conflict.

Examples

Change the password for a role:

```
ALTER ROLE daria WITH PASSWORD 'passwd123';
```

Change a password expiration date:

```
ALTER ROLE scott VALID UNTIL 'May 4 12:00:00 2015 +1';
```

Make a password valid forever:

```
ALTER ROLE luke VALID UNTIL 'infinity';
```

Give a role the ability to create other roles and new databases:

```
ALTER ROLE joelle CREATEROLE CREATEDB;
```

Give a role a non-default setting of the *maintenance_work_mem* parameter:

```
ALTER ROLE admin SET maintenance_work_mem = 100000;
```

Assign a role to a resource queue:

```
ALTER ROLE sammy RESOURCE QUEUE poweruser;
```

Give a role permission to create writable external tables:

```
ALTER ROLE load CREATEEXTTABLE (type='writable');
```

Alter a role so it does not allow login access on Sundays:

```
ALTER ROLE user3 DENY DAY 'Sunday';
```

Alter a role to remove the constraint that does not allow login access on Sundays:

```
ALTER ROLE user3 DROP DENY FOR DAY 'Sunday';
```

Compatibility

The `ALTER ROLE` statement is a HAWQ extension.

See Also

`CREATE ROLE`, `DROP ROLE`, `SET`, `CREATE RESOURCE QUEUE`, `GRANT`, `REVOKE`

ALTER TABLE

Changes the definition of a table.

Synopsis

```
ALTER TABLE [ONLY] name RENAME [COLUMN] column TO new_column

ALTER TABLE name RENAME TO new_name

ALTER TABLE name SET SCHEMA new_schema

ALTER TABLE [ONLY] name SET
     DISTRIBUTED BY (column, [ ... ] )
   | DISTRIBUTED RANDOMLY
   | WITH (REORGANIZE=true|false)


ALTER TABLE [ONLY] name action [, ... ]

ALTER TABLE name
   [ ALTER PARTITION { partition_name | FOR (RANK(number))
                     | FOR (value) } partition_action [...] ]
   partition_action
```

where *action* is one of:

```
  ADD [COLUMN] column_name type
      [ ENCODING ( storage_directive [,…] ) ]
      [column_constraint [ ... ]]
  DROP [COLUMN] column [RESTRICT | CASCADE]
  ALTER [COLUMN] column TYPE type [USING expression]
  ALTER [COLUMN] column SET DEFAULT expression
  ALTER [COLUMN] column DROP DEFAULT
  ALTER [COLUMN] column { SET | DROP } NOT NULL
  ALTER [COLUMN] column SET STATISTICS integer
  ADD table_constraint
  DROP CONSTRAINT constraint_name [RESTRICT | CASCADE]
  SET WITHOUT OIDS
  INHERIT parent_table
  NO INHERIT parent_table
  OWNER TO new_owner
```

where *partition_action* is one of:

```
  ALTER DEFAULT PARTITION
  DROP DEFAULT PARTITION [IF EXISTS]
  DROP PARTITION [IF EXISTS] { partition_name |
      FOR (RANK(number)) | FOR (value) } [CASCADE]
  TRUNCATE DEFAULT PARTITION
  TRUNCATE PARTITION { partition_name | FOR (RANK(number)) |
      FOR (value) }
  RENAME DEFAULT PARTITION TO new_partition_name
  RENAME PARTITION { partition_name | FOR (RANK(number)) |
```

```
    FOR (value) } TO new_partition_name
ADD DEFAULT PARTITION name [ ( subpartition_spec ) ]
ADD PARTITION [name] partition_element
    [ ( subpartition_spec ) ]
EXCHANGE PARTITION { partition_name | FOR (RANK(number)) |
     FOR (value) } WITH TABLE table_name
      [ WITH | WITHOUT VALIDATION ]
EXCHANGE DEFAULT PARTITION WITH TABLE table_name
 [ WITH | WITHOUT VALIDATION ]
SET SUBPARTITION TEMPLATE (subpartition_spec)
SPLIT DEFAULT PARTITION
  {  AT (list_value)
   | START([datatype] range_value) [INCLUSIVE | EXCLUSIVE]
      END([datatype] range_value) [INCLUSIVE | EXCLUSIVE] }
  [ INTO ( PARTITION new_partition_name,
           PARTITION default_partition_name ) ]
SPLIT PARTITION { partition_name | FOR (RANK(number)) |
   FOR (value) } AT (value)
  [ INTO (PARTITION partition_name, PARTITION
partition_name)]
```

where *partition_element* is:

```
    VALUES (list_value [,...] )

  | START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]

  | END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]

[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[ TABLESPACE tablespace ]
```

where *subpartition_spec* is:

```
subpartition_element [, ...]
```

and *subpartition_element* is:

```
   DEFAULT SUBPARTITION subpartition_name

  | [SUBPARTITION subpartition_name] VALUES (list_value [,...] )

  | [SUBPARTITION subpartition_name]
     START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
     [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
     [ EVERY ( [number | datatype] 'interval_value') ]

  | [SUBPARTITION subpartition_name]
     END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
     [ EVERY ( [number | datatype] 'interval_value') ]

[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[ TABLESPACE tablespace ]
```

where *storage_parameter* is:

```
   APPENDONLY={TRUE}
   BLOCKSIZE={8192-2097152}
```

```
   ORIENTATION={COLUMN|ROW}
   COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
   COMPRESSLEVEL={0-9}
   FILLFACTOR={10-100}
   OIDS[=TRUE|FALSE]
```

where *storage_directive* is:

```
   COMPRESSTYPE={ZLIB | QUICKLZ | RLE_TYPE | NONE}
 | COMPRESSLEVEL={0-9}
 | BLOCKSIZE={8192-2097152}
```

Where *column_reference_storage_directive* is:

```
COLUMN column_name ENCODING ( storage_directive [, … ] ), …  |
DEFAULT COLUMN ENCODING ( storage_directive [, … ] )
```

Description

`ALTER TABLE` changes the definition of an existing table. There are several subforms:

`ADD COLUMN` — Adds a new column to the table, using the same syntax as `CREATE TABLE`.

- **`DROP COLUMN`** — Drops a column from a table. Note that if you drop table columns that are being used as the HAWQ distribution key, the distribution policy for the table will be changed to `DISTRIBUTED RANDOMLY`. Table constraints involving the column will be automatically dropped as well. You will need to say `CASCADE` if anything outside the table depends on the column (such as views).
- **`ALTER COLUMN TYPE`** — Changes the data type of a column of a table. Note that you cannot alter column data types that are being used as the HAWQ distribution key. Simple table constraints involving the column will be automatically converted to use the new column type by reparsing the originally supplied expression. The optional `USING` clause specifies how to compute the new column value from the old. If omitted, the default conversion is the same as an assignment cast from old data type to new. A `USING` clause must be provided if there is no implicit or assignment cast from old to new type.
- **`SET/DROP DEFAULT`** — Sets or removes the default value for a column. The default values only apply to subsequent `INSERT` commands. They do not cause rows already in the table to change. Defaults may also be created for views, in which case they are inserted into statements on the view before the view's `ON INSERT` rule is applied.
- **`SET/DROP NOT NULL`** — Changes whether a column is marked to allow null values or to reject null values. You can only use `SET NOT NULL` when the column contains no null values.
- **`SET STATISTICS`** — Sets the per-column statistics-gathering target for subsequent `ANALYZE` operations. The target can be set in the range 0 to 1000, or set to -1 to revert to using the system default statistics target (`default_statistics_target`).
- **`ADD table_constraint`** — Adds a new constraint to a table (not just a partition) using the same syntax as `CREATE TABLE`.
- **`DROP CONSTRAINT`** — Drops the specified constraint on a table.

- **SET WITHOUT OIDS** — Removes the OID system column from the table. Note that there is no variant of `ALTER TABLE` that allows OIDs to be restored to a table once they have been removed.
- **SET DISTRIBUTED** — Changes the distribution policy of a table. Changes to a hash distribution policy will cause the table data to be physically redistributed on disk, which can be resource intensive.
- **INHERIT parent_table / NO INHERIT parent_table** — Adds or removes the target table as a child of the specified parent table. Queries against the parent will include records of its child table. To be added as a child, the target table must already contain all the same columns as the parent (it could have additional columns, too). The columns must have matching data types, and if they have `NOT NULL` constraints in the parent then they must also have `NOT NULL` constraints in the child. There must also be matching child-table constraints for all `CHECK` constraints of the parent.
- **OWNER** — Changes the owner of the table, sequence, or view to the specified user.
- **RENAME** — Changes the name of a table (sequence, or view) or the name of an individual column in a table. There is no effect on the stored data. Note that HAWQ distribution key columns cannot be renamed.
- **SET SCHEMA** — Moves the table into another schema. Associated constraints and sequences owned by table columns are moved as well.
- **ALTER PARTITION | DROP PARTITION | RENAME PARTITION | TRUNCATE PARTITION | ADD PARTITION | SPLIT PARTITION | EXCHANGE PARTITION | SET SUBPARTITION TEMPLATE** — Changes the structure of a partitioned table. In most cases, you must go through the parent table to alter one of its child table partitions.

You must own the table to use `ALTER TABLE`. To change the schema of a table, you must also have `CREATE` privilege on the new schema. To add the table as a new child of a parent table, you must own the parent table as well. To alter the owner, you must also be a direct or indirect member of the new owning role, and that role must have `CREATE` privilege on the table's schema. A superuser has these privileges automatically.

Note: Memory usage increases significantly when a table has many partitions, if a table has compression, or if the blocksize for a table is large. If the number of relations associated with the table is large, this condition can force an operation on the table to use more memory. For example, if the table is a CO table and has a large number of columns, each column is a relation. An operation like `ALTER TABLE ALTER COLUMN` opens all the columns in the table allocates associated buffers. If a CO table has 40 columns and 100 partitions, and the columns are compressed and the blocksize is 2 MB (with a system factor of 3), the system attempts to allocate 24 GB, that is $(40 \times 100) \times (2 \times 3)$ MB or 24 GB.

Parameters

ONLY

Only perform the operation on the table name specified. If the `ONLY` keyword is not used, the operation will be performed on the named table and any child table partitions associated with that table.

name

The name (possibly schema-qualified) of an existing table to alter. If `ONLY` is specified, only that table is altered. If `ONLY` is not specified, the table and all its descendant tables (if any) are updated.

Note: Constraints can only be added to an entire table, not to a partition. Because of that restriction, the *name* parameter can only contain a table name, not a partition name.

column

Name of a new or existing column. Note that HAWQ distribution key columns must be treated with special care. Altering or dropping these columns can change the distribution policy for the table.

new_column

New name for an existing column.

new_name

New name for the table.

type

Data type of the new column, or new data type for an existing column. If changing the data type of a HAWQ distribution key column, you are only allowed to change it to a compatible type (for example, `text` to `varchar` is OK, but `text` to `int` is not).

table_constraint

New table constraint for the table. Note that foreign key constraints are currently not supported in HAWQ. Also a table is only allowed one unique constraint and the uniqueness must be within the HAWQ distribution key.

constraint_name

Name of an existing constraint to drop.

CASCADE

Automatically drop objects that depend on the dropped column or constraint (for example, views referencing the column).

RESTRICT

Refuse to drop the column or constraint if there are any dependent objects. This is the default behavior.

ALL

Disable or enable all triggers belonging to the table including constraint related triggers. This requires superuser privilege.

USER

Disable or enable all user-created triggers belonging to the table.

DISTRIBUTED BY (*column*) | DISTRIBUTED RANDOMLY

Specifies the distribution policy for a table. Changing a hash distribution policy will cause the table data to be physically redistributed on disk, which can be resource intensive. If you declare the same hash distribution policy or change from hash to random distribution, data will not be redistributed unless you declare `SET WITH (REORGANIZE=true)`.

REORGANIZE=true|false

Use `REORGANIZE=true` when the hash distribution policy has not changed or when you have changed from a hash to a random distribution, and you want to redistribute the data anyways.

parent_table

A parent table to associate or de-associate with this table.

new_owner

The role name of the new owner of the table.

new_schema

The name of the schema to which the table will be moved.

parent_table_name

When altering a partitioned table, the name of the top-level parent table.

ALTER [DEFAULT] PARTITION

If altering a partition deeper than the first level of partitions, the `ALTER PARTITION` clause is used to specify which subpartition in the hierarchy you want to alter.

DROP [DEFAULT] PARTITION

Drops the specified partition. If the partition has subpartitions, the subpartitions are automatically dropped as well.

TRUNCATE [DEFAULT] PARTITION

Truncates the specified partition. If the partition has subpartitions, the subpartitions are automatically truncated as well.

RENAME [DEFAULT] PARTITION

Changes the partition name of a partition (not the relation name). Partitioned tables are created using the naming convention:
`<parentname>_<level>_prt_<partition_name>`.

ADD DEFAULT PARTITION

Adds a default partition to an existing partition design. When data does not match to an existing partition, it is inserted into the default partition. Partition designs that do not have a default partition will reject incoming rows that do not match to an existing partition. Default partitions must be given a name.

ADD PARTITION

partition_element - Using the existing partition type of the table (range or list), defines the boundaries of new partition you are adding.

name - A name for this new partition.

VALUES - For list partitions, defines the value(s) that the partition will contain.

START - For range partitions, defines the starting range value for the partition. By default, start values are `INCLUSIVE`. For example, if you declared a start date of '`2008-01-01`', then the partition would contain all dates greater than or equal to '`2008-01-01`'. Typically the data type of the `START` expression is the same type as the partition key column. If that is not the case, then you must explicitly cast to the intended data type.

END - For range partitions, defines the ending range value for the partition. By default, end values are `EXCLUSIVE`. For example, if you declared an end date of '`2008-02-01`', then the partition would contain all dates less than but not equal to '`2008-02-01`'. Typically the data type of the `END` expression is the same type as the partition key column. If that is not the case, then you must explicitly cast to the intended data type.

WITH - Sets the table storage options for a partition. For example, you may want older partitions to be append-only tables and newer partitions to be regular heap tables. See "CREATE TABLE" on page 129 for a description of the storage options.

TABLESPACE - The name of the tablespace in which the partition is to be created.

subpartition_spec - Only allowed on partition designs that were created without a subpartition template. Declares a subpartition specification for the new partition you are adding. If the partitioned table was originally defined using a subpartition template, then the template will be used to generate the subpartitions automatically.

EXCHANGE [DEFAULT] PARTITION

Exchanges another table into the partition hierarchy into the place of an existing partition. In a multi-level partition design, you can only exchange the lowest level partitions (those that contain data).

WITH TABLE *table_name* - The name of the table you are swapping in to the partition design.

WITH | WITHOUT VALIDATION - Validates that the data in the table matches the `CHECK` constraint of the partition you are exchanging. The default is to validate the data against the `CHECK` constraint.

SET SUBPARTITION TEMPLATE

Modifies the subpartition template for an existing partition. After a new subpartition template is set, all new partitions added will have the new subpartition design (existing partitions are not modified).

SPLIT DEFAULT PARTITION

Splits a default partition. In a multi-level partition design, you can only split the lowest level default partitions (those that contain data). Splitting a default partition creates a new partition containing the values specified and leaves the default partition containing any values that do not match to an existing partition.

AT - For list partitioned tables, specifies a single list value that should be used as the criteria for the split.

START - For range partitioned tables, specifies a starting value for the new partition.

END - For range partitioned tables, specifies an ending value for the new partition.

INTO - Allows you to specify a name for the new partition. When using the `INTO` clause to split a default partition, the second partition name specified should always be that of the existing default partition. If you do not know the name of the default partition, you can look it up using the *pg_partitions* view.

SPLIT PARTITION

Splits an existing partition into two partitions. In a multi-level partition design, you can only split the lowest level partitions (those that contain data).

AT - Specifies a single value that should be used as the criteria for the split. The partition will be divided into two new partitions with the split value specified being the starting range for the *latter* partition.

INTO - Allows you to specify names for the two new partitions created by the split.

partition_name

The given name of a partition.

FOR (RANK(*number*))

For range partitions, the rank of the partition in the range.

FOR ('value')

Specifies a partition by declaring a value that falls within the partition boundary specification. If the value declared with `FOR` matches to both a partition and one of its subpartitions (for example, if the value is a date and the table is partitioned by month and then by day), then `FOR` will operate on the first level where a match is found (for example, the monthly partition). If your intent is to operate on a subpartition, you must declare so as follows:

```
ALTER TABLE name ALTER PARTITION FOR ('2008-10-01') DROP
PARTITION FOR ('2008-10-01');
```

Notes

Take special care when altering or dropping columns that are part of the HAWQ distribution key as this can change the distribution policy for the table.

HAWQ does not currently support foreign key constraints. For a unique constraint to be enforced in HAWQ, the table must be hash-distributed (not `DISTRIBUTED RANDOMLY`), and all of the distribution key columns must be the same as the initial columns of the unique constraint columns.

Note: The table name specified in the ALTER TABLE command cannot be the name of a partition within a table.

Adding a `CHECK` or `NOT NULL` constraint requires scanning the table to verify that existing rows meet the constraint.

When a column is added with `ADD COLUMN`, all existing rows in the table are initialized with the column's default value (`NULL` if no `DEFAULT` clause is specified). Adding a column with a non-null default or changing the type of an existing column will require the entire table to be rewritten. This may take a significant amount of time for a large table; and it will temporarily require double the disk space.

You can specify multiple changes in a single `ALTER TABLE` command, which will be done in a single pass over the table.

The `DROP COLUMN` form does not physically remove the column, but simply makes it invisible to SQL operations. Subsequent insert and update operations in the table will store a null value for the column. Thus, dropping a column is quick but it will not immediately reduce the on-disk size of your table, as the space occupied by the dropped column is not reclaimed. The space will be reclaimed over time as existing rows are updated.

The fact that `ALTER TYPE` requires rewriting the whole table is sometimes an advantage, because the rewriting process eliminates any dead space in the table. For example, to reclaim the space occupied by a dropped column immediately, the fastest way is: `ALTER TABLE table ALTER COLUMN anycol TYPE sametype;` Where *anycol* is any remaining table column and *sametype* is the same type that column already has. This results in no semantically-visible change in the table, but the command forces rewriting, which gets rid of no-longer-useful data.

If a table is partitioned or has any descendant tables, it is not permitted to add, rename, or change the type of a column in the parent table without doing the same to the descendants. This ensures that the descendants always have columns matching the parent.

A recursive `DROP COLUMN` operation will remove a descendant table's column only if the descendant does not inherit that column from any other parents and never had an independent definition of the column. A nonrecursive `DROP COLUMN` (`ALTER TABLE ONLY ... DROP COLUMN`) never removes any descendant columns, but instead marks them as independently defined rather than inherited.

The `OWNER` action never recurse to descendant tables; that is, they always act as though `ONLY` were specified. Adding a constraint can recurse only for `CHECK` constraints.

Changing any part of a system catalog table is not permitted.

Examples

Add a column to a table:

```
ALTER TABLE distributors ADD COLUMN address varchar(30);
```

Rename an existing column:

```
ALTER TABLE distributors RENAME COLUMN address TO city;
```

Rename an existing table:

```
ALTER TABLE distributors RENAME TO suppliers;
```

Add a not-null constraint to a column:

```
ALTER TABLE distributors ALTER COLUMN street SET NOT NULL;
```

Add a check constraint to a table:

```
ALTER TABLE distributors ADD CONSTRAINT zipchk CHECK
(char_length(zipcode) = 5);
```

Move a table to a different schema:

```
ALTER TABLE myschema.distributors SET SCHEMA yourschema;
```

Add a new partition to a partitioned table:

```
ALTER TABLE sales ADD PARTITION
            START (date '2009-02-01') INCLUSIVE
            END (date '2009-03-01') EXCLUSIVE;
```

Add a default partition to an existing partition design:

```
ALTER TABLE sales ADD DEFAULT PARTITION other;
```

Rename a partition:

```
ALTER TABLE sales RENAME PARTITION FOR ('2008-01-01') TO
jan08;
```

Drop the first (oldest) partition in a range sequence:

```
ALTER TABLE sales DROP PARTITION FOR (RANK(1));
```

Exchange a table into your partition design:

```
ALTER TABLE sales EXCHANGE PARTITION FOR ('2008-01-01') WITH
TABLE jan08;
```

Split the default partition (where the existing default partition's name is '*other*') to add a new monthly partition for January 2009:

```
ALTER TABLE sales SPLIT DEFAULT PARTITION
START ('2009-01-01') INCLUSIVE
END ('2009-02-01') EXCLUSIVE
INTO (PARTITION jan09, PARTITION other);
```

Split a monthly partition into two with the first partition containing dates January 1-15 and the second partition containing dates January 16-31:

```
ALTER TABLE sales SPLIT PARTITION FOR ('2008-01-01')
AT ('2008-01-16')
INTO (PARTITION jan081to15, PARTITION jan0816to31);
```

Compatibility

The ADD, DROP, and SET DEFAULT forms conform with the SQL standard. The other forms are HAWQ extensions of the SQL standard. Also, the ability to specify more than one manipulation in a single ALTER TABLE command is an extension.

ALTER TABLE DROP COLUMN can be used to drop the only column of a table, leaving a zero-column table. This is an extension of SQL, which disallows zero-column tables.

See Also

CREATE TABLE, DROP TABLE

ALTER USER

Changes the definition of a database role (user).

Synopsis

```
ALTER USER name RENAME TO newname

ALTER USER name SET config_parameter {TO | =} {value | DEFAULT}

ALTER USER name RESET config_parameter

ALTER USER name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
```

Description

`ALTER USER` is a deprecated command but is still accepted for historical reasons. It is an alias for `ALTER ROLE`. See `ALTER ROLE` for more information.

Compatibility

The `ALTER USER` statement is a HAWQ extension. The SQL standard leaves the definition of users to the implementation.

See Also

`ALTER ROLE`

ANALYZE

Collects statistics about a database.

Synopsis

```
ANALYZE [VERBOSE] [table [ (column [, ...] ) ]]
```

Description

ANALYZE collects statistics about the contents of tables in the database, and stores the results in the system table *pg_statistic*. Subsequently, the query planner uses these statistics to help determine the most efficient execution plans for queries.

With no parameter, ANALYZE examines every table in the current database. With a parameter, ANALYZE examines only that table. It is further possible to give a list of column names, in which case only the statistics for those columns are collected.

Parameters

VERBOSE

Enables display of progress messages. When specified, ANALYZE emits progress messages to indicate which table is currently being processed. Various statistics about the tables are printed as well.

table

The name (possibly schema-qualified) of a specific table to analyze. Defaults to all tables in the current database.

column

The name of a specific column to analyze. Defaults to all columns.

Notes

It is a good idea to run ANALYZE periodically, or just after making major changes in the contents of a table. Accurate statistics will help the query planner to choose the most appropriate query plan, and thereby improve the speed of query processing. A common strategy is to run VACUUM and ANALYZE once a day during a low-usage time of day.

ANALYZE requires only a read lock on the target table, so it can run in parallel with other activity on the table.

The statistics collected by ANALYZE usually include a list of some of the most common values in each column and a histogram showing the approximate data distribution in each column. One or both of these may be omitted if ANALYZE deems them uninteresting (for example, in a unique-key column, there are no common values) or if the column data type does not support the appropriate operators.

For large tables, `ANALYZE` takes a random sample of the table contents, rather than examining every row. This allows even very large tables to be analyzed in a small amount of time. Note, however, that the statistics are only approximate, and will change slightly each time `ANALYZE` is run, even if the actual table contents did not change. This may result in small changes in the planner's estimated costs shown by `EXPLAIN`. In rare situations, this non-determinism will cause the query optimizer to choose a different query plan between runs of `ANALYZE`. To avoid this, raise the amount of statistics collected by `ANALYZE` by adjusting the *default_statistics_target* configuration parameter, or on a column-by-column basis by setting the per-column statistics target with `ALTER TABLE ... ALTER COLUMN ... SET STATISTICS` (see `ALTER TABLE`). The target value sets the maximum number of entries in the most-common-value list and the maximum number of bins in the histogram. The default target value is 10, but this can be adjusted up or down to trade off accuracy of planner estimates against the time taken for `ANALYZE` and the amount of space occupied in *pg_statistic*. In particular, setting the statistics target to zero disables collection of statistics for that column. It may be useful to do that for columns that are never used as part of the `WHERE`, `GROUP BY`, or `ORDER BY` clauses of queries, since the planner will have no use for statistics on such columns.

The largest statistics target among the columns being analyzed determines the number of table rows sampled to prepare the statistics. Increasing the target causes a proportional increase in the time and space needed to do `ANALYZE`.

There may be situations where the remote Analyzer may not be able to perform a task on a PXF table. For example, if a PXF Java component is down, the remote analyzer may not perform the task, so that the database transaction can succeed. In these cases the statistics remain with the default external table values.

Examples

Collect statistics for the table *mytable*:

```
ANALYZE mytable;
```

Compatibility

There is no `ANALYZE` statement in the SQL standard.

See Also

`ALTER TABLE`, `EXPLAIN`, `VACUUM`

BEGIN

Starts a transaction block.

Synopsis

```
BEGIN [WORK | TRANSACTION] [SERIALIZABLE | REPEATABLE READ |
READ COMMITTED | READ UNCOMMITTED] [READ WRITE | READ ONLY]
```

Description

`BEGIN` initiates a transaction block, that is, all statements after a `BEGIN` command will be executed in a single transaction until an explicit `COMMIT` or `ROLLBACK` is given. By default (without `BEGIN`), HAWQ executes transactions in autocommit mode, that is, each statement is executed in its own transaction and a commit is implicitly performed at the end of the statement (if execution was successful, otherwise a rollback is done).

Statements are executed more quickly in a transaction block, because transaction start/commit requires significant CPU and disk activity. Execution of multiple statements inside a transaction is also useful to ensure consistency when making several related changes: other sessions will be unable to see the intermediate states wherein not all the related updates have been done.

Parameters

WORK
TRANSACTION

Optional key words. They have no effect.

SERIALIZABLE
REPEATABLE READ
READ COMMITTED
READ UNCOMMITTED

The SQL standard defines four transaction isolation levels: `READ COMMITTED`, `READ UNCOMMITTED`, `SERIALIZABLE`, and `REPEATABLE READ`. The default behavior is that a statement can only see rows committed before it began (`READ COMMITTED`). In HAWQ `READ UNCOMMITTED` is treated the same as `READ COMMITTED`. `SERIALIZABLE` is supported the same as `REPEATABLE READ` wherein all statements of the current transaction can only see rows committed before the first statement was executed in the transaction. `SERIALIZABLE` is the strictest transaction isolation. This level emulates serial transaction execution, as if transactions had been executed one after another, serially, rather than concurrently. Applications using this level must be prepared to retry transactions due to serialization failures.

READ WRITE
READ ONLY

Determines whether the transaction is read/write or read-only. Read/write is the default. When a transaction is read-only, the following SQL commands are disallowed: `INSERT`, `UPDATE`, `DELETE`, and `COPY FROM` if the table they would write to is not a temporary table; all `CREATE`, `ALTER`, and `DROP` commands; `GRANT`, `REVOKE`, `TRUNCATE`; and `EXPLAIN ANALYZE` and `EXECUTE` if the command they would execute is among those listed.

Notes

Use `COMMIT` or `ROLLBACK` to terminate a transaction block.

Issuing `BEGIN` when already inside a transaction block will provoke a warning message. The state of the transaction is not affected. To nest transactions within a transaction block, use savepoints (see `SAVEPOINT`).

Examples

To begin a transaction block:

```
BEGIN;
```

Compatibility

`BEGIN` is a HAWQ language extension. It is equivalent to the SQL-standard command `START TRANSACTION`.

Incidentally, the `BEGIN` key word is used for a different purpose in embedded SQL. You are advised to be careful about the transaction semantics when porting database applications.

See Also

`COMMIT`, `ROLLBACK`, `SAVEPOINT`

CHECKPOINT

Forces a transaction log checkpoint.

Synopsis

```
CHECKPOINT
```

Description

Write-Ahead Logging (WAL) puts a checkpoint in the transaction log every so often. The automatic checkpoint interval is set per HAWQ segment instance by the server configuration parameters *checkpoint_segments* and *checkpoint_timeout*. The `CHECKPOINT` command forces an immediate checkpoint when the command is issued, without waiting for a scheduled checkpoint.

A checkpoint is a point in the transaction log sequence at which all data files have been updated to reflect the information in the log. All data files will be flushed to disk.

Only superusers may call `CHECKPOINT`. The command is not intended for use during normal operation.

Compatibility

The `CHECKPOINT` command is a HAWQ language extension.

CLOSE

Closes a cursor.

Synopsis

```
CLOSE cursor_name
```

Description

`CLOSE` frees the resources associated with an open cursor. After the cursor is closed, no subsequent operations are allowed on it. A cursor should be closed when it is no longer needed.

Every non-holdable open cursor is implicitly closed when a transaction is terminated by `COMMIT` or `ROLLBACK`. A holdable cursor is implicitly closed if the transaction that created it aborts via `ROLLBACK`. If the creating transaction successfully commits, the holdable cursor remains open until an explicit `CLOSE` is executed, or the client disconnects.

Parameters

cursor_name

The name of an open cursor to close.

Notes

HAWQ does not have an explicit `OPEN` cursor statement. A cursor is considered open when it is declared. Use the `DECLARE` statement to declare (and open) a cursor.

You can see all available cursors by querying the *pg_cursors* system view.

Examples

Close the cursor *portala*:

```
CLOSE portala;
```

Compatibility

`CLOSE` is fully conforming with the SQL standard.

See Also

`DECLARE`, `FETCH`

COMMIT

Commits the current transaction.

Synopsis

```
COMMIT [WORK | TRANSACTION]
```

Description

`COMMIT` commits the current transaction. All changes made by the transaction become visible to others and are guaranteed to be durable if a crash occurs.

Parameters

WORK
TRANSACTION

Optional key words. They have no effect.

Notes

Use `ROLLBACK` to abort a transaction.

Issuing `COMMIT` when not inside a transaction does no harm, but it will provoke a warning message.

Examples

To commit the current transaction and make all changes permanent:

```
COMMIT;
```

Compatibility

The SQL standard only specifies the two forms `COMMIT` and `COMMIT WORK`. Otherwise, this command is fully conforming.

See Also

`BEGIN`, `END`, `ROLLBACK`

COPY

Copies data between a file and a table.

Synopsis

```
COPY table [(column [, ...])] FROM {'file' | STDIN}
     [ [WITH]
       [OIDS]
       [HEADER]
       [DELIMITER [ AS ] 'delimiter']
       [NULL [ AS ] 'null string']
       [ESCAPE [ AS ] 'escape' | 'OFF']
       [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
       [CSV [QUOTE [ AS ] 'quote']
            [FORCE NOT NULL column [, ...]]
       [FILL MISSING FIELDS]
```

```
COPY {table [(column [, ...])] | (query)} TO {'file' | STDOUT}
      [ [WITH]
        [OIDS]
        [HEADER]
        [DELIMITER [ AS ] 'delimiter']
        [NULL [ AS ] 'null string']
        [ESCAPE [ AS ] 'escape' | 'OFF']
        [CSV [QUOTE [ AS ] 'quote']
             [FORCE QUOTE column [, ...]] ]
```

Description

`COPY` moves data between HAWQ tables and standard file-system files. `COPY TO` copies the contents of a table to a file, while `COPY FROM` copies data from a file to a table (appending the data to whatever is in the table already). `COPY TO` can also copy the results of a `SELECT` query.

If a list of columns is specified, `COPY` will only copy the data in the specified columns to or from the file. If there are any columns in the table that are not in the column list, `COPY FROM` will insert the default values for those columns.

`COPY` with a file name instructs the HAWQ master host to directly read from or write to a file. The file must be accessible to the master host and the name must be specified from the viewpoint of the master host. When `STDIN` or `STDOUT` is specified, data is transmitted via the connection between the client and the master.

If `SEGMENT REJECT LIMIT` is used, then a `COPY FROM` operation will operate in single row error isolation mode. In this release, single row error isolation mode only applies to rows in the input file with format errors — for example, extra or missing attributes, attributes of a wrong data type, or invalid client encoding sequences. Constraint errors such as violation of a `NOT NULL`, `CHECK`, or `UNIQUE` constraint will still be handled in 'all-or-nothing' input mode. The user can specify the number of error rows acceptable (on a per-segment basis), after which the entire `COPY FROM` operation will be aborted and no rows will be loaded. Note that the count of error rows is per-segment, not per entire load operation. If the per-segment reject limit is not reached, then all rows not containing an error will be loaded. If the limit is not reached, all good rows will be loaded and any error rows discarded. If you would like to keep error rows for further examination, you can optionally declare an error table using the `LOG ERRORS INTO` clause. Any rows containing a format error would then be logged to the specified error table.

Outputs

On successful completion, a `COPY` command returns a command tag of the form, where *`count`* is the number of rows copied:

```
COPY count
```

If running a `COPY FROM` command in single row error isolation mode, the following notice message will be returned if any rows were not loaded due to format errors, where *`count`* is the number of rows rejected:

```
NOTICE: Rejected count badly formatted rows.
```

Parameters

table

The name (optionally schema-qualified) of an existing table.

column

An optional list of columns to be copied. If no column list is specified, all columns of the table will be copied.

query

A `SELECT` or `VALUES` command whose results are to be copied. Note that parentheses are required around the query.

file

The absolute path name of the input or output file.

STDIN

Specifies that input comes from the client application.

STDOUT

Specifies that output goes to the client application.

OIDS

Specifies copying the OID for each row. (An error is raised if OIDS is specified for a table that does not have OIDs, or in the case of copying a query.)

delimiter

The single ASCII character that separates columns within each row (line) of the file. The default is a tab character in text mode, a comma in `CSV` mode.

null string

The string that represents a null value. The default is `\N` (backslash-N) in text mode, and a empty value with no quotes in `CSV` mode. You might prefer an empty string even in text mode for cases where you don't want to distinguish nulls from empty strings. When using `COPY FROM`, any data item that matches this string will be stored as a null value, so you should make sure that you use the same string as you used with `COPY TO`.

escape

Specifies the single character that is used for C escape sequences (such as `\n`,`\t`,`\100`, and so on) and for quoting data characters that might otherwise be taken as row or column delimiters. Make sure to choose an escape character that is not used anywhere in your actual column data. The default escape character is `\` (backslash) for text files or `"` (double quote) for CSV files, however it is possible to specify any other character to represent an escape. It is also possible to disable escaping on text-formatted files by specifying the value '`OFF'` as the escape value. This is very useful for data such as web log data that has many embedded backslashes that are not intended to be escapes.

NEWLINE

Specifies the newline used in your data files — `LF` (Line feed, 0x0A), `CR` (Carriage return, 0x0D), or `CRLF` (Carriage return plus line feed, 0x0D 0x0A). If not specified, a HAWQ segment will detect the newline type by looking at the first row of data it receives and using the first newline type encountered.

CSV

Selects Comma Separated Value (CSV) mode.

HEADER

Specifies that a file contains a header line with the names of each column in the file. On output, the first line contains the column names from the table, and on input, the first line is ignored.

quote

Specifies the quotation character in CSV mode. The default is double-quote.

FORCE QUOTE

In `CSV COPY TO` mode, forces quoting to be used for all non-`NULL` values in each specified column. `NULL` output is never quoted.

FORCE NOT NULL

In `CSV COPY FROM` mode, process each specified column as though it were quoted and hence not a `NULL` value. For the default null string in `CSV` mode (nothing between two delimiters), this causes missing values to be evaluated as zero-length strings.

FILL MISSING FIELDS

In `COPY FROM` more for both `TEXT` and `CSV`, specifying `FILL MISSING FIELDS` will set missing trailing field values to `NULL` (instead of reporting an error) when a row of data has missing data fields at the end of a line or row. Blank rows, fields with a `NOT NULL` constraint, and trailing delimiters on a line will still report an error.

Notes

`COPY` can only be used with tables, not with views. However, you can write `COPY (SELECT * FROM viewname) TO` ....

The `BINARY` key word causes all data to be stored/read as binary format rather than as text. It is somewhat faster than the normal text mode, but a binary-format file is less portable across machine architectures and HAWQ versions. Also, you cannot run `COPY FROM` in single row error isolation mode if the data is in binary format.

You must have `SELECT` privilege on the table whose values are read by `COPY TO`, and insert privilege on the table into which values are inserted by `COPY FROM`.

Files named in a `COPY` command are read or written directly by the database server, not by the client application. Therefore, they must reside on or be accessible to the HAWQ master host machine, not the client. They must be accessible to and readable or writable by the HAWQ system user (the user ID the server runs as), not the client. `COPY` naming a file is only allowed to database superusers, since it allows reading or writing any file that the server has privileges to access.

`COPY FROM` will invoke any triggers and check constraints on the destination table. However, it will not invoke rewrite rules. Note that in this release, violations of constraints are not evaluated for single row error isolation mode.

`COPY` input and output is affected by `DateStyle`. To ensure portability to other HAWQ installations that might use non-default `DateStyle` settings, `DateStyle` should be set to ISO before using `COPY TO`.

By default, `COPY` stops operation at the first error. This should not lead to problems in the event of a `COPY TO`, but the target table will already have received earlier rows in a `COPY FROM`. These rows will not be visible or accessible, but they still occupy disk space. This may amount to a considerable amount of wasted disk space if the failure happened well into a large `COPY FROM` operation. You may wish to invoke `VACUUM` to recover the wasted space. Another option would be to use single row error isolation mode to filter out error rows while still loading good rows.

File Formats

Text Format

When `COPY` is used without the `BINARY` or `CSV` options, the data read or written is a text file with one line per table row. Columns in a row are separated by the *`delimiter`* character (tab by default). The column values themselves are strings generated by the output function, or acceptable to the input function, of each attribute's data type. The specified null string is used in place of columns that are null.

`COPY FROM` will raise an error if any line of the input file contains more or fewer columns than are expected. If `OIDS` is specified, the OID is read or written as the first column, preceding the user data columns.

The data file has two reserved characters that have special meaning to `COPY`:

- The designated delimiter character (tab by default), which is used to separate fields in the data file.
- A UNIX-style line feed (`\n` or `0x0a`), which is used to designate a new row in the data file. It is strongly recommended that applications generating `COPY` data convert data line feeds to UNIX-style line feeds rather than Microsoft Windows style carriage return line feeds (`\r\n` or `0x0a 0x0d`).

If your data contains either of these characters, you must escape the character so `COPY` treats it as data and not as a field separator or new row.

By default, the escape character is a \ (backslash) for text-formatted files and a `"` (double quote) for csv-formatted files. If you want to use a different escape character, you can do so using the `ESCAPE AS` clause. Make sure to choose an escape character that is not used anywhere in your data file as an actual data value. You can also disable escaping in text-formatted files by using `ESCAPE 'OFF'`.

For example, suppose you have a table with three columns and you want to load the following three fields using COPY.

- percentage sign = %
- vertical bar = |
- backslash = \

Your designated `DELIMITER` character is `|` (pipe character), and your designated `ESCAPE` character is `*` (asterisk). The formatted row in your data file would look like this:

```
percentage sign = % | vertical bar = *| | backslash = \
```

Notice how the pipe character that is part of the data has been escaped using the asterisk character (*). Also notice that we do not need to escape the backslash since we are using an alternative escape character.

The following characters must be preceded by the escape character if they appear as part of a column value: the escape character itself, newline, carriage return, and the current delimiter character. You can specify a different escape character using the `ESCAPE AS` clause.

CSV Format

This format is used for importing and exporting the Comma Separated Value (CSV) file format used by many other programs, such as spreadsheets. Instead of the escaping used by HAWQ standard text mode, it produces and recognizes the common CSV escaping mechanism.

The values in each record are separated by the `DELIMITER` character. If the value contains the delimiter character, the `QUOTE` character, the `ESCAPE` character (which is double quote by default), the `NULL` string, a carriage return, or line feed character, then the whole value is prefixed and suffixed by the `QUOTE` character. You can also use `FORCE QUOTE` to force quotes when outputting non-`NULL` values in specific columns.

The CSV format has no standard way to distinguish a `NULL` value from an empty string. HAWQ `COPY` handles this by quoting. A `NULL` is output as the `NULL` string and is not quoted, while a data value matching the `NULL` string is quoted. Therefore, using the default settings, a `NULL` is written as an unquoted empty string, while an empty string is written with double quotes (""). Reading values follows similar rules. You can use `FORCE NOT NULL` to prevent `NULL` input comparisons for specific columns.

Because backslash is not a special character in the `CSV` format, `\.`, the end-of-data marker, could also appear as a data value. To avoid any misinterpretation, a `\.` data value appearing as a lone entry on a line is automatically quoted on output, and on input, if quoted, is not interpreted as the end-of-data marker. If you are loading a file created by another application that has a single unquoted column and might have a value of `\.`, you might need to quote that value in the input file.

Note: In `CSV` mode, all characters are significant. A quoted value surrounded by white space, or any characters other than `DELIMITER`, will include those characters. This can cause errors if you import data from a system that pads CSV lines with white space out to some fixed width. If such a situation arises you might need to preprocess the CSV file to remove the trailing white space, before importing the data into HAWQ.

Note: `CSV` mode will both recognize and produce CSV files with quoted values containing embedded carriage returns and line feeds. Thus the files are not strictly one line per table row like text-mode files.

Note: Many programs produce strange and occasionally perverse CSV files, so the file format is more a convention than a standard. Thus you might encounter some files that cannot be imported using this mechanism, and `COPY` might produce files that other programs cannot process.

Binary Format

The `BINARY` format consists of a file header, zero or more tuples containing the row data, and a file trailer. Headers and data are in network byte order.

- **File Header** — The file header consists of 15 bytes of fixed fields, followed by a variable-length header extension area. The fixed fields are:
  - **Signature** — 11-byte sequence PGCOPY\n\377\r\n\0 — note that the zero byte is a required part of the signature. (The signature is designed to allow easy identification of files that have been munged by a non-8-bit-clean transfer. This signature will be changed by end-of-line-translation filters, dropped zero bytes, dropped high bits, or parity changes.)
  - **Flags field** — 32-bit integer bit mask to denote important aspects of the file format. Bits are numbered from 0 (LSB) to 31 (MSB). Note that this field is stored in network byte order (most significant byte first), as are all the integer fields used in the file format. Bits 16-31 are reserved to denote critical file format issues; a reader should abort if it finds an unexpected bit set in this range. Bits 0-15 are reserved to signal backwards-compatible format issues; a reader should simply ignore any unexpected bits set in this range. Currently only one flag is defined, and the rest must be zero (Bit 16: 1 if data has OIDs, 0 if not).

    - **Header extension area length** — 32-bit integer, length in bytes of remainder of header, not including self. Currently, this is zero, and the first tuple follows immediately. Future changes to the format might allow additional data to be present in the header. A reader should silently skip over any header extension data it does not know what to do with. The header extension area is envisioned to contain a sequence of self-identifying chunks. The flags field is not intended to tell readers what is in the extension area. Specific design of header extension contents is left for a later release.

- **Tuples** — Each tuple begins with a 16-bit integer count of the number of fields in the tuple. (Presently, all tuples in a table will have the same count, but that might not always be true.) Then, repeated for each field in the tuple, there is a 32-bit length word followed by that many bytes of field data. (The length word does not include itself, and can be zero.) As a special case, -1 indicates a NULL field value. No value bytes follow in the NULL case.

  There is no alignment padding or any other extra data between fields.

  Presently, all data values in a COPY BINARY file are assumed to be in binary format (format code one). It is anticipated that a future extension may add a header field that allows per-column format codes to be specified.

  If OIDs are included in the file, the OID field immediately follows the field-count word. It is a normal field except that it's not included in the field-count. In particular it has a length word — this will allow handling of 4-byte vs. 8-byte OIDs without too much pain, and will allow OIDs to be shown as null if that ever proves desirable.

- **File Trailer** — The file trailer consists of a 16-bit integer word containing `-1`. This is easily distinguished from a tuple's field-count word. A reader should report an error if a field-count word is neither `-1` nor the expected number of columns. This provides an extra check against somehow getting out of sync with the data.

Examples

Copy a table to the client using the vertical bar (|) as the field delimiter:

```
COPY country TO STDOUT WITH DELIMITER '|';
```

Copy data from a file into the *country* table:

```
COPY country FROM '/home/usr1/sql/country_data';
```

Copy into a file just the countries whose names start with 'A':

```
COPY (SELECT * FROM country WHERE country_name LIKE 'A%') TO
'/home/usr1/sql/a_list_countries.copy';
```

Compatibility

There is no `COPY` statement in the SQL standard.

See Also

`CREATE EXTERNAL TABLE`

CREATE EXTERNAL TABLE

Defines a new external table.

Synopsis

```
CREATE [READABLE] EXTERNAL TABLE table_name
      ( column_name data_type [, ...] | LIKE other_table )
       LOCATION ('file://seghost[:port]/path/file' [, ...])
          | ('gpfdist://filehost[:port]/file_pattern[#transform]'
            [, ...])
       FORMAT 'TEXT'
             [( [HEADER]
                [DELIMITER [AS] 'delimiter' | 'OFF']
                [NULL [AS] 'null string']
                [ESCAPE [AS] 'escape' | 'OFF']
                [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
                [FILL MISSING FIELDS] )]
            | 'CSV'
             [( [HEADER]
                [QUOTE [AS] 'quote']
                [DELIMITER [AS] 'delimiter']
                [NULL [AS] 'null string']
                [FORCE NOT NULL column [, ...]]
                [ESCAPE [AS] 'escape']
                [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
                [FILL MISSING FIELDS] )]
      [ ENCODING 'encoding' ]

CREATE [READABLE] EXTERNAL WEB TABLE table_name
      ( column_name data_type [, ...] | LIKE other_table )
       LOCATION ('http://webhost[:port]/path/file' [, ...])
     | EXECUTE 'command' [ON ALL
                           | MASTER
                           | number_of_segments
                           | HOST ['segment_hostname']
                           | SEGMENT segment_id ]
       FORMAT 'TEXT'
             [( [HEADER]
                [DELIMITER [AS] 'delimiter' | 'OFF']
                [NULL [AS] 'null string']
                [ESCAPE [AS] 'escape' | 'OFF']
                [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
                [FILL MISSING FIELDS] )]
            | 'CSV'
             [( [HEADER]
                [QUOTE [AS] 'quote']
                [DELIMITER [AS] 'delimiter']
                [NULL [AS] 'null string']
```

```
                  [FORCE NOT NULL column [, ...]]
                  [ESCAPE [AS] 'escape']
                  [NEWLINE [ AS ] 'LF' | 'CR' | 'CRLF']
                  [FILL MISSING FIELDS] )]
      [ ENCODING 'encoding' ]

CREATE WRITABLE EXTERNAL TABLE table_name
     ( column_name data_type [, ...] | LIKE other_table )
      LOCATION('gpfdist://outputhost[:port]/filename[#transform]'
                 [, ...])
       FORMAT 'TEXT'
                  [( [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [ESCAPE [AS] 'escape' | 'OFF'] )]
            | 'CSV'
                  [([QUOTE [AS] 'quote']
                  [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [FORCE QUOTE column [, ...]] ]
                  [ESCAPE [AS] 'escape'] )]
     [ ENCODING 'write_encoding' ]
     [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]

CREATE WRITABLE EXTERNAL WEB TABLE table_name
     ( column_name data_type [, ...] | LIKE other_table )
     EXECUTE 'command' [ON ALL]
     FORMAT 'TEXT'
                  [( [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [ESCAPE [AS] 'escape' | 'OFF'] )]
            | 'CSV'
                  [([QUOTE [AS] 'quote']
                  [DELIMITER [AS] 'delimiter']
                  [NULL [AS] 'null string']
                  [FORCE QUOTE column [, ...]] ]
                  [ESCAPE [AS] 'escape'] )]
     [ ENCODING 'write_encoding' ]
     [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]
```

Description

`CREATE EXTERNAL TABLE` or `CREATE EXTERNAL WEB TABLE` creates a new readable external table definition in HAWQ. Readable external tables are typically used for fast, parallel data loading. Once an external table is defined, you can query its data directly (and in parallel) using SQL commands. For example, you can select, join, or sort external table data. You can also create views for external tables. DML operations (`UPDATE`, `INSERT`, `DELETE`, or `TRUNCATE`) are not allowed on readable external tables.

`CREATE WRITABLE EXTERNAL TABLE` or `CREATE WRITABLE EXTERNAL WEB TABLE` creates a new writable external table definition in HAWQ. Writable external tables are typically used for unloading data from the database into a set of files or named pipes.

Writable external web tables can also be used to output data to an executable program. Once a writable external table is defined, data can be selected from database tables and inserted into the writable external table. Writable external tables only allow `INSERT` operations – `SELECT`, `UPDATE`, `DELETE` or `TRUNCATE` are not allowed.

The main difference between regular external tables and web external tables is their data sources. Regular readable external tables access static flat files, whereas web external tables access dynamic data sources – either on a web server or by executing OS commands or scripts.

The `FORMAT` clause is used to describe how the external table files are formatted. Valid file formats are delimited text (`TEXT`) for all protocols and comma separated values (`CSV`) format for `gpfdist` and `file` protocols, similar to the formatting options available with the PostgreSQL `COPY` command. If the data in the file does not use the default column delimiter, escape character, null string and so on, you must specify the additional formatting options so that the data in the external file is read correctly by HAWQ.

Parameters

READABLE | WRITABLE

Specifiies the type of external table, readable being the default. Readable external tables are used for loading data into HAWQ. Writable external tables are used for unloading data.

WEB

Creates a readable or wrtiable web external table definition in HAWQ. There are two forms of readable web external tables – those that access files via the `http://` protocol or those that access data by executing OS commands. Writable web external tables output data to an executable program that can accept an input stream of data. Web external tables are not rescannable during query execution.

table_name

The name of the new external table.

column_name

The name of a column to create in the external table definition. Unlike regular tables, external tables do not have column constraints or default values, so do not specify those.

LIKE *other_table*

The `LIKE` clause specifies a table from which the new external table automatically copies all column names, data types and HAWQ distribution policy. If the original table specifies any column constraints or default column values, those will not be copied over to the new external table definition.

data_type

The data type of the column.

LOCATION ('*protocol*://*host*[:*port*]/*path*/*file*' [, ...])

For readable external tables, specifies the URI of the external data source(s) to be used to populate the external table or web table. Regular readable external tables allow the `gpfdist` or `file` protocols. Web external tables allow the `http` protocol. If `port` is omitted, port `8080` is assumed for `http` and `gpfdist` protocols. If using the `gpfdist` protocol, the `path` is relative to the directory from which `gpfdist` is serving files (the directory specified when you started the `gpfdist` program). Also, `gpfdist` can use wildcards (or other C-style pattern matching) to denote multiple files in a directory. For example:

```
'gpfdist://filehost:8081/*'
'gpfdist://masterhost/my_load_file'
'file://seghost1/dbfast1/external/myfile.txt'
'http://intranet.mycompany.com/finance/expenses.csv'
```

For writable external tables, specifies the URI location of the `gpfdist` process that will collect data output from the HAWQ segments and write it to the named file. The `path` is relative to the directory from which `gpfdist` is serving files (the directory specified when you started the `gpfdist` program). If multiple `gpfdist` locations are listed, the segments sending data will be evenly divided across the available output locations. For example:

```
'gpfdist://outputhost:8081/data1.out',
'gpfdist://outputhost:8081/data2.out'
```

With two `gpfdist` locations listed as in the above example, half of the segments would send their output data to the `data1.out` file and the other half to the `data2.out` file.

EXECUTE '*command*' [ON ...]

Allowed for readable web external tables or writable external tables only. For readable web external tables, specifies the OS command to be executed by the segment instances. The *command* can be a single OS command or a script. The `ON` clause is used to specify which segment instances will execute the given command.

- **ON ALL** is the default. The command will be executed by every active (primary) segment instance on all segment hosts in the HAWQ system. If the command executes a script, that script must reside in the same location on all of the segment hosts and be executable by the HAWQ superuser (`gpadmin`).
- **ON MASTER** runs the command on the master host only.
- **ON *number*** means the command will be executed by the specified number of segments. The particular segments are chosen randomly at runtime by the HAWQ system. If the command executes a script, that script must reside in the same location on all of the segment hosts and be executable by the HAWQ superuser (`gpadmin`).
- **HOST** means the command will be executed by one segment on each segment host (once per segment host), regardless of the number of active segment instances per host.
- **HOST *segment_hostname*** means the command will be executed by all active (primary) segment instances on the specified segment host.

- **SEGMENT *segment_id*** means the command will be executed only once by the specified segment. The *content* ID of the HAWQ master is always `-1`.

For writable external tables, the *`command`* specified in the `EXECUTE` clause must be prepared to have data piped into it. Since all segments that have data to send will write their output to the specified command or program, the only available option for the `ON` clause is `ON ALL`.

FORMAT 'TEXT | CSV' (*options*)

Specifies the format of the external or web table data - either plain text (TEXT) or comma separated values (CSV) format.

DELIMITER

Specifies a single ASCII character that separates columns within each row (line) of data. The default is a tab character in `TEXT` mode, a comma in `CSV` mode. In `TEXT` mode for readable external tables, the delimiter can be set to `OFF` for special use cases in which unstructured data is loaded into a single-column table.

NULL

Specifies the string that represents a null value. The default is `\N` (backslash-N) in `TEXT` mode, and an empty value with no quotations in `CSV` mode. You might prefer an empty string even in `TEXT` mode for cases where you do not want to distinguish nulls from empty strings. When using external and web tables, any data item that matches this string will be considered a null value.

ESCAPE

Specifies the single character that is used for C escape sequences (such as `\n`,`\t`,`\100`, and so on) and for escaping data characters that might otherwise be taken as row or column delimiters. Make sure to choose an escape character that is not used anywhere in your actual column data. The default escape character is a \ (backslash) for text-formatted files and a `"` (double quote) for csv-formatted files, however it is possible to specify another character to represent an escape. It is also possible to disable escaping in text-formatted files by specifying the value `'OFF'` as the escape value. This is very useful for data such as text-formatted web log data that has many embedded backslashes that are not intended to be escapes.

NEWLINE

Specifies the newline used in your data files – `LF` (Line feed, 0x0A), `CR` (Carriage return, 0x0D), or `CRLF` (Carriage return plus line feed, 0x0D 0x0A). If not specified, a HAWQ segment will detect the newline type by looking at the first row of data it receives and using the first newline type encountered.

HEADER

For readable external tables, specifies that the first line in the data file(s) is a header row (contains the names of the table columns) and should not be included as data for the table. If using multiple data source files, all files must have a header row.

QUOTE

Specifies the quotation character for `CSV` mode. The default is double-quote (`"`).

FORCE NOT NULL

In CSV mode, processes each specified column as though it were quoted and hence not a NULL value. For the default null string in CSV mode (nothing between two delimiters), this causes missing values to be evaluated as zero-length strings.

FORCE QUOTE

In CSV mode for writable external tables, forces quoting to be used for all non-NULL values in each specified column. NULL output is never quoted.

FILL MISSING FIELDS

In both TEXT and CSV mode for readable external tables, specifying FILL MISSING FIELDS will set missing trailing field values to NULL (instead of reporting an error) when a row of data has missing data fields at the end of a line or row. Blank rows, fields with a NOT NULL constraint, and trailing delimiters on a line will still report an error.

ENCODING '*encoding*'

Character set encoding to use for the external table. Specify a string constant (such as 'SQL_ASCII'), an integer encoding number, or DEFAULT to use the default client encoding.

DISTRIBUTED BY (*column*, [...])
DISTRIBUTED RANDOMLY

Used to declare the HAWQ distribution policy for a writable external table. By default, writable external tables are distributed randomly. If the source table you are exporting data from has a hash distribution policy, defining the same distribution key column(s) for the writable external table will improve unload performance by eliminating the need to move rows over the interconnect. When you issue an unload command such as INSERT INTO *wex_table* SELECT * FROM *source_table*, the rows that are unloaded can be sent directly from the segments to the output location if the two tables have the same hash distribution policy.

Examples

Start the gpfdist file server program in the background on port *8081* serving files from directory */var/data/staging*:

```
gpfdist -p 8081 -d /var/data/staging -l /home/gpadmin/log &
```

Create a readable external table named *ext_customer* using the gpfdist protocol and any text formatted files (*.txt) found in the gpfdist directory. The files are formatted with a pipe (|) as the column delimiter and an empty space as null.

```
CREATE EXTERNAL TABLE ext_customer
    (id int, name text, sponsor text)
    LOCATION ( 'gpfdist://filehost:8081/*.txt' )
    FORMAT 'TEXT' ( DELIMITER '|' NULL ' ')
```

Create the same readable external table definition as above, but with CSV formatted files:

```
CREATE EXTERNAL TABLE ext_customer
```

```
   (id int, name text, sponsor text)
   LOCATION ( 'gpfdist://filehost:8081/*.csv' )
   FORMAT 'CSV' ( DELIMITER ',' );
```

Create a readable external table named *ext_expenses* using the `file` protocol and several CSV formatted files that have a header row:

```
CREATE EXTERNAL TABLE ext_expenses (name text, date date,
amount float4, category text, description text)
LOCATION (
'file://seghost1/dbfast/external/expenses1.csv',
'file://seghost1/dbfast/external/expenses2.csv',
'file://seghost2/dbfast/external/expenses3.csv',
'file://seghost2/dbfast/external/expenses4.csv',
'file://seghost3/dbfast/external/expenses5.csv',
'file://seghost3/dbfast/external/expenses6.csv'
)
FORMAT 'CSV' ( HEADER );
```

Create a readable web external table that executes a script once per segment host:

```
CREATE EXTERNAL WEB TABLE log_output (linenum int, message
text)  EXECUTE '/var/load_scripts/get_log_data.sh' ON HOST
 FORMAT 'TEXT' (DELIMITER '|');
```

Create a writable external table named *sales_out* that uses `gpfdist` to write output data to a file named *sales.out*. The files are formatted with a pipe (`|`) as the column delimiter and an empty space as null.

```
CREATE WRITABLE EXTERNAL TABLE sales_out (LIKE sales)
   LOCATION ('gpfdist://etl1:8081/sales.out')
   FORMAT 'TEXT' ( DELIMITER '|' NULL ' ')
   DISTRIBUTED BY (txn_id);
```

Create a writable external web table that pipes output data received by the segments to an executable script named *to_adreport_etl.sh*:

```
CREATE WRITABLE EXTERNAL WEB TABLE campaign_out
(LIKE campaign)
 EXECUTE '/var/unload_scripts/to_adreport_etl.sh'
 FORMAT 'TEXT' (DELIMITER '|');
```

Use the writable external table defined above to unload selected data:

```
INSERT INTO campaign_out SELECT * FROM campaign WHERE
customer_id=123;
```

Compatibility

`CREATE EXTERNAL TABLE` is a HAWQ extension. The SQL standard makes no provisions for external tables.

See Also

`CREATE TABLE AS`, `CREATE TABLE`, `COPY`, `SELECT INTO`, `INSERT`

CREATE GROUP

Defines a new database role.

Synopsis

```
CREATE GROUP name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | IN GROUP rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | USER rolename [, ...]
    | SYSID uid
```

Description

As of HAWQ release 2.2, `CREATE GROUP` has been replaced by `CREATE ROLE`, although it is still accepted for backwards compatibility.

Compatibility

There is no `CREATE GROUP` statement in the SQL standard.

See Also

`CREATE ROLE`

CREATE DATABASE

Creates a new database.

Synopsis

```
CREATE DATABASE name [ [WITH] [OWNER [=] dbowner]
                     [TEMPLATE [=] template]
                     [ENCODING [=] encoding]
                     [TABLESPACE [=] tablespace]
                     [CONNECTION LIMIT [=] connlimit ] ]
```

Description

`CREATE DATABASE` creates a new database. To create a database, you must be a superuser or have the special `CREATEDB` privilege.

The creator becomes the owner of the new database by default. Superusers can create databases owned by other users by using the `OWNER` clause. They can even create databases owned by users with no special privileges. Non-superusers with `CREATEDB` privilege can only create databases owned by themselves.

By default, the new database will be created by cloning the standard system database *template1*. A different template can be specified by writing `TEMPLATE` *name*. In particular, by writing `TEMPLATE template0`, you can create a clean database containing only the standard objects predefined by HAWQ. This is useful if you wish to avoid copying any installation-local objects that may have been added to *template1*.

Parameters

name

The name of a database to create.

dbowner

The name of the database user who will own the new database, or `DEFAULT` to use the default owner (the user executing the command).

template

The name of the template from which to create the new database, or `DEFAULT` to use the default template (*template1*).

encoding

Character set encoding to use in the new database. Specify a string constant (such as `'SQL_ASCII'`), an integer encoding number, or `DEFAULT` to use the default encoding.

tablespace

The name of the tablespace that will be associated with the new database, or `DEFAULT` to use the template database's tablespace. This tablespace will be the default tablespace used for objects created in this database.

connlimit

The maximum number of concurrent connections posible. The default of -1 means there is no limitation.

Notes

`CREATE DATABASE` cannot be executed inside a transaction block.

When you copy a database by specifying its name as the template, no other sessions can be connected to the template database while it is being copied. New connections to the template database are locked out until `CREATE DATABASE` completes.

The `CONNECTION LIMIT` is not enforced against superusers.

Examples

To create a new database:

```
CREATE DATABASE gpdb;
```

To create a database *sales* owned by user *salesapp* with a default tablespace of *salesspace*:

```
CREATE DATABASE sales OWNER salesapp TABLESPACE salesspace;
```

To create a database *music* which supports the ISO-8859-1 character set:

```
CREATE DATABASE music ENCODING 'LATIN1';
```

Compatibility

There is no `CREATE DATABASE` statement in the SQL standard. Databases are equivalent to catalogs, whose creation is implementation-defined.

See Also

`DROP DATABASE`

CREATE RESOURCE QUEUE

Defines a new resource queue.

Synopsis

```
CREATE RESOURCE QUEUE name WITH (queue_attribute=value [, ... ])
```

where *queue_attribute* is:

```
   ACTIVE_STATEMENTS=integer
        [ MAX_COST=float [COST_OVERCOMMIT={TRUE|FALSE}] ]
        [ MIN_COST=float ]
        [ PRIORITY={MIN|LOW|MEDIUM|HIGH|MAX} ]
        [ MEMORY_LIMIT='memory_units' ]

|  MAX_COST=float [ COST_OVERCOMMIT={TRUE|FALSE} ]
        [ ACTIVE_STATEMENTS=integer ]
        [ MIN_COST=float ]
        [ PRIORITY={MIN|LOW|MEDIUM|HIGH|MAX} ]
        [ MEMORY_LIMIT='memory_units' ]
```

Description

Creates a new resource queue for HAWQ workload management. A resource queue must have either an `ACTIVE_STATEMENTS` or a `MAX_COST` value (or it can have both). Only a superuser can create a resource queue.

Resource queues with an `ACTIVE_STATEMENTS` threshold set a maximum limit on the number of queries that can be executed by roles assigned to that queue. It controls the number of active queries that are allowed to run at the same time. The value for `ACTIVE_STATEMENTS` should be an integer greater than 0.

Resource queues with a `MAX_COST` threshold set a maximum limit on the total cost of queries that can be executed by roles assigned to that queue. Cost is measured in the *estimated total cost* for the query as determined by the HAWQ query planner (as shown in the `EXPLAIN` output for a query). Therefore, an administrator must be familiar with the queries typically executed on the system in order to set an appropriate cost threshold for a queue. Cost is measured in units of disk page fetches; 1.0 equals one sequential disk page read. The value for `MAX_COST` is specified as a floating point number (for example 100.0) or can also be specified as an exponent (for example 1e+2). If a resource queue is limited based on a cost threshold, then the administrator can allow `COST_OVERCOMMIT=TRUE` (the default). This means that a query that exceeds the allowed cost threshold will be allowed to run but only when the system is idle. If `COST_OVERCOMMIT=FALSE` is specified, queries that exceed the cost limit will always be rejected and never allowed to run. Specifying a value for `MIN_COST` allows the administrator to define a cost for small queries that will be exempt from resource queueing.

If a value is not defined for `ACTIVE_STATEMENTS` or `MAX_COST`, it is set to `-1` by default (meaning no limit). After defining a resource queue, you must assign roles to the queue using the `ALTER ROLE` or `CREATE ROLE` command.

You can optionally assign a `PRIORITY` to a resource queue to control the relative share of available CPU resources used by queries associated with the queue in relation to other resource queues. If a value is not defined for `PRIORITY`, queries associated with the queue have a default priority of `MEDIUM`.

Resource queues with an optional `MEMORY_LIMIT` threshold set a maximum limit on the amount of memory that all queries submitted through a resource queue can consume on a segment host. This determines the total amount of memory that all worker processes of a query can consume on a segment host during query execution. Greenplum recommends that `MEMORY_LIMIT` be used in conjunction with `ACTIVE_STATEMENTS` rather than with `MAX_COST`. The default amount of memory allotted per query on statement-based queues is: `MEMORY_LIMIT / ACTIVE_STATEMENTS`. The default amount of memory allotted per query on cost-based queues is: `MEMORY_LIMIT * (query_cost / MAX_COST).`

The default memory allotment can be overridden on a per-query basis using the `statement_mem` server configuration parameter, provided that `MEMORY_LIMIT` or `max_statement_mem` is not exceeded. For example, to allocate more memory to a particular query:

```
=> SET statement_mem='2GB';
=> SELECT * FROM my_big_table WHERE column='value' ORDER BY id;
=> RESET statement_mem;
```

As a general guideline, `MEMORY_LIMIT` for all of your resource queues should not exceed the amount of physical memory of a segment host.If workloads are staggered over multiple queues, memory allocations can be oversubscribed. However, queries can be cancelled during execution if the segment host memory limit specified in `gp_vmem_protect_limit` is exceeded.

Parameters

name

The name of the resource queue.

ACTIVE_STATEMENTS *integer*

Resource queues with an `ACTIVE_STATEMENTS` threshold limit the number of queries that can be executed by roles assigned to that queue. It controls the number of active queries that are allowed to run at the same time. The value for `ACTIVE_STATEMENTS` should be an integer greater than 0.

MEMORY_LIMIT '*memory_units*'

Sets the total memory quota for all statements submitted from users in this resource queue. Memory units can be specified in kB, MB or GB. The minimum memory quota for a resource queue is 10MB. There is no maximum, however the upper boundary at query execution time is limited by the physical memory of a segment host. The default is no limit (`-1`).

MAX_COST *float*

Resource queues with a MAX_COST threshold set a maximum limit on the total cost of queries that can be executed by roles assigned to that queue. Cost is measured in the *estimated total cost* for the query as determined by the HAWQ query planner (as shown in the EXPLAIN output for a query). Therefore, an administrator must be familiar with the queries typically executed on the system in order to set an appropriate cost threshold for a queue. Cost is measured in units of disk page fetches; 1.0 equals one sequential disk page read. The value for MAX_COST is specified as a floating point number (for example 100.0) or can also be specified as an exponent (for example 1e+2).

COST_OVERCOMMIT *boolean*

If a resource queue is limited based on MAX_COST, then the administrator can allow COST_OVERCOMMIT (the default). This means that a query that exceeds the allowed cost threshold will be allowed to run but only when the system is idle. If COST_OVERCOMMIT=FALSE is specified, queries that exceed the cost limit will always be rejected and never allowed to run.

MIN_COST *float*

The minimum query cost limit of what is considered a small query. Queries with a cost under this limit will not be queued and run immediately. Cost is measured in the *estimated total cost* for the query as determined by the HAWQ query planner (as shown in the EXPLAIN output for a query). Therefore, an administrator must be familiar with the queries typically executed on the system in order to set an appropriate cost for what is considered a small query. Cost is measured in units of disk page fetches; 1.0 equals one sequential disk page read. The value for MIN_COST is specified as a floating point number (for example 100.0) or can also be specified as an exponent (for example 1e+2).

PRIORITY={MIN|LOW|MEDIUM|HIGH|MAX}

Sets the priority of queries associated with a resource queue. Queries or statements in queues with higher priority levels will receive a larger share of available CPU resources in case of contention. Queries in low-priority queues may be delayed while higher priority queries are executed. If no priority is specified, queries associated with the queue have a priority of MEDIUM.

Notes

Use the *gp_toolkit.gp_resqueue_status* system view to see the limit settings and current status of a resource queue:

```
SELECT * from gp_toolkit.gp_resqueue_status WHERE
rsqname='queue_name';
```

There is also another system view named *pg_stat_resqueues* which shows statistical metrics for a resource queue over time. To use this view, however, you must enable the *stats_queue_level* server configuration parameter.

CREATE RESOURCE QUEUE cannot be run within a transaction.

Examples

Create a resource queue with an active query limit of 20:

```
CREATE RESOURCE QUEUE myqueue WITH (ACTIVE_STATEMENTS=20);
```

Create a resource queue with an active query limit of 20 and a total memory limit of 2000MB (each query will be allocated 100MB of segment host memory at execution time):

```
CREATE RESOURCE QUEUE myqueue WITH (ACTIVE_STATEMENTS=20,
MEMORY_LIMIT='2000MB');
```

Create a resource queue with a query cost limit of 3000.0:

```
CREATE RESOURCE QUEUE myqueue WITH (MAX_COST=3000.0);
```

Create a resource queue with a query cost limit of 3^{10} (or 30000000000.0) and do not allow overcommit. Allow small queries with a cost under 500 to run immediately:

```
CREATE RESOURCE QUEUE myqueue WITH (MAX_COST=3e+10,
COST_OVERCOMMIT=FALSE, MIN_COST=500.0);
```

Create a resource queue with both an active query limit and a query cost limit:

```
CREATE RESOURCE QUEUE myqueue WITH (ACTIVE_STATEMENTS=30,
MAX_COST=5000.00);
```

Create a resource queue with an active query limit of 5 and a maximum priority setting:

```
CREATE RESOURCE QUEUE myqueue WITH (ACTIVE_STATEMENTS=5,
PRIORITY=MAX);
```

Compatibility

`CREATE RESOURCE QUEUE` is a HAWQ extension. There is no provision for resource queues or workload management in the SQL standard.

See Also

`ALTER ROLE`, `CREATE ROLE`, `DROP RESOURCE QUEUE`

CREATE ROLE

Defines a new database role (user or group).

Synopsis

```
CREATE ROLE name [[WITH] option [ ... ]]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEEXTTABLE | NOCREATEEXTTABLE
      [ ( attribute='value'[, ...] ) ]
           where attributes and values are:
           type='readable'|'writable'
           protocol='gpfdist'|'http'
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | CONNECTION LIMIT connlimit
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | RESOURCE QUEUE queue_name
    | [ DENY deny_point ]
    | [ DENY BETWEEN deny_point AND deny_point]
```

Description

`CREATE ROLE` adds a new role to a HAWQ system. A role is an entity that can own database objects and have database privileges. A role can be considered a user, a group, or both depending on how it is used. You must have `CREATEROLE` privilege or be a database superuser to use this command.

Note that roles are defined at the system-level and are valid for all databases in your HAWQ system.

Parameters

name

The name of the new role.

SUPERUSER
NOSUPERUSER

If `SUPERUSER` is specified, the role being defined will be a superuser, who can override all access restrictions within the database. Superuser status is dangerous and should be used only when really needed. You must yourself be a superuser to create a new superuser. `NOSUPERUSER` is the default.

CREATEDB
NOCREATEDB

If `CREATEDB` is specified, the role being defined will be allowed to create new databases. `NOCREATEDB` (the default) will deny a role the ability to create databases.

CREATEROLE
NOCREATEROLE

If `CREATEDB` is specified, the role being defined will be allowed to create new roles, alter other roles, and drop other roles. `NOCREATEROLE` (the default) will deny a role the ability to create roles or modify roles other than their own.

CREATEEXTTABLE
NOCREATEEXTTABLE

If `CREATEEXTTABLE` is specified, the role being defined is allowed to create external tables. The default `type` is `readable` and the default `protocol` is `gpfdist` if not specified. `NOCREATEEXTTABLE` (the default) denies the role the ability to create external tables. Note that external tables that use the `file` or `execute` protocols can only be created by superusers.

INHERIT
NOINHERIT

If specified, `INHERIT` (the default) allows the role to use whatever database privileges have been granted to all roles it is directly or indirectly a member of. With `NOINHERIT`, membership in another role only grants the ability to `SET ROLE` to that other role.

LOGIN
NOLOGIN

If specified, `LOGIN` allows a role to log in to a database. A role having the `LOGIN` attribute can be thought of as a user. Roles with `NOLOGIN` (the default) are useful for managing database privileges, and can be thought of as groups.

CONNECTION LIMIT *connlimit*

The number maximum of concurrent connections this role can make. The default of -1 means there is no limitation.

PASSWORD *password*

Sets the user password for roles with the `LOGIN` attribute. If you do not plan to use password authentication you can omit this option. If no password is specified, the password will be set to null and password authentication will always fail for that user. A null password can optionally be written explicitly as `PASSWORD NULL`.

ENCRYPTED
UNENCRYPTED

These key words control whether the password is stored encrypted in the system catalogs. (If neither is specified, the default behavior is determined by the configuration parameter *password_encryption*.) If the presented password string is already in MD5-encrypted format, then it is stored encrypted as-is, regardless of whether `ENCRYPTED` or `UNENCRYPTED` is specified (since the system cannot decrypt the specified encrypted password string). This allows reloading of encrypted passwords during dump/restore.

Note that older clients may lack support for the MD5 authentication mechanism that is needed to work with passwords that are stored encrypted.

VALID UNTIL '*timestamp*'

The VALID UNTIL clause sets a date and time after which the role's password is no longer valid. If this clause is omitted the password will never expire.

IN ROLE *rolename*

Adds the new role as a member of the named roles. Note that there is no option to add the new role as an administrator; use a separate `GRANT` command to do that.

ROLE *rolename*

Adds the named roles as members of this role, making this new role a group.

ADMIN *rolename*

The `ADMIN` clause is like `ROLE`, but the named roles are added to the new role `WITH ADMIN OPTION`, giving them the right to grant membership in this role to others.

RESOURCE QUEUE *queue_name*

The name of the resource queue to which the new user-level role is to be assigned. Only roles with `LOGIN` privilege can be assigned to a resource queue. The special keyword `NONE` means that the role is assigned to the default resource queue. A role can only belong to one resource queue.

DENY *deny_point*
DENY BETWEEN *deny_point* AND *deny_point*

The `DENY` and `DENY BETWEEN` keywords set time-based constraints that are enforced at login. `DENY` sets a day or a day and time to deny access. `DENY BETWEEN` sets an interval during which access is denied. Both use the parameter *deny_point* that has the following format:

```
DAY day [ TIME 'time' ]
```

The two parts of the `deny_point` parameter use the following formats:

For day:

{'Sunday' | 'Monday' | 'Tuesday' |'Wednesday' | 'Thursday' | 'Friday' | 'Saturday' | 0-6 }

For `time`:

{ 00-23 : 00-59 | 01-12 : 00-59 { AM | PM }}

The `DENY BETWEEN` clause uses two *deny_point* parameters.

```
DENY BETWEEN deny_point AND deny_point
```

Notes

The preferred way to add and remove role members (manage groups) is to use `GRANT` and `REVOKE`.

The `VALID UNTIL` clause defines an expiration time for a password only, not for the role. The expiration time is not enforced when logging in using a non-password-based authentication method.

The `INHERIT` attribute governs inheritance of grantable privileges (access privileges for database objects and role memberships). It does not apply to the special role attributes set by `CREATE ROLE` and `ALTER ROLE`. For example, being a member of a role with `CREATEDB` privilege does not immediately grant the ability to create databases, even if `INHERIT` is set.

The `INHERIT` attribute is the default for reasons of backwards compatibility. In prior releases of HAWQ, users always had access to all privileges of groups they were members of. However, `NOINHERIT` provides a closer match to the semantics specified in the SQL standard.

Be careful with the `CREATEROLE` privilege. There is no concept of inheritance for the privileges of a `CREATEROLE`-role. That means that even if a role does not have a certain privilege but is allowed to create other roles, it can easily create another role with different privileges than its own (except for creating roles with superuser privileges). For example, if a role has the `CREATEROLE` privilege but not the `CREATEDB` privilege, it can create a new role with the `CREATEDB` privilege. Therefore, regard roles that have the `CREATEROLE` privilege as almost-superuser-roles.

The `CONNECTION LIMIT` option is never enforced for superusers.

Caution must be exercised when specifying an unencrypted password with this command. The password will be transmitted to the server in clear-text, and it might also be logged in the client's command history or the server log. The client program `createuser`, however, transmits the password encrypted. Also, psql contains a command `\password` that can be used to safely change the password later.

Examples

Create a role that can log in, but don't give it a password:

```
CREATE ROLE jonathan LOGIN;
```

Create a role that belongs to a resource queue:

```
CREATE ROLE jonathan LOGIN RESOURCE QUEUE poweruser;
```

Create a role with a password that is valid until the end of 2009 (`CREATE USER` is the same as `CREATE ROLE` except that it implies `LOGIN`):

```
CREATE USER joelle WITH PASSWORD 'jw8s0F4' VALID UNTIL
'2010-01-01';
```

Create a role that can create databases and manage other roles:

```
CREATE ROLE admin WITH CREATEDB CREATEROLE;
```

Create a role that does not allow login access on Sundays:

```
CREATE ROLE user3 DENY DAY 'Sunday';
```

Compatibility

The SQL standard defines the concepts of users and roles, but it regards them as distinct concepts and leaves all commands defining users to be specified by the database implementation. In HAWQ users and roles are unified into a single type of object. Roles therefore have many more optional attributes than they do in the standard.

`CREATE ROLE` is in the SQL standard, but the standard only requires the syntax:

```
CREATE ROLE name [WITH ADMIN rolename]
```

Allowing multiple initial administrators, and all the other options of `CREATE ROLE`, are HAWQ extensions.

The behavior specified by the SQL standard is most closely approximated by giving users the `NOINHERIT` attribute, while roles are given the `INHERIT` attribute.

See Also

`SET ROLE`, `ALTER ROLE`, `DROP ROLE`, `GRANT`, `REVOKE`, `CREATE RESOURCE QUEUE`

CREATE SCHEMA

Defines a new schema.

Synopsis

```
CREATE SCHEMA schema_name [AUTHORIZATION username]
[schema_element [ ... ]]

CREATE SCHEMA AUTHORIZATION rolename [schema_element [ ... ]]
```

Description

`CREATE SCHEMA` enters a new schema into the current database. The schema name must be distinct from the name of any existing schema in the current database.

A schema is essentially a namespace: it contains named objects (tables, data types, functions, and operators) whose names may duplicate those of other objects existing in other schemas. Named objects are accessed either by qualifying their names with the schema name as a prefix, or by setting a search path that includes the desired schema(s). A `CREATE` command specifying an unqualified object name creates the object in the current schema (the one at the front of the search path, which can be determined with the function `current_schema`).

Optionally, `CREATE SCHEMA` can include subcommands to create objects within the new schema. The subcommands are treated essentially the same as separate commands issued after creating the schema, except that if the `AUTHORIZATION` clause is used, all the created objects will be owned by that role.

Parameters

schema_name

The name of a schema to be created. If this is omitted, the user name is used as the schema name. The name cannot begin with *pg_*, as such names are reserved for system catalog schemas.

rolename

The name of the role who will own the schema. If omitted, defaults to the role executing the command. Only superusers may create schemas owned by roles other than themselves.

schema_element

An SQL statement defining an object to be created within the schema. Currently, only `CREATE TABLE`, `CREATE VIEW`, `CREATE SEQUENCE` and `GRANT` are accepted as clauses within `CREATE SCHEMA`. Other kinds of objects may be created in separate commands after the schema is created.

Notes

To create a schema, the invoking user must have the `CREATE` privilege for the current database or be a superuser.

Examples

Create a schema:

```
CREATE SCHEMA myschema;
```

Create a schema for role *joe* (the schema will also be named *joe*):

```
CREATE SCHEMA AUTHORIZATION joe;
```

Compatibility

The SQL standard allows a `DEFAULT CHARACTER SET` clause in `CREATE SCHEMA`, as well as more subcommand types than are presently accepted by HAWQ.

The SQL standard specifies that the subcommands in `CREATE SCHEMA` may appear in any order. The present HAWQ implementation does not handle all cases of forward references in subcommands; it may sometimes be necessary to reorder the subcommands in order to avoid forward references.

According to the SQL standard, the owner of a schema always owns all objects within it. HAWQ allows schemas to contain objects owned by users other than the schema owner. This can happen only if the schema owner grants the `CREATE` privilege on the schema to someone else.

See Also

`DROP SCHEMA`

CREATE SEQUENCE

Defines a new sequence generator.

Synopsis

```
CREATE [TEMPORARY | TEMP] SEQUENCE name
       [INCREMENT [BY] value]
       [MINVALUE minvalue | NO MINVALUE]
       [MAXVALUE maxvalue | NO MAXVALUE]
       [START [ WITH ] start]
       [CACHE cache]
       [[NO] CYCLE]
       [OWNED BY { table.column | NONE }]
```

Description

`CREATE SEQUENCE` creates a new sequence number generator. This involves creating and initializing a new special single-row table. The generator will be owned by the user issuing the command.

If a schema name is given, then the sequence is created in the specified schema. Otherwise it is created in the current schema. Temporary sequences exist in a special schema, so a schema name may not be given when creating a temporary sequence. The sequence name must be distinct from the name of any other sequence, table, or view in the same schema.

After a sequence is created, you use the `nextval` function to operate on the sequence. For example, to insert a row into a table that gets the next value of a sequence:

```
INSERT INTO distributors VALUES (nextval('myserial'),
'acme');
```

You can also use the function `setval` to operate on a sequence, but only for queries that do not operate on distributed data. For example, the following query is allowed because it resets the sequence counter value for the sequence generator process on the master:

```
SELECT setval('myserial', 201);
```

But the following query will be rejected in HAWQ because it operates on distributed data:

```
INSERT INTO product VALUES (setval('myserial', 201),
'gizmo');
```

In a regular (non-distributed) database, functions that operate on the sequence go to the local sequence table to get values as they are needed. In HAWQ, however, keep in mind that each segment is its own distinct database process. Therefore the segments need a single point of truth to go for sequence values so that all segments get incremented correctly and the sequence moves forward in the right order. A sequence server process runs on the master and is the point-of-truth for a sequence in a HAWQ distributed database. Segments get sequence values at runtime from the master.

Because of this distributed sequence design, there are some limitations on the functions that operate on a sequence in HAWQ:

- `lastval` and `currval` functions are not supported.
- `setval` can only be used to set the value of the sequence generator on the master, it cannot be used in subqueries to update records on distributed table data.
- `nextval` sometimes grabs a block of values from the master for a segment to use, depending on the query. So values may sometimes be skipped in the sequence if all of the block turns out not to be needed at the segment level. Note that a regular PostgreSQL database does this too, so this is not something unique to HAWQ.

Although you cannot update a sequence directly, you can use a query like:

```
SELECT * FROM sequence_name;
```

to examine the parameters and current state of a sequence. In particular, the *last_value* field of the sequence shows the last value allocated by any session.

Parameters

TEMPORARY | TEMP

If specified, the sequence object is created only for this session, and is automatically dropped on session exit. Existing permanent sequences with the same name are not visible (in this session) while the temporary sequence exists, unless they are referenced with schema-qualified names.

name

The name (optionally schema-qualified) of the sequence to be created.

increment

Specifies which value is added to the current sequence value to create a new value. A positive value will make an ascending sequence, a negative one a descending sequence. The default value is 1.

minvalue
NO MINVALUE

Determines the minimum value a sequence can generate. If this clause is not supplied or `NO MINVALUE` is specified, then defaults will be used. The defaults are 1 and -263-1 for ascending and descending sequences, respectively.

maxvalue
NO MAXVALUE

Determines the maximum value for the sequence. If this clause is not supplied or `NO MAXVALUE` is specified, then default values will be used. The defaults are 263-1 and -1 for ascending and descending sequences, respectively.

start

Allows the sequence to begin anywhere. The default starting value is *`minvalue`* for ascending sequences and *`maxvalue`* for descending ones.

cache

Specifies how many sequence numbers are to be preallocated and stored in memory for faster access. The minimum (and default) value is 1 (no cache).

CYCLE
NO CYCLE

Allows the sequence to wrap around when the *`maxvalue`* (for ascending) or *`minvalue`* (for descending) has been reached. If the limit is reached, the next number generated will be the *`minvalue`* (for ascending) or *`maxvalue`* (for descending). If `NO CYCLE` is specified, any calls to `nextval` after the sequence has reached its maximum value will return an error. If not specified, `NO CYCLE` is the default.

OWNED BY *table.column*
OWNED BY NONE

Causes the sequence to be associated with a specific table column, such that if that column (or its whole table) is dropped, the sequence will be automatically dropped as well. The specified table must have the same owner and be in the same schema as the sequence. `OWNED BY NONE`, the default, specifies that there is no such association.

Notes

Sequences are based on bigint arithmetic, so the range cannot exceed the range of an eight-byte integer (-9223372036854775808 to 9223372036854775807).

Although multiple sessions are guaranteed to allocate distinct sequence values, the values may be generated out of sequence when all the sessions are considered. For example, session A might reserve values 1..10 and return `nextval=1`, then session B might reserve values 11..20 and return `nextval=11` before session A has generated nextval=2. Thus, you should only assume that the `nextval` values are all distinct, not that they are generated purely sequentially. Also, *last_value* will reflect the latest value reserved by any session, whether or not it has yet been returned by `nextval`.

Examples

Create a sequence named *myseq*:

```
CREATE SEQUENCE myseq START 101;
```

Insert a row into a table that gets the next value:

```
INSERT INTO distributors VALUES (nextval('myseq'), 'acme');
```

Reset the sequence counter value on the master:

```
SELECT setval('myseq', 201);
```

Illegal use of `setval` in HAWQ (setting sequence values on distributed data):

```
INSERT INTO product VALUES (setval('myseq', 201), 'gizmo');
```

Compatibility

`CREATE SEQUENCE` conforms to the SQL standard, with the following exceptions:

- The `AS` *`data_type`* expression specified in the SQL standard is not supported.
- Obtaining the next value is done using the `nextval()` function instead of the `NEXT VALUE FOR` expression specified in the SQL standard.
- The `OWNED BY` clause is a HAWQ extension.

See Also

`DROP SEQUENCE`

CREATE TABLE

Defines a new table.

Synopsis

```
CREATE [[GLOBAL | LOCAL] {TEMPORARY | TEMP}] TABLE table_name (
[ { column_name data_type [ DEFAULT default_expr ]
   [column_constraint [ ... ]
[ ENCODING ( storage_directive [,...] ) ]
]
   | table_constraint
   | LIKE other_table [{INCLUDING | EXCLUDING}
                      {DEFAULTS | CONSTRAINTS}] ...}
   [, ... ] ]
   [column_reference_storage_directive [, …] ]
   )
   [ INHERITS ( parent_table [, ... ] ) ]
   [ WITH ( storage_parameter=value [, ... ] )
   [ ON COMMIT {PRESERVE ROWS | DELETE ROWS | DROP} ]
   [ TABLESPACE tablespace ]
   [ DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY ]
   [ PARTITION BY partition_type (column)
       [ SUBPARTITION BY partition_type (column) ]
          [ SUBPARTITION TEMPLATE ( template_spec ) ]
       [...]
    ( partition_spec )
        | [ SUBPARTITION BY partition_type (column) ]
          [...]
    ( partition_spec
      [ ( subpartition_spec
           [(...)]
         ) ]
    )
```

where *storage_parameter* is:

```
APPENDONLY={TRUE}
BLOCKSIZE={8192-2097152}
ORIENTATION={COLUMN|ROW}
COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
COMPRESSLEVEL={0-9}
FILLFACTOR={10-100}
OIDS[=TRUE|FALSE]
```

where *column_constraint* is:

```
[CONSTRAINT constraint_name]
NOT NULL | NULL
| CHECK ( expression )
```

and *table_constraint* is:

```
    [CONSTRAINT constraint_name]
    CHECK ( expression )
```

where *partition_type* is:

```
     LIST
   | RANGE
```

where *partition_specification* is:

```
partition_element [, ...]
```

and *partition_element* is:

```
    DEFAULT PARTITION name
  | [PARTITION name] VALUES (list_value [,...] )
  | [PARTITION name]
      START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
      [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
      [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
  | [PARTITION name]
      END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
      [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[column_reference_storage_directive [, …] ]
[ TABLESPACE tablespace ]
```

where *subpartition_spec* or *template_spec* is:

```
subpartition_element [, ...]
```

and *subpartition_element* is:

```
    DEFAULT SUBPARTITION name
  | [SUBPARTITION name] VALUES (list_value [,...] )
  | [SUBPARTITION name]
      START ([datatype] 'start_value') [INCLUSIVE | EXCLUSIVE]
      [ END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE] ]
      [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
  | [SUBPARTITION name]
      END ([datatype] 'end_value') [INCLUSIVE | EXCLUSIVE]
      [ EVERY ([datatype] [number | INTERVAL] 'interval_value') ]
[ WITH ( partition_storage_parameter=value [, ... ] ) ]
[column_reference_storage_directive [, …] ]
[ TABLESPACE tablespace ]
```

where *storage_parameter* is:

```
    APPENDONLY={TRUE}
    BLOCKSIZE={8192-2097152}
    ORIENTATION={COLUMN|ROW}
    COMPRESSTYPE={ZLIB|QUICKLZ|RLE_TYPE|NONE}
    COMPRESSLEVEL={0-9}
    FILLFACTOR={10-100}
    OIDS[=TRUE|FALSE]
```

where *storage_directive* is:

```
   COMPRESSTYPE={ZLIB | QUICKLZ | RLE_TYPE | NONE}
 | COMPRESSLEVEL={0-9}
 | BLOCKSIZE={8192-2097152}
```

Where *column_reference_storage_directive* is:

```
COLUMN column_name ENCODING (storage_directive [, ... ] ), ...
 |
DEFAULT COLUMN ENCODING (storage_directive [, ... ] )
```

Description

`CREATE TABLE` will create a new, initially empty table in the current database. The table will be owned by the user issuing the command.

If a schema name is given then the table is created in the specified schema. Otherwise it is created in the current schema. Temporary tables exist in a special schema, so a schema name may not be given when creating a temporary table. The name of the table must be distinct from the name of any other table, external table, sequence, or view in the same schema.

The optional constraint clauses specify conditions that new or updated rows must satisfy for an insert or update operation to succeed. A constraint is an SQL object that helps define the set of valid values in the table in various ways. Constraints apply to tables, not to partitions. You cannot add a constraint to a partition or subpartition.

There are two ways to define constraints: table constraints and column constraints. A column constraint is defined as part of a column definition. A table constraint definition is not tied to a particular column, and it can encompass more than one column. Every column constraint can also be written as a table constraint; a column constraint is only a notational convenience for use when the constraint only affects one column.

When creating a table, there is an additional clause to declare the HAWQ distribution policy. If a `DISTRIBUTED BY` or `DISTRIBUTED RANDOMLY` clause is not supplied, then HAWQ assigns a hash distribution policy to the table using the first column of the table as the distribution key. Columns of geometric or user-defined data types are not eligible as HAWQ distribution key columns. If a table does not have a column of an eligible data type, the rows are distributed based on a round-robin or random distribution. To ensure an even distribution of data in your HAWQ system, you want to choose a distribution key that is unique for each record, or if that is not possible, then choose `DISTRIBUTED RANDOMLY`.

The `PARTITION BY` clause allows you to divide the table into multiple sub-tables (or parts) that, taken together, make up the parent table and share its schema. Though the sub-tables exist as independent tables, HAWQ restricts their use in important ways. Internally, partitioning is implemented as a special form of inheritance. Each child table partition is created with a distinct `CHECK` constraint which limits the data the table can contain, based on some defining criteria. The `CHECK` constraints are also used by the query planner to determine which table partitions to scan in order to satisfy a given query predicate. These partition constraints are managed automatically by HAWQ.

Parameters

GLOBAL | LOCAL

These keywords are present for SQL standard compatibility, but have no effect in HAWQ.

TEMPORARY | TEMP

If specified, the table is created as a temporary table. Temporary tables are automatically dropped at the end of a session, or optionally at the end of the current transaction (see `ON COMMIT`). Existing permanent tables with the same name are not visible to the current session while the temporary table exists, unless they are referenced with schema-qualified names.

table_name

The name (optionally schema-qualified) of the table to be created.

column_name

The name of a column to be created in the new table.

data_type

The data type of the column. This may include array specifiers.

DEFAULT *default_expr*

The `DEFAULT` clause assigns a default data value for the column whose column definition it appears within. The value is any variable-free expression (subqueries and cross-references to other columns in the current table are not allowed). The data type of the default expression must match the data type of the column. The default expression will be used in any insert operation that does not specify a value for the column. If there is no default for a column, then the default is null.

INHERITS

The optional `INHERITS` clause specifies a list of tables from which the new table automatically inherits all columns. Use of `INHERITS` creates a persistent relationship between the new child table and its parent table(s). Schema modifications to the parent(s) normally propagate to children as well, and by default the data of the child table is included in scans of the parent(s).

In HAWQ, the `INHERITS` clause is not used when creating partitioned tables. Although the concept of inheritance is used in partition hierarchies, the inheritance structure of a partitioned table is created using the `PARTITION BY` clause.

If the same column name exists in more than one parent table, an error is reported unless the data types of the columns match in each of the parent tables. If there is no conflict, then the duplicate columns are merged to form a single column in the new table. If the column name list of the new table contains a column name that is also inherited, the data type must likewise match the inherited column(s), and the column definitions are merged into one. However, inherited and new column declarations of the same name need not specify identical constraints: all constraints provided from any declaration are merged together and all are applied to the new table. If the new table explicitly specifies a default value for the column, this default overrides any defaults from inherited declarations of the column. Otherwise, any parents that specify default values for the column must all specify the same default, or an error will be reported.

LIKE *other_table* [{INCLUDING | EXCLUDING} {DEFAULTS | CONSTRAINTS}]

The `LIKE` clause specifies a table from which the new table automatically copies all column names, data types, not-null constraints, and distribution policy. Storage properties like append-only or partition structure are not copied. Unlike `INHERITS`, the new table and original table are completely decoupled after creation is complete.

Default expressions for the copied column definitions will only be copied if `INCLUDING DEFAULTS` is specified. The default behavior is to exclude default expressions, resulting in the copied columns in the new table having null defaults.

Not-null constraints are always copied to the new table. `CHECK` constraints will only be copied if `INCLUDING CONSTRAINTS` is specified; other types of constraints will *never* be copied. Also, no distinction is made between column constraints and table constraints — when constraints are requested, all check constraints are copied.

Note also that unlike `INHERITS`, copied columns and constraints are not merged with similarly named columns and constraints. If the same name is specified explicitly or in another `LIKE` clause an error is signalled.

NULL | NOT NULL

Specifies if the column is or is not allowed to contain null values. `NULL` is the default.

CHECK (*expression*)

The `CHECK` clause specifies an expression producing a Boolean result which new or updated rows must satisfy for an insert or update operation to succeed. Expressions evaluating to `TRUE` or `UNKNOWN` succeed. Should any row of an insert or update operation produce a `FALSE` result an error exception is raised and the insert or update does not alter the database. A check constraint specified as a column constraint should reference that column's value only, while an expression appearing in a table constraint may reference multiple columns. `CHECK` expressions cannot contain subqueries nor refer to variables other than columns of the current row.

WITH (*storage_option=value*)

The `WITH` clause can be used to set storage options for the table. Note that you can also set storage parameters on a particular partition or subpartition by declaring the `WITH` clause in the partition specification.

Note: You cannot create a table with both column encodings and compression parameters in a `WITH` clause.

The following storage options are available:

APPENDONLY - Set to `TRUE` or not declared to create the table as an append-only table. If `FALSE`, an error message will notify that heap table does not support.

BLOCKSIZE - Set to the size, in bytes for each block in a table. The `BLOCKSIZE` must be between 8192 and 2097152 bytes, and be a multiple of 8192. The default is 32768.

ORIENTATION - Set to `column` for column-oriented storage, or `row` (the default) for row-oriented storage. This option is only valid if `APPENDONLY=TRUE`. Heap-storage tables can only be row-oriented.

COMPRESSTYPE - Set to `ZLIB` (the default) or `QUICKLZ` to specify the type of compression used. QuickLZ uses less CPU power and compresses data faster at a lower compression ratio than zlib. Conversely, zlib provides more compact compression ratios at lower speeds. This option is only valid if `APPENDONLY=TRUE`.

COMPRESSLEVEL - For zlib compression of append-only tables, set to a value between 1 (fastest compression) to 9 (highest compression ratio). QuickLZ compression level can only be set to 1. If not declared, the default is 1. This option is only valid if `APPENDONLY=TRUE`.

OIDS - Set to `OIDS=FALSE` (the default) so that rows do not have object identifiers assigned to them. Greenplum strongly recommends that you do not enable OIDS when creating a table. On large tables, such as those in a typical HAWQ system, using OIDs for table rows can cause wrap-around of the 32-bit OID counter. Once the counter wraps around, OIDs can no longer be assumed to be unique, which not only makes them useless to user applications, but can also cause problems in the HAWQ system catalog tables. In addition, excluding OIDs from a table reduces the space required to store the table on disk by 4 bytes per row, slightly improving performance. OIDS are not allowed on partitioned tables or append-only column-oriented tables.

ON COMMIT

The behavior of temporary tables at the end of a transaction block can be controlled using `ON COMMIT`. The three options are:

PRESERVE ROWS

No special action is taken at the ends of transactions for temporary tables. This is the default behavior.

DELETE ROWS

All rows in the temporary table will be deleted at the end of each transaction block. Essentially, an automatic `TRUNCATE` is done at each commit.

DROP

The temporary table will be dropped at the end of the current transaction block.

TABLESPACE ***tablespace***

The name of the tablespace in which the new table is to be created. If not specified, the database’s default tablespace dfs_default is used. Creating table on tablespace 'pg_default' is not allowed.

DISTRIBUTED BY (*column*, [...])
DISTRIBUTED RANDOMLY

Used to declare the HAWQ distribution policy for the table. `DISTIBUTED BY` uses hash distribution with one or more columns declared as the distribution key. For the most even data distribution, the distribution key should be the primary key of the table or a unique column (or set of columns). If that is not possible, then you may choose `DISTRIBUTED RANDOMLY`, which will send the data round-robin to the segment instances. If not supplied, then hash distribution is chosen using the first eligible column of the table as the distribution key.

PARTITION BY

Declares one or more columns by which to partition the table.

partition_type

Declares partition type: `LIST` (list of values) or `RANGE` (a numeric or date range).

partition_specification

Declares the individual partitions to create. Each partition can be defined individually or, for range partitions, you can use the `EVERY` clause (with a `START` and optional `END` clause) to define an increment pattern to use to create the individual partitions.

DEFAULT PARTITION *name* - Declares a default partition. When data does not match to an existing partition, it is inserted into the default partition. Partition designs that do not have a default partition will reject incoming rows that do not match to an existing partition.

PARTITION *name* - Declares a name to use for the partition. Partitions are created using the following naming convention:
parentname_level#_prt_givenname.

VALUES - For list partitions, defines the value(s) that the partition will contain.

START - For range partitions, defines the starting range value for the partition. By default, start values are `INCLUSIVE`. For example, if you declared a start date of '`2008-01-01`', then the partition would contain all dates greater than or equal to '`2008-01-01`'. Typically the data type of the `START` expression is the same type as the partition key column. If that is not the case, then you must explicitly cast to the intended data type.

END - For range partitions, defines the ending range value for the partition. By default, end values are `EXCLUSIVE`. For example, if you declared an end date of '`2008-02-01`', then the partition would contain all dates less than but not equal to '`2008-02-01`'. Typically the data type of the `END` expression is the same type as the partition key column. If that is not the case, then you must explicitly cast to the intended data type.

EVERY - For range partitions, defines how to increment the values from `START` to `END` to create individual partitions. Typically the data type of the `EVERY` expression is the same type as the partition key column. If that is not the case, then you must explicitly cast to the intended data type.

`WITH` - Sets the table storage options for a partition. For example, you may want older partitions to be append-only tables and newer partitions to be regular heap tables.

`TABLESPACE` - The name of the tablespace in which the partition is to be created.

`SUBPARTITION BY`

Declares one or more columns by which to subpartition the first-level partitions of the table. The format of the subpartition specification is similar to that of a partition specification described above.

`SUBPARTITION TEMPLATE`

Instead of declaring each subpartition definition individually for each partition, you can optionally declare a subpartition template to be used to create the subpartitions. This subpartition specification would then apply to all parent partitions.

Notes

Using OIDs in new applications is not recommended: where possible, using a `SERIAL` or other sequence generator as the table's primary key is preferred. However, if your application does make use of OIDs to identify specific rows of a table, it is recommended to create a unique constraint on the OID column of that table, to ensure that OIDs in the table will indeed uniquely identify rows even after counter wrap-around. Avoid assuming that OIDs are unique across tables; if you need a database-wide unique identifier, use the combination of table OID and row OID for the purpose.

HAWQ has some special conditions for primary key and unique constraints with regards to columns that are the *distribution key* in a HAWQ table. For a unique constraint to be enforced in HAWQ, the table must be hash-distributed (not `DISTRIBUTED RANDOMLY`), and the constraint columns must be the same as (or a superset of) the table's distribution key columns.

Primary key and foreign key constraints are not supported in HAWQ.

For inherited tables, table privileges *are not* inherited in the current implementation.

Examples

Create a table named *rank* in the schema named *baby* and distribute the data using the columns *rank*, *gender*, and *year*:

```
CREATE TABLE baby.rank (id int, rank int, year smallint,
gender char(1), count int ) DISTRIBUTED BY (rank, gender,
year);
```

Create table films and table distributors (the first column will be used as the HAWQ distribution key by default):

```
CREATE TABLE films (
code        char(5),
title       varchar(40) NOT NULL,
did         integer NOT NULL,
```

```
date_prod   date,
kind        varchar(10),
len         interval hour to minute
);

CREATE TABLE distributors (
did    integer,
name   varchar(40) NOT NULL CHECK (name <> '')
);
```

Create a gzip-compressed, append-only table:

```
CREATE TABLE sales (txn_id int, qty int, date date)
WITH (appendonly=true, compresslevel=5)
DISTRIBUTED BY (txn_id);
```

Create a three level partitioned table using subpartition templates and default partitions at each level:

```
CREATE TABLE sales (id int, year int, month int, day int,
region text)
DISTRIBUTED BY (id)
PARTITION BY RANGE (year)

  SUBPARTITION BY RANGE (month)
    SUBPARTITION TEMPLATE (
       START (1) END (13) EVERY (1),
       DEFAULT SUBPARTITION other_months )

  SUBPARTITION BY LIST (region)
    SUBPARTITION TEMPLATE (
       SUBPARTITION usa VALUES ('usa'),
       SUBPARTITION europe VALUES ('europe'),
       SUBPARTITION asia VALUES ('asia'),
       DEFAULT SUBPARTITION other_regions)

( START (2002) END (2010) EVERY (1),
  DEFAULT PARTITION outlying_years);
```

Compatibility

`CREATE TABLE` command conforms to the SQL standard, with the following exceptions:

- **Temporary Tables** — In the SQL standard, temporary tables are defined just once and automatically exist (starting with empty contents) in every session that needs them. HAWQ instead requires each session to issue its own `CREATE TEMPORARY TABLE` command for each temporary table to be used. This allows different sessions to use the same temporary table name for different purposes, whereas the standard's approach constrains all instances of a given temporary table name to have the same table structure.

  The standard's distinction between global and local temporary tables is not in HAWQ. HAWQ will accept the `GLOBAL` and `LOCAL` keywords in a temporary table declaration, but they have no effect.

If the `ON COMMIT` clause is omitted, the SQL standard specifies that the default behavior as `ON COMMIT DELETE ROWS`. However, the default behavior in HAWQ is `ON COMMIT PRESERVE ROWS`. The `ON COMMIT DROP` option does not exist in the SQL standard.

- **Column Check Constraints** — The SQL standard says that `CHECK` column constraints may only refer to the column they apply to; only `CHECK` table constraints may refer to multiple columns. HAWQ does not enforce this restriction; it treats column and table check constraints alike.
- **NULL Constraint** — The `NULL` constraint is a HAWQ extension to the SQL standard that is included for compatibility with some other database systems (and for symmetry with the `NOT NULL` constraint). Since it is the default for any column, its presence is not required.
- **Inheritance** — Multiple inheritance via the `INHERITS` clause is a HAWQ language extension. SQL:1999 and later define single inheritance using a different syntax and different semantics. SQL:1999-style inheritance is not yet supported by HAWQ.
- **Partitioning** — Table partitioning via the `PARTITION BY` clause is a HAWQ language extension.
- **Zero-column tables** — HAWQ allows a table of no columns to be created (for example, `CREATE TABLE foo();`). This is an extension from the SQL standard, which does not allow zero-column tables. Zero-column tables are not in themselves very useful, but disallowing them creates odd special cases for `ALTER TABLE DROP COLUMN`, so HAWQ decided to ignore this spec restriction.
- **WITH clause** — The `WITH` clause is a HAWQ extension; neither storage parameters nor OIDs are in the standard.
- **Tablespaces** — The HAWQ concept of tablespaces is not part of the SQL standard. The clauses `TABLESPACE` is extensions.
- **Data Distribution** — The HAWQ concept of a parallel or distributed database is not part of the SQL standard. The `DISTRIBUTED` clauses are extensions.

See Also

`ALTER TABLE`, `DROP TABLE`, `CREATE EXTERNAL TABLE`, `CREATE TABLE AS`

CREATE TABLE AS

Defines a new table from the results of a query.

Synopsis

```
CREATE [ [GLOBAL | LOCAL] {TEMPORARY | TEMP} ] TABLE table_name
    [(column_name [, ...] )]
    [ WITH ( storage_parameter=value [, ... ] ) ]
    [ON COMMIT {PRESERVE ROWS | DELETE ROWS | DROP}]
    [TABLESPACE tablespace]
    AS query
    [DISTRIBUTED BY (column, [ ... ] ) | DISTRIBUTED RANDOMLY]
```

where *storage_parameter* is:

```
    APPENDONLY={TRUE}
    BLOCKSIZE={8192-2097152}
    ORIENTATION={COLUMN|ROW}
    COMPRESSTYPE={ZLIB|QUICKLZ}
    COMPRESSLEVEL={1-9 | 1}
    FILLFACTOR={10-100}
    OIDS[=TRUE|FALSE]
```

Description

`CREATE TABLE AS` creates a table and fills it with data computed by a `SELECT` command. The table columns have the names and data types associated with the output columns of the `SELECT`, however you can override the column names by giving an explicit list of new column names.

`CREATE TABLE AS` creates a new table and evaluates the query just once to fill the new table initially. The new table will not track subsequent changes to the source tables of the query.

Parameters

GLOBAL | LOCAL

These keywords are present for SQL standard compatibility, but have no effect in Greenplum Database.

TEMPORARY | TEMP

If specified, the new table is created as a temporary table. Temporary tables are automatically dropped at the end of a session, or optionally at the end of the current transaction (see `ON COMMIT`). Existing permanent tables with the same name are not visible to the current session while the temporary table exists, unless they are referenced with schema-qualified names.

table_name

The name (optionally schema-qualified) of the new table to be created.

column_name

The name of a column in the new table. If column names are not provided, they are taken from the output column names of the query. If the table is created from an `EXECUTE` command, a column name list cannot be specified.

WITH (*storage_parameter=value*)

The `WITH` clause can be used to set storage options for the table. Note that you can also set different storage parameters on a particular partition or subpartition by declaring the `WITH` clause in the partition specification. The following storage options are available:

APPENDONLY - Set to `TRUE` to create the table as an append-only table. If `FALSE` or not declared, the table will be created as a regular heap-storage table.

BLOCKSIZE - Set to the size, in bytes for each block in a table. The `BLOCKSIZE` must be between 8192 and 2097152 bytes, and be a multiple of 8192. The default is 32768.

ORIENTATION - Set to `column` for column-oriented storage, or `row` (the default) for row-oriented storage. This option is only valid if `APPENDONLY=TRUE`. Heap-storage tables can only be row-oriented.

COMPRESSTYPE - Set to `ZLIB` (the default) or `QUICKLZ` to specify the type of compression used. QuickLZ uses less CPU power and compresses data faster at a lower compression ratio than zlib. Conversely, zlib provides more compact compression ratios at lower speeds. This option is only valid if `APPENDONLY=TRUE`.

COMPRESSLEVEL - For zlib compression of append-only tables, set to a value between 1 (fastest compression) to 9 (highest compression ratio). QuickLZ compression level can only be set to 1. If not declared, the default is 1. This option is only valid if `APPENDONLY=TRUE`.

OIDS - Set to `OIDS=FALSE` (the default) so that rows do not have object identifiers assigned to them. Greenplum strongly recommends that you do not enable OIDS when creating a table. On large tables, such as those in a typical Greenplum Database system, using OIDs for table rows can cause wrap-around of the 32-bit OID counter. Once the counter wraps around, OIDs can no longer be assumed to be unique, which not only makes them useless to user applications, but can also cause problems in the Greenplum Database system catalog tables. In addition, excluding OIDs from a table reduces the space required to store the table on disk by 4 bytes per row, slightly improving performance. OIDS are not allowed on column-oriented tables.

ON COMMIT

The behavior of temporary tables at the end of a transaction block can be controlled using `ON COMMIT`. The three options are:

PRESERVE ROWS

No special action is taken at the ends of transactions for temporary tables. This is the default behavior.

DELETE ROWS

All rows in the temporary table will be deleted at the end of each transaction block. Essentially, an automatic `TRUNCATE` is done at each commit.

DROP

The temporary table will be dropped at the end of the current transaction block.

TABLESPACE *tablespace*

The tablespace is the name of the tablespace in which the new table is to be created. If not specified, the database's default tablespace is used.

AS *query*

A `SELECT` command, or an `EXECUTE` command that runs a prepared `SELECT` query.

DISTRIBUTED BY (*column*, [...])
DISTRIBUTED RANDOMLY

Used to declare the Greenplum Database distribution policy for the table. One or more columns can be used as the distribution key, meaning those columns are used by the hashing algorithm to divide the data evenly across all of the segments. The distribution key should be the primary key of the table or a unique column (or set of columns). If that is not possible, then you may choose to distribute randomly, which will send the data round-robin to the segment instances. If not supplied, then either the `PRIMARY KEY` (if the table has one) or the first eligible column of the table will be used.

Notes

This command is functionally similar to `SELECT INTO`, but it is preferred since it is less likely to be confused with other uses of the `SELECT INTO` syntax. Furthermore, `CREATE TABLE AS` offers a superset of the functionality offered by `SELECT INTO`.

`CREATE TABLE AS` can be used for fast data loading from external table data sources. See `CREATE EXTERNAL TABLE`.

Examples

Create a new table *films_recent* consisting of only recent entries from the table *films*:

```
CREATE TABLE films_recent AS SELECT * FROM films WHERE
date_prod >= '2007-01-01';
```

Create a new temporary table *films_recent*, consisting of only recent entries from the table films, using a prepared statement. The new table has OIDs and will be dropped at commit:

```
PREPARE recentfilms(date) AS SELECT * FROM films WHERE
date_prod > $1;
CREATE TEMP TABLE films_recent WITH (OIDS) ON COMMIT DROP AS
EXECUTE recentfilms('2007-01-01');
```

Compatibility

CREATE TABLE AS conforms to the SQL standard, with the following exceptions:

- The standard requires parentheses around the subquery clause; in Greenplum Database, these parentheses are optional.
- The standard defines a WITH [NO] DATA clause; this is not currently implemented by Greenplum Database. The behavior provided by Greenplum Database is equivalent to the standard's WITH DATA case. WITH NO DATA can be simulated by appending LIMIT 0 to the query.
- Greenplum Database handles temporary tables differently from the standard; see CREATE TABLE for details.
- The WITH clause is a Greenplum Database extension; neither storage parameters nor OIDs are in the standard.
- The Greenplum Database concept of tablespaces is not part of the standard. The TABLESPACE clause is an extension.

See Also

CREATE EXTERNAL TABLE, EXECUTE, SELECT, SELECT INTO

CREATE USER

Defines a new database role with the `LOGIN` privilege by default.

Synopsis

```
CREATE USER name [ [WITH] option [ ... ] ]
```

where *option* can be:

```
      SUPERUSER | NOSUPERUSER
    | CREATEDB | NOCREATEDB
    | CREATEROLE | NOCREATEROLE
    | CREATEUSER | NOCREATEUSER
    | INHERIT | NOINHERIT
    | LOGIN | NOLOGIN
    | [ ENCRYPTED | UNENCRYPTED ] PASSWORD 'password'
    | VALID UNTIL 'timestamp'
    | IN ROLE rolename [, ...]
    | IN GROUP rolename [, ...]
    | ROLE rolename [, ...]
    | ADMIN rolename [, ...]
    | USER rolename [, ...]
    | SYSID uid
    | RESOURCE QUEUE queue_name
```

Description

As of HAWQ release 2.2, `CREATE USER` has been replaced by `CREATE ROLE`, although it is still accepted for backwards compatibility.

The only difference between `CREATE ROLE` and `CREATE USER` is that `LOGIN` is assumed by default with `CREATE USER`, whereas `NOLOGIN` is assumed by default with `CREATE ROLE`.

Compatibility

There is no `CREATE USER` statement in the SQL standard.

See Also

`CREATE ROLE`

CREATE VIEW

Defines a new view.

Synopsis

```
CREATE [OR REPLACE] [TEMP | TEMPORARY] VIEW name
       [ ( column_name [, ...] ) ]
       AS query
```

Description

`CREATE VIEW` defines a view of a query. The view is not physically materialized. Instead, the query is run every time the view is referenced in a query.

`CREATE OR REPLACE VIEW` is similar, but if a view of the same name already exists, it is replaced. You can only replace a view with a new query that generates the identical set of columns (same column names and data types).

If a schema name is given then the view is created in the specified schema. Otherwise it is created in the current schema. Temporary views exist in a special schema, so a schema name may not be given when creating a temporary view. The name of the view must be distinct from the name of any other view, table, or sequence in the same schema.

Parameters

TEMPORARY | TEMP

If specified, the view is created as a temporary view. Temporary views are automatically dropped at the end of the current session. Existing permanent relations with the same name are not visible to the current session while the temporary view exists, unless they are referenced with schema-qualified names. If any of the tables referenced by the view are temporary, the view is created as a temporary view (whether `TEMPORARY` is specified or not).

name

The name (optionally schema-qualified) of a view to be created.

column_name

An optional list of names to be used for columns of the view. If not given, the column names are deduced from the query.

query

A `SELECT` command which will provide the columns and rows of the view.

Notes

Views in Greenplum Database are read only. The system will not allow an insert, update, or delete on a view. You can get the effect of an updatable view by creating rewrite rules on the view into appropriate actions on other tables. For more information see `CREATE RULE`.

Be careful that the names and data types of the view's columns will be assigned the way you want. For example:

```
CREATE VIEW vista AS SELECT 'Hello World';
```

is bad form in two ways: the column name defaults to `?column?`, and the column data type defaults to `unknown`. If you want a string literal in a view's result, use something like:

```
CREATE VIEW vista AS SELECT text 'Hello World' AS hello;
```

Access to tables referenced in the view is determined by permissions of the view owner not the current user (even if the current user is a superuser). This can be confusing in the case of superusers, since superusers typically have access to all objects. In the case of a view, even superusers must be explicitly granted access to tables referenced in the view if they are not the owner of the view.

However, functions called in the view are treated the same as if they had been called directly from the query using the view. Therefore the user of a view must have permissions to call any functions used by the view.

If you create a view with an `ORDER BY` clause, the `ORDER BY` clause is ignored when you do a `SELECT` from the view.

Examples

Create a view consisting of all comedy films:

```
CREATE VIEW comedies AS SELECT * FROM films WHERE kind =
'comedy';
```

Create a view that gets the top ten ranked baby names:

```
CREATE VIEW topten AS SELECT name, rank, gender, year FROM
names, rank WHERE rank < '11' AND names.id=rank.id;
```

Compatibility

The SQL standard specifies some additional capabilities for the `CREATE VIEW` statement that are not in Greenplum Database. The optional clauses for the full SQL command in the standard are:

- **`CHECK OPTION`** — This option has to do with updatable views. All `INSERT` and `UPDATE` commands on the view will be checked to ensure data satisfy the view-defining condition (that is, the new data would be visible through the view). If they do not, the update will be rejected.
- **`LOCAL`** — Check for integrity on this view.

- **`CASCADED`** — Check for integrity on this view and on any dependent view. `CASCADED` is assumed if neither `CASCADED` nor `LOCAL` is specified.

`CREATE OR REPLACE VIEW` is a Greenplum Database language extension. So is the concept of a temporary view.

See Also

`SELECT`, `DROP VIEW`

DEALLOCATE

Deallocates a prepared statement.

Synopsis

```
DEALLOCATE [PREPARE] name
```

Description

`DEALLOCATE` is used to deallocate a previously prepared SQL statement. If you do not explicitly deallocate a prepared statement, it is deallocated when the session ends.

For more information on prepared statements, see `PREPARE`.

Parameters

PREPARE

Optional key word which is ignored.

name

The name of the prepared statement to deallocate.

Examples

Deallocated the previously prepared statement named *insert_names*:

```
DEALLOCATE insert_names;
```

Compatibility

The SQL standard includes a `DEALLOCATE` statement, but it is only for use in embedded SQL.

See Also

`EXECUTE`, `PREPARE`

DECLARE

Defines a cursor.

Synopsis

```
DECLARE name [BINARY] [INSENSITIVE] [NO SCROLL] CURSOR
             [{WITH | WITHOUT} HOLD]
             FOR query [FOR READ ONLY]
```

Description

DECLARE allows a user to create cursors, which can be used to retrieve a small number of rows at a time out of a larger query. Cursors can return data either in text or in binary format using FETCH.

Normal cursors return data in text format, the same as a SELECT would produce. Since data is stored natively in binary format, the system must do a conversion to produce the text format. Once the information comes back in text form, the client application may need to convert it to a binary format to manipulate it. In addition, data in the text format is often larger in size than in the binary format. Binary cursors return the data in a binary representation that may be more easily manipulated. Nevertheless, if you intend to display the data as text anyway, retrieving it in text form will save you some effort on the client side.

As an example, if a query returns a value of one from an integer column, you would get a string of 1 with a default cursor whereas with a binary cursor you would get a 4-byte field containing the internal representation of the value (in big-endian byte order).

Binary cursors should be used carefully. Many applications, including psql, are not prepared to handle binary cursors and expect data to come back in the text format.

Note: When the client application uses the 'extended query' protocol to issue a FETCH command, the Bind protocol message specifies whether data is to be retrieved in text or binary format. This choice overrides the way that the cursor is defined. The concept of a binary cursor as such is thus obsolete when using extended query protocol — any cursor can be treated as either text or binary.

Parameters

name

The name of the cursor to be created.

BINARY

Causes the cursor to return data in binary rather than in text format.

INSENSITIVE

Indicates that data retrieved from the cursor should be unaffected by updates to the tables underlying the cursor while the cursor exists. In Greenplum Database, all cursors are insensitive. This key word currently has no effect and is present for compatibility with the SQL standard.

NO SCROLL

A cursor cannot be used to retrieve rows in a nonsequential fashion. This is the default behavior in Greenplum Database, since scrollable cursors (`SCROLL`) are not supported.

WITH HOLD
WITHOUT HOLD

`WITH HOLD` specifies that the cursor may continue to be used after the transaction that created it successfully commits. `WITHOUT HOLD` specifies that the cursor cannot be used outside of the transaction that created it. `WITHOUT HOLD` is the default.

query

A `SELECT` command which will provide the rows to be returned by the cursor.

FOR READ ONLY

Cursors can only be used in a read-only mode in Greenplum Database. Greenplum Database does not support updatable cursors (`FOR UPDATE`), so this is the default behavior.

Notes

Unless `WITH HOLD` is specified, the cursor created by this command can only be used within the current transaction. Thus, `DECLARE` without `WITH HOLD` is useless outside a transaction block: the cursor would survive only to the completion of the statement. Therefore Greenplum Database reports an error if this command is used outside a transaction block. Use `BEGIN`, `COMMIT` and `ROLLBACK` to define a transaction block.

If `WITH HOLD` is specified and the transaction that created the cursor successfully commits, the cursor can continue to be accessed by subsequent transactions in the same session. (But if the creating transaction is aborted, the cursor is removed.) A cursor created with `WITH HOLD` is closed when an explicit `CLOSE` command is issued on it, or the session ends. In the current implementation, the rows represented by a held cursor are copied into a temporary file or memory area so that they remain available for subsequent transactions.

Scrollable cursors are not currently supported in Greenplum Database. You can only use `FETCH` to move the cursor position forward, not backwards.

You can see all available cursors by querying the *pg_cursors* system view.

Examples

Declare a cursor:

```
DECLARE mycursor CURSOR FOR SELECT * FROM mytable;
```

Compatibility

SQL standard allows cursors only in embedded SQL and in modules. Greenplum Database permits cursors to be used interactively.

Greenplum Database does not implement an `OPEN` statement for cursors. A cursor is considered to be open when it is declared.

The SQL standard allows cursors to update table data. All Greenplum Database cursors are read only.

The SQL standard allows cursors to move both forward and backward. All Greenplum Database cursors are forward moving only (not scrollable).

Binary cursors are a Greenplum Database extension.

See Also

`CLOSE`, `FETCH`, `SELECT`

DROP DATABASE

Removes a database.

Synopsis

```
DROP DATABASE [IF EXISTS] name
```

Description

`DROP DATABASE` drops a database. It removes the catalog entries for the database and deletes the directory containing the data. It can only be executed by the database owner. Also, it cannot be executed while you or anyone else are connected to the target database. (Connect to *template1* or any other database to issue this command.)

`DROP DATABASE` cannot be undone. Use it with care!

Parameters

IF EXISTS

Do not throw an error if the database does not exist. A notice is issued in this case.

name

The name of the database to remove.

Notes

`DROP DATABASE` cannot be executed inside a transaction block.

This command cannot be executed while connected to the target database. Thus, it might be more convenient to use the program `dropdb` instead, which is a wrapper around this command.

Examples

Drop the database named *testdb*:

```
DROP DATABASE testdb;
```

Compatibility

There is no `DROP DATABASE` statement in the SQL standard.

See Also

CREATE DATABASE

DROP EXTERNAL TABLE

Removes an external table definition.

Synopsis

```
DROP EXTERNAL [WEB] TABLE [IF EXISTS] name [CASCADE | RESTRICT]
```

Description

`DROP EXTERNAL TABLE` drops an existing external table definition from the database system. The external data sources or files are not deleted. To execute this command you must be the owner of the external table.

Parameters

WEB

Optional keyword for dropping external web tables.

IF EXISTS

Do not throw an error if the external table does not exist. A notice is issued in this case.

name

The name (optionally schema-qualified) of an existing external table.

CASCADE

Automatically drop objects that depend on the external table (such as views).

RESTRICT

Refuse to drop the external table if any objects depend on it. This is the default.

Examples

Remove the external table named *staging* if it exists:

```
DROP EXTERNAL TABLE IF EXISTS staging;
```

Compatibility

There is no `DROP EXTERNAL TABLE` statement in the SQL standard.

See Also

`CREATE EXTERNAL TABLE`

DROP FILESPACE

Removes a filespace.

Synopsis

```
DROP FILESPACE [IF EXISTS] filespacename
```

Description

`DROP FILESPACE` removes a filespace definition and its system-generated data directories from the system.

A filespace can only be dropped by its owner or a superuser. The filespace must be empty of all tablespace objects before it can be dropped. It is possible that tablespaces in other databases may still be using a filespace even if no tablespaces in the current database are using the filespace.

Parameters

IF EXISTS

Do not throw an error if the filespace does not exist. A notice is issued in this case.

tablespacename

The name of the filespace to remove.

Examples

Remove the tablespace *myfs*:

```
DROP FILESPACE myfs;
```

Compatibility

There is no `DROP FILESPACE` statement in the SQL standard or in PostgreSQL.

See Also

`gpfilespace`, `DROP TABLESPACE`

DROP GROUP

Removes a database role.

Synopsis

```
DROP GROUP [IF EXISTS] name [, ...]
```

Description

`DROP GROUP` is an obsolete command, though still accepted for backwards compatibility. Groups (and users) have been superseded by the more general concept of roles. See `DROP ROLE` for more information.

Parameters

`IF EXISTS`

Do not throw an error if the role does not exist. A notice is issued in this case.

`name`

The name of an existing role.

Compatibility

There is no `DROP GROUP` statement in the SQL standard.

See Also

`DROP ROLE`

DROP OWNED

Removes database objects owned by a database role.

Synopsis

```
DROP OWNED BY name [, ...] [CASCADE | RESTRICT]
```

Description

`DROP OWNED` drops all the objects in the current database that are owned by one of the specified roles. Any privileges granted to the given roles on objects in the current database will also be revoked.

Parameters

name

The name of a role whose objects will be dropped, and whose privileges will be revoked.

CASCADE

Automatically drop objects that depend on the affected objects.

RESTRICT

Refuse to drop the objects owned by a role if any other database objects depend on one of the affected objects. This is the default.

Notes

`DROP OWNED` is often used to prepare for the removal of one or more roles. Because `DROP OWNED` only affects the objects in the current database, it is usually necessary to execute this command in each database that contains objects owned by a role that is to be removed.

Using the `CASCADE` option may make the command recurse to objects owned by other users.

The `REASSIGN OWNED` command is an alternative that reassigns the ownership of all the database objects owned by one or more roles.

Examples

Remove any database objects owned by the role named *sally*:

```
DROP OWNED BY sally;
```

Compatibility

The `DROP OWNED` statement is a HAWQ extension.

See Also

`REASSIGN OWNED`, `DROP ROLE`

DROP RESOURCE QUEUE

Removes a resource queue.

Synopsis

```
DROP RESOURCE QUEUE queue_name
```

Description

This command removes a workload management resource queue from HAWQ. To drop a resource queue, the queue cannot have any roles assigned to it, nor can it have any statements waiting in the queue. Only a superuser can drop a resource queue.

Parameters

queue_name

The name of a resource queue to remove.

Notes

Use `ALTER ROLE` to remove a user from a resource queue.

To see all the currently active queries for all resource queues, perform the following query of the `pg_locks` table joined with the `pg_roles` and `pg_resqueue` tables:

```
SELECT rolname, rsqname, locktype, objid, transaction, pid,
mode, granted FROM pg_roles, pg_resqueue, pg_locks WHERE
pg_roles.rolresqueue=pg_locks.objid AND
pg_locks.objid=pg_resqueue.oid;
```

To see the roles assigned to a resource queue, perform the following query of the `pg_roles` and `pg_resqueue` system catalog tables:

```
SELECT rolname, rsqname FROM pg_roles, pg_resqueue WHERE
pg_roles.rolresqueue=pg_resqueue.oid;
```

Examples

Remove a role from a resource queue (and move the role to the default resource queue, `pg_default`):

```
ALTER ROLE bob RESOURCE QUEUE NONE;
```

Remove the resource queue named *adhoc*:

```
DROP RESOURCE QUEUE adhoc;
```

Compatibility

The `DROP RESOURCE QUEUE` statement is a HAWQ extension.

See Also

`CREATE RESOURCE QUEUE`, `ALTER ROLE`

DROP ROLE

Removes a database role.

Synopsis

```
DROP ROLE [IF EXISTS] name [, ...]
```

Description

`DROP ROLE` removes the specified role(s). To drop a superuser role, you must be a superuser yourself. To drop non-superuser roles, you must have `CREATEROLE` privilege.

A role cannot be removed if it is still referenced in any database; an error will be raised if so. Before dropping the role, you must drop all the objects it owns (or reassign their ownership) and revoke any privileges the role has been granted. The `REASSIGN OWNED` and `DROP OWNED` commands can be useful for this purpose.

However, it is not necessary to remove role memberships involving the role; `DROP ROLE` automatically revokes any memberships of the target role in other roles, and of other roles in the target role. The other roles are not dropped nor otherwise affected.

Parameters

IF EXISTS

Do not throw an error if the role does not exist. A notice is issued in this case.

name

The name of the role to remove.

Examples

Remove the roles named *sally* and *bob*:

```
DROP ROLE sally, bob;
```

Compatibility

The SQL standard defines `DROP ROLE`, but it allows only one role to be dropped at a time, and it specifies different privilege requirements than HAWQ uses.

See Also

`REASSIGN OWNED`, `DROP OWNED`, `CREATE ROLE`, `ALTER ROLE`, `SET ROLE`

DROP SCHEMA

Removes a schema.

Synopsis

```
DROP SCHEMA [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

Description

`DROP SCHEMA` removes schemas from the database. A schema can only be dropped by its owner or a superuser. Note that the owner can drop the schema (and thereby all contained objects) even if he does not own some of the objects within the schema.

Parameters

IF EXISTS

Do not throw an error if the schema does not exist. A notice is issued in this case.

name

The name of the schema to remove.

CASCADE

Automatically drops any objects contained in the schema (tables, functions, etc.).

RESTRICT

Refuse to drop the schema if it contains any objects. This is the default.

Examples

Remove the schema *mystuff* from the database, along with everything it contains:

```
DROP SCHEMA mystuff CASCADE;
```

Compatibility

`DROP SCHEMA` is fully conforming with the SQL standard, except that the standard only allows one schema to be dropped per command. Also, the `IF EXISTS` option is a HAWQ extension.

See Also

CREATE SCHEMA

DROP SEQUENCE

Removes a sequence.

Synopsis

```
DROP SEQUENCE [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

Description

`DROP SEQUENCE` removes a sequence generator table. You must own the sequence to drop it (or be a superuser).

Parameters

IF EXISTS

Do not throw an error if the sequence does not exist. A notice is issued in this case.

name

The name (optionally schema-qualified) of the sequence to remove.

CASCADE

Automatically drop objects that depend on the sequence.

RESTRICT

Refuse to drop the sequence if any objects depend on it. This is the default.

Examples

Remove the sequence *myserial*:

```
DROP SEQUENCE myserial;
```

Compatibility

`DROP SEQUENCE` is fully conforming with the SQL standard, except that the standard only allows one sequence to be dropped per command. Also, the `IF EXISTS` option is a HAWQ extension.

See Also

CREATE SEQUENCE

DROP TABLE

Removes a table.

Synopsis

```
DROP TABLE [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

Description

`DROP TABLE` removes tables from the database. Only its owner may drop a table. To empty a table of rows without removing the table definition, use `DELETE` or `TRUNCATE`.

`DROP TABLE` always removes any rules and constraints that exist for the target table. However, to drop a table that is referenced by a view, `CASCADE` must be specified. `CASCADE` will remove a dependent view entirely.

Parameters

IF EXISTS

Do not throw an error if the table does not exist. A notice is issued in this case.

name

The name (optionally schema-qualified) of the table to remove.

CASCADE

Automatically drop objects that depend on the table (such as views).

RESTRICT

Refuse to drop the table if any objects depend on it. This is the default.

Examples

Remove the table *mytable*:

```
DROP TABLE mytable;
```

Compatibility

`DROP TABLE` is fully conforming with the SQL standard, except that the standard only allows one table to be dropped per command. Also, the `IF EXISTS` option is a HAWQ extension.

See Also

`CREATE TABLE`, `ALTER TABLE`, `TRUNCATE`

DROP TABLESPACE

Removes a tablespace.

Synopsis

```
DROP TABLESPACE [IF EXISTS] tablespacename
```

Description

`DROP TABLESPACE` removes a tablespace from the system.

A tablespace can only be dropped by its owner or a superuser. The tablespace must be empty of all database objects before it can be dropped. It is possible that objects in other databases may still reside in the tablespace even if no objects in the current database are using the tablespace.

Parameters

IF EXISTS

Do not throw an error if the tablespace does not exist. A notice is issued in this case.

tablespacename

The name of the tablespace to remove.

Examples

Remove the tablespace *mystuff*:

```
DROP TABLESPACE mystuff;
```

Compatibility

`DROP TABLESPACE` is a HAWQ extension.

DROP USER

Removes a database role.

Synopsis

```
DROP USER [IF EXISTS] name [, ...]
```

Description

`DROP USER` is an obsolete command, though still accepted for backwards compatibility. Groups (and users) have been superseded by the more general concept of roles. See `DROP ROLE` for more information.

Parameters

`IF EXISTS`

Do not throw an error if the role does not exist. A notice is issued in this case.

`name`

The name of an existing role.

Compatibility

There is no `DROP USER` statement in the SQL standard. The SQL standard leaves the definition of users to the implementation.

See Also

`DROP ROLE`

DROP VIEW

Removes a view.

Synopsis

```
DROP VIEW [IF EXISTS] name [, ...] [CASCADE | RESTRICT]
```

Description

`DROP VIEW` will remove an existing view. Only the owner of a view can remove it.

Parameters

IF EXISTS

Do not throw an error if the view does not exist. A notice is issued in this case.

name

The name (optionally schema-qualified) of the view to remove.

CASCADE

Automatically drop objects that depend on the view (such as other views).

RESTRICT

Refuse to drop the view if any objects depend on it. This is the default.

Examples

Remove the view *topten*;

```
DROP VIEW topten;
```

Compatibility

`DROP VIEW` is fully conforming with the SQL standard, except that the standard only allows one view to be dropped per command. Also, the `IF EXISTS` option is a HAWQ extension.

See Also

CREATE VIEW

END

Commits the current transaction.

Synopsis

```
END [WORK | TRANSACTION]
```

Description

`END` commits the current transaction. All changes made by the transaction become visible to others and are guaranteed to be durable if a crash occurs. This command is a HAWQ extension that is equivalent to `COMMIT`.

Parameters

WORK
TRANSACTION

Optional keywords. They have no effect.

Examples

Commit the current transaction:

```
END;
```

Compatibility

`END` is a HAWQ extension that provides functionality equivalent to `COMMIT`, which is specified in the SQL standard.

See Also

`BEGIN`, `ROLLBACK`, `COMMIT`

EXECUTE

Executes a prepared SQL statement.

Synopsis

```
EXECUTE name [ (parameter [, ...] ) ]
```

Description

`EXECUTE` is used to execute a previously prepared statement. Since prepared statements only exist for the duration of a session, the prepared statement must have been created by a `PREPARE` statement executed earlier in the current session.

If the `PREPARE` statement that created the statement specified some parameters, a compatible set of parameters must be passed to the `EXECUTE` statement, or else an error is raised. Note that (unlike functions) prepared statements are not overloaded based on the type or number of their parameters; the name of a prepared statement must be unique within a database session.

For more information on the creation and usage of prepared statements, see `PREPARE`.

Parameters

name

The name of the prepared statement to execute.

parameter

The actual value of a parameter to the prepared statement. This must be an expression yielding a value that is compatible with the data type of this parameter, as was determined when the prepared statement was created.

Examples

Create a prepared statement for an `INSERT` statement, and then execute it:

```
PREPARE fooplan (int, text, bool, numeric) AS INSERT INTO
foo VALUES($1, $2, $3, $4);
EXECUTE fooplan(1, 'Hunter Valley', 't', 200.00);
```

Compatibility

The SQL standard includes an `EXECUTE` statement, but it is only for use in embedded SQL. This version of the `EXECUTE` statement also uses a somewhat different syntax.

See Also

`DEALLOCATE`, `PREPARE`

EXPLAIN

Shows the query plan of a statement.

Synopsis

```
EXPLAIN [ANALYZE] [VERBOSE] statement
```

Description

`EXPLAIN` displays the query plan that the HAWQ planner generates for the supplied statement. Query plans are a tree plan of nodes. Each node in the plan represents a single operation, such as table scan, join, aggregation or a sort.

Plans should be read from the bottom up as each node feeds rows into the node directly above it. The bottom nodes of a plan are usually sequential table scan operations. If the query requires joins, aggregations, or sorts (or other operations on the raw rows) then there will be additional nodes above the scan nodes to perform these operations. The topmost plan nodes are usually the HAWQ motion nodes (redistribute, explicit redistribute, broadcast, or gather motions). These are the operations responsible for moving rows between the segment instances during query processing.

The output of `EXPLAIN` has one line for each node in the plan tree, showing the basic node type plus the following cost estimates that the planner made for the execution of that plan node:

- **cost** - measured in units of disk page fetches; that is, 1.0 equals one sequential disk page read. The first estimate is the start-up cost (cost of getting to the first row) and the second is the total cost (cost of getting all rows). Note that the total cost assumes that all rows will be retrieved, which may not always be the case (if using `LIMIT` for example).
- **rows** - the total number of rows output by this plan node. This is usually less than the actual number of rows processed or scanned by the plan node, reflecting the estimated selectivity of any `WHERE` clause conditions. Ideally the top-level nodes estimate will approximate the number of rows actually returned, updated, or deleted by the query.
- **width** - total bytes of all the rows output by this plan node.

It is important to note that the cost of an upper-level node includes the cost of all its child nodes. The topmost node of the plan has the estimated total execution cost for the plan. This is this number that the planner seeks to minimize. It is also important to realize that the cost only reflects things that the query planner cares about. In particular, the cost does not consider the time spent transmitting result rows to the client.

`EXPLAIN ANALYZE` causes the statement to be actually executed, not only planned. The `EXPLAIN ANALYZE` plan shows the actual results along with the planner's estimates. This is useful for seeing whether the planner's estimates are close to reality. In addition to the information shown in the `EXPLAIN` plan, `EXPLAIN ANALYZE` will show the following additional information:

- The total elapsed time (in milliseconds) that it took to run the query.
- The number of *workers* (segments) involved in a plan node operation. Only segments that return rows are counted.
- The maximum number of rows returned by the segment that produced the most rows for an operation. If multiple segments produce an equal number of rows, the one with the longest *time to end* is the one chosen.
- The segment id number of the segment that produced the most rows for an operation.
- For relevant operations, the *work_mem* used by the operation. If `work_mem` was not sufficient to perform the operation in memory, the plan will show how much data was spilled to disk and how many passes over the data were required for the lowest performing segment. For example:

  ```
  Work_mem used: 64K bytes avg, 64K bytes max (seg0).
  Work_mem wanted: 90K bytes avg, 90K bytes max (seg0) to abate workfile
  I/O affecting 2 workers.
  [seg0] pass 0: 488 groups made from 488 rows; 263 rows written to
  workfile
  [seg0] pass 1: 263 groups made from 263 rows
  ```

- The time (in milliseconds) it took to retrieve the first row from the segment that produced the most rows, and the total time taken to retrieve all rows from that segment. The *<time> to first row* may be omitted if it is the same as the *<time> to end*.

Important: Keep in mind that the statement is actually executed when `EXPLAIN ANALYZE` is used. Although `EXPLAIN ANALYZE` will discard any output that a `SELECT` would return, other side effects of the statement will happen as usual. If you wish to use `EXPLAIN ANALYZE` on a DML statement without letting the command affect your data, use this approach:

```
BEGIN;
EXPLAIN ANALYZE ...;
ROLLBACK;
```

Parameters

name

The name of the prepared statement to execute.

parameter

The actual value of a parameter to the prepared statement. This must be an expression yielding a value that is compatible with the data type of this parameter, as was determined when the prepared statement was created.

Notes

In order to allow the query planner to make reasonably informed decisions when optimizing queries, the `ANALYZE` statement should be run to record statistics about the distribution of data within the table. If you have not done this (or if the statistical distribution of the data in the table has changed significantly since the last time `ANALYZE` was run), the estimated costs are unlikely to conform to the real properties of the query, and consequently an inferior query plan may be chosen.

Examples

To illustrate how to read an `EXPLAIN` query plan, consider the following example for a very simple query:

```
EXPLAIN SELECT * FROM names WHERE name = 'Joelle';
                        QUERY PLAN
------------------------------------------------------------
Gather Motion 2:1 (slice1) (cost=0.00..20.88 rows=1 width=13)
   -> Seq Scan on 'names' (cost=0.00..20.88 rows=1 width=13)
         Filter: name::text ~~ 'Joelle'::text
```

If we read the plan from the bottom up, the query planner starts by doing a sequential scan of the *names* table. Notice that the `WHERE` clause is being applied as a *filter* condition. This means that the scan operation checks the condition for each row it scans, and outputs only the ones that pass the condition.

The results of the scan operation are passed up to a *gather motion* operation. In HAWQ, a gather motion is when segments send rows up to the master. In this case we have 2 segment instances sending to 1 master instance (2:1). This operation is working on *slice1* of the parallel query execution plan. In HAWQ a query plan is divided into *slices* so that portions of the query plan can be worked on in parallel by the segments.

The estimated startup cost for this plan is `00.00` (no cost) and a total cost of `20.88` disk page fetches. The planner is estimating that this query will return one row.

Compatibility

There is no `EXPLAIN` statement defined in the SQL standard.

See Also

`ANALYZE`

FETCH

Retrieves rows from a query using a cursor.

Synopsis

```
FETCH [ forward_direction { FROM | IN } ] cursorname
```

where forward_direction can be empty or one of:

```
NEXT
FIRST
LAST
ABSOLUTE count
RELATIVE count
count
ALL
FORWARD
FORWARD count
FORWARD ALL
```

Description

`FETCH` retrieves rows using a previously-created cursor.

A cursor has an associated position, which is used by `FETCH`. The cursor position can be before the first row of the query result, on any particular row of the result, or after the last row of the result. When created, a cursor is positioned before the first row. After fetching some rows, the cursor is positioned on the row most recently retrieved. If `FETCH` runs off the end of the available rows then the cursor is left positioned after the last row. `FETCH ALL` will always leave the cursor positioned after the last row.

The forms `NEXT`, `FIRST`, `LAST`, `ABSOLUTE`, `RELATIVE` fetch a single row after moving the cursor appropriately. If there is no such row, an empty result is returned, and the cursor is left positioned before the first row or after the last row as appropriate.

The forms using `FORWARD` retrieve the indicated number of rows moving in the forward direction, leaving the cursor positioned on the last-returned row (or after all rows, if the count exceeds the number of rows available). Note that it is not possible to move a cursor position backwards in HAWQ, since scrollable cursors are not supported. You can only move a cursor forward in position using `FETCH`.

`RELATIVE 0` and `FORWARD 0` request fetching the current row without moving the cursor, that is, re-fetching the most recently fetched row. This will succeed unless the cursor is positioned before the first row or after the last row, in which case no row is returned.

Outputs

On successful completion, a `FETCH` command returns a command tag of the form

```
FETCH count
```

The count is the number of rows fetched (possibly zero). Note that in `psql`, the command tag will not actually be displayed, since `psql` displays the fetched rows instead.

Parameters

forward_direction

Defines the fetch direction and number of rows to fetch. Only forward fetches are allowed in HAWQ. It can be one of the following:

NEXT

Fetch the next row. This is the default if direction is omitted.

FIRST

Fetch the first row of the query (same as `ABSOLUTE 1`). Only allowed if it is the first `FETCH` operation using this cursor.

LAST

Fetch the last row of the query (same as `ABSOLUTE -1`).

ABSOLUTE *count*

Fetch the specified row of the query. Position after last row if count is out of range. Only allowed if the row specified by *count* moves the cursor position forward.

RELATIVE *count*

Fetch the specified row of the query *count* rows ahead of the current cursor position. `RELATIVE 0` re-fetches the current row, if any. Only allowed if *count* moves the cursor position forward.

count

Fetch the next *count* number of rows (same as `FORWARD` *count*).

ALL

Fetch all remaining rows (same as `FORWARD ALL`).

FORWARD

Fetch the next row (same as `NEXT`).

FORWARD *count*

Fetch the next *count* number of rows. `FORWARD 0` re-fetches the current row.

FORWARD ALL

Fetch all remaining rows.

cursorname

The name of an open cursor.

Notes

HAWQ does not support scrollable cursors, so you can only use `FETCH` to move the cursor position forward.

`ABSOLUTE` fetches are not any faster than navigating to the desired row with a relative move: the underlying implementation must traverse all the intermediate rows anyway.

Updating data via a cursor is currently not supported by HAWQ.

`DECLARE` is used to define a cursor. Use `MOVE` to change cursor position without retrieving data.

Examples

-- Start the transaction:

```
BEGIN;
```

-- Set up a cursor:

```
DECLARE mycursor CURSOR FOR SELECT * FROM films;
```

-- Fetch the first 5 rows in the cursor *mycursor*:

```
FETCH FORWARD 5 FROM mycursor;
 code  |          title          | did | date_prod  |   kind   |  len
-------+-------------------------+-----+------------+----------+------
-
 BL101 | The Third Man           | 101 | 1949-12-23 | Drama    | 01:44
 BL102 | The African Queen       | 101 | 1951-08-11 | Romantic | 01:43
 JL201 | Une Femme est une Femme | 102 | 1961-03-12 | Romantic | 01:25
 P_301 | Vertigo                 | 103 | 1958-11-14 | Action   | 02:08
 P_302 | Becket                  | 103 | 1964-02-03 | Drama    | 02:28
```

-- Close the cursor and end the transaction:

```
CLOSE mycursor;
COMMIT;
```

Compatibility

SQL standard allows cursors only in embedded SQL and in modules. HAWQ permits cursors to be used interactively.

The variant of `FETCH` described here returns the data as if it were a `SELECT` result rather than placing it in host variables. Other than this point, `FETCH` is fully upward-compatible with the SQL standard.

The `FETCH` forms involving `FORWARD`, as well as the forms `FETCH` count and `FETCH ALL`, in which `FORWARD` is implicit, are HAWQ extensions. `BACKWARD` is not supported.

The SQL standard allows only `FROM` preceding the cursor name; the option to use `IN` is an extension.

See Also

DECLARE, CLOSE

GRANT

Defines access privileges.

Synopsis

```
GRANT { {SELECT | INSERT | UPDATE | DELETE | REFERENCES |
TRIGGER} [,...] | ALL [PRIVILEGES] }
    ON [TABLE] tablename [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { {USAGE | SELECT | UPDATE} [,...] | ALL [PRIVILEGES] }
    ON SEQUENCE sequencename [, ...]
    TO { rolename | PUBLIC } [, ...] [WITH GRANT OPTION]

GRANT { {CREATE | CONNECT | TEMPORARY | TEMP} [,...] | ALL
[PRIVILEGES] }
    ON DATABASE dbname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { EXECUTE | ALL [PRIVILEGES] }
    ON FUNCTION funcname ( [ [argmode] [argname] argtype [, ...]
] ) [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { USAGE | ALL [PRIVILEGES] }
    ON LANGUAGE langname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { {CREATE | USAGE} [,...] | ALL [PRIVILEGES] }
    ON SCHEMA schemaname [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT { CREATE | ALL [PRIVILEGES] }
    ON TABLESPACE tablespacename [, ...]
    TO {rolename | PUBLIC} [, ...] [WITH GRANT OPTION]

GRANT parent_role [, ...]
    TO member_role [, ...] [WITH ADMIN OPTION]

GRANT { SELECT | INSERT | ALL [PRIVILEGES] }
    ON PROTOCOL protocolname
    TO username
```

Description

The `GRANT` command has two basic variants: one that grants privileges on a database object (table, view, sequence, database, function, procedural language, schema, or tablespace), and one that grants membership in a role.

GRANT on Database Objects

This variant of the `GRANT` command gives specific privileges on a database object to one or more roles. These privileges are added to those already granted, if any.

The key word `PUBLIC` indicates that the privileges are to be granted to all roles, including those that may be created later. `PUBLIC` may be thought of as an implicitly defined group-level role that always includes all roles. Any particular role will have the sum of privileges granted directly to it, privileges granted to any role it is presently a member of, and privileges granted to `PUBLIC`.

If `WITH GRANT OPTION` is specified, the recipient of the privilege may in turn grant it to others. Without a grant option, the recipient cannot do that. Grant options cannot be granted to `PUBLIC`.

There is no need to grant privileges to the owner of an object (usually the role that created it), as the owner has all privileges by default. The right to drop an object, or to alter its definition in any way is not described by a grantable privilege; it is inherent in the owner, and cannot be granted or revoked. The owner implicitly has all grant options for the object, too.

Depending on the type of object, the initial default privileges may include granting some privileges to `PUBLIC`. The default is no public access for tables, schemas, and tablespaces; `CONNECT` privilege and `TEMP` table creation privilege for databases; `EXECUTE` privilege for functions; and `USAGE` privilege for languages. The object owner may of course revoke these privileges.

Grant on Roles

This variant of the `GRANT` command grants membership in a role to one or more other roles. Membership in a role is significant because it conveys the privileges granted to a role to each of its members.

If `WITH ADMIN OPTION` is specified, the member may in turn grant membership in the role to others, and revoke membership in the role as well. Database superusers can grant or revoke membership in any role to anyone. Roles having `CREATEROLE` privilege can grant or revoke membership in any role that is not a superuser.

Unlike the case with privileges, membership in a role cannot be granted to `PUBLIC`.

Grant on Protocols

After creating a custom protocol, specify `CREATE TRUSTED PROTOCOL` to be able to allowing any user besides the owner to access it. If the protocol is not trusted, you cannot give any other user permission to use it to read or write data. After a `TRUSTED` protocol is created, you can specify which other users can access it with the `GRANT` command.

- To allow a user to create a readable external table with a trusted protocol

  `GRANT SELECT ON PROTOCOL` *`protocolname`* `TO` *`username`*

- To allow a user to create a writable external table with a trusted protocol

  `GRANT INSERT ON PROTOCOL` *`protocolname`* `TO` *`username`*

- To allow a user to create both readable and writable external table with a trusted protocol

  `GRANT ALL ON PROTOCOL` *`protocolname`* `TO` *`username`*

Parameters

SELECT

Allows `SELECT` from any column of the specified table, view, or sequence. Also allows the use of `COPY TO`. For sequences, this privilege also allows the use of the `currval` function.

INSERT

Allows `INSERT` of a new row into the specified table. Also allows `COPY FROM`.

UPDATE

Allows `UPDATE` of any column of the specified table. `SELECT ... FOR UPDATE` and `SELECT ... FOR SHARE` also require this privilege (as well as the `SELECT` privilege). For sequences, this privilege allows the use of the `nextval` and `setval` functions.

DELETE

Allows `DELETE` of a row from the specified table.

REFERENCES

This keyword is accepted, although foreign key constraints are currently not supported in HAWQ. To create a foreign key constraint, it is necessary to have this privilege on both the referencing and referenced tables.

TRIGGER

Allows the creation of a trigger on the specified table.

CREATE

For databases, allows new schemas to be created within the database.

For schemas, allows new objects to be created within the schema. To rename an existing object, you must own the object and have this privilege for the containing schema.

For tablespaces, allows tables to be created within the tablespace, and allows databases to be created that have the tablespace as their default tablespace. (Note that revoking this privilege will not alter the placement of existing objects.)

CONNECT

Allows the user to connect to the specified database. This privilege is checked at connection startup (in addition to checking any restrictions imposed by `pg_hba.conf`).

TEMPORARY
TEMP

Allows temporary tables to be created while using the database.

EXECUTE

Allows the use of the specified function and the use of any operators that are implemented on top of the function. This is the only type of privilege that is applicable to functions. (This syntax works for aggregate functions, as well.)

USAGE

For procedural languages, allows the use of the specified language for the creation of functions in that language. This is the only type of privilege that is applicable to procedural languages.

For schemas, allows access to objects contained in the specified schema (assuming that the objects' own privilege requirements are also met). Essentially this allows the grantee to look up objects within the schema.

For sequences, this privilege allows the use of the `currval` and `nextval` functions.

ALL PRIVILEGES

Grant all of the available privileges at once. The `PRIVILEGES` key word is optional in HAWQ, though it is required by strict SQL.

PUBLIC

A special group-level role that denotes that the privileges are to be granted to all roles, including those that may be created later.

WITH GRANT OPTION

The recipient of the privilege may in turn grant it to others.

WITH ADMIN OPTION

The member of a role may in turn grant membership in the role to others.

Notes

Database superusers can access all objects regardless of object privilege settings. One exception to this rule is view objects. Access to tables referenced in the view is determined by permissions of the view owner not the current user (even if the current user is a superuser).

If a superuser chooses to issue a `GRANT` or `REVOKE` command, the command is performed as though it were issued by the owner of the affected object. In particular, privileges granted via such a command will appear to have been granted by the object owner. For role membership, the membership appears to have been granted by the containing role itself.

`GRANT` and `REVOKE` can also be done by a role that is not the owner of the affected object, but is a member of the role that owns the object, or is a member of a role that holds privileges `WITH GRANT OPTION` on the object. In this case the privileges will be recorded as having been granted by the role that actually owns the object or holds the privileges `WITH GRANT OPTION`.

Granting permission on a table does not automatically extend permissions to any sequences used by the table, including sequences tied to `SERIAL` columns. Permissions on a sequence must be set separately.

HAWQ does not support granting or revoking privileges for individual columns of a table. One possible workaround is to create a view having just the desired columns and then grant privileges to that view.

Use psql's `\z` meta-command to obtain information about existing privileges for an object.

Examples

Grant insert privilege to all roles on table *mytable*:

```
GRANT INSERT ON mytable TO PUBLIC;
```

Grant all available privileges to role *sally* on the view *topten*. Note that while the above will indeed grant all privileges if executed by a superuser or the owner of *topten*, when executed by someone else it will only grant those permissions for which the granting role has grant options.

```
GRANT ALL PRIVILEGES ON topten TO sally;
```

Grant membership in role *admins* to user *joe*:

```
GRANT admins TO joe;
```

Compatibility

The `PRIVILEGES` key word in is required in the SQL standard, but optional in HAWQ. The SQL standard does not support setting the privileges on more than one object per command.

HAWQ allows an object owner to revoke his own ordinary privileges: for example, a table owner can make the table read-only to himself by revoking his own `INSERT`, `UPDATE`, and `DELETE` privileges. This is not possible according to the SQL standard. HAWQ treats the owner's privileges as having been granted by the owner to himself; therefore he can revoke them too. In the SQL standard, the owner's privileges are granted by an assumed *system* entity.

The SQL standard allows setting privileges for individual columns within a table.

The SQL standard provides for a `USAGE` privilege on other kinds of objects: character sets, collations, translations, domains.

Privileges on databases, tablespaces, schemas, and languages are HAWQ extensions.

See Also

`REVOKE`

INSERT

Creates new rows in a table.

Synopsis

```
INSERT INTO table [( column [, ...] )]
   {DEFAULT VALUES | VALUES ( {expression | DEFAULT} [, ...] )
[, ...] | query}
```

Description

`INSERT` inserts new rows into a table. One can insert one or more rows specified by value expressions, or zero or more rows resulting from a query.

The target column names may be listed in any order. If no list of column names is given at all, the default is the columns of the table in their declared order. The values supplied by the `VALUES` clause or query are associated with the explicit or implicit column list left-to-right.

Each column not present in the explicit or implicit column list will be filled with a default value, either its declared default value or null if there is no default.

If the expression for any column is not of the correct data type, automatic type conversion will be attempted.

You must have `INSERT` privilege on a table in order to insert into it.

Note. Greenplum supports 127 concurrent inserts currently.

Outputs

On successful completion, an INSERT command returns a command tag of the form:

```
INSERT oid count
```

The *`count`* is the number of rows inserted. If count is exactly one, and the target table has OIDs, then *`oid`* is the OID assigned to the inserted row. Otherwise *`oid`* is zero.

Parameters

table

The name (optionally schema-qualified) of an existing table.

column

The name of a column in table. The column name can be qualified with a subfield name or array subscript, if needed. (Inserting into only some fields of a composite column leaves the other fields null.)

DEFAULT VALUES

All columns will be filled with their default values.

expression

An expression or value to assign to the corresponding column.

DEFAULT

The corresponding column will be filled with its default value.

query

A query (`SELECT` statement) that supplies the rows to be inserted. Refer to the `SELECT` statement for a description of the syntax.

Examples

Insert a single row into table *films*:

```
INSERT INTO films VALUES ('UA502', 'Bananas', 105,
'1971-07-13', 'Comedy', '82 minutes');
```

In this example, the *length* column is omitted and therefore it will have the default value:

```
INSERT INTO films (code, title, did, date_prod, kind) VALUES
('T_601', 'Yojimbo', 106, '1961-06-16', 'Drama');
```

This example uses the `DEFAULT` clause for the *date_prod* column rather than specifying a value:

```
INSERT INTO films VALUES ('UA502', 'Bananas', 105, DEFAULT,
'Comedy', '82 minutes');
```

To insert a row consisting entirely of default values:

```
INSERT INTO films DEFAULT VALUES;
```

To insert multiple rows using the multirow `VALUES` syntax:

```
INSERT INTO films (code, title, did, date_prod, kind) VALUES
    ('B6717', 'Tampopo', 110, '1985-02-10', 'Comedy'),
    ('HG120', 'The Dinner Game', 140, DEFAULT, 'Comedy');
```

This example inserts some rows into table *films* from a table *tmp_films* with the same column layout as *films*:

```
INSERT INTO films SELECT * FROM tmp_films WHERE date_prod <
'2004-05-07';
```

Compatibility

`INSERT` conforms to the SQL standard. The case in which a column name list is omitted, but not all the columns are filled from the `VALUES` clause or query, is disallowed by the standard.

Possible limitations of the *`query`* clause are documented under `SELECT`.

See Also

`COPY`, `SELECT`, `CREATE EXTERNAL TABLE`

PREPARE

Prepare a statement for execution.

Synopsis

```
PREPARE name [ (datatype [, ...] ) ] AS statement
```

Description

`PREPARE` creates a prepared statement, possibly with unbound parameters. A prepared statement is a server-side object that can be used to optimize performance. A prepared statement may be subsequently executed with a binding for its parameters. HAWQ may choose to replan the query for different executions of the same prepared statement.

Prepared statements can take parameters: values that are substituted into the statement when it is executed. When creating the prepared statement, refer to parameters by position, using `$1`, `$2`, etc. A corresponding list of parameter data types can optionally be specified. When a parameter's data type is not specified or is declared as unknown, the type is inferred from the context in which the parameter is used (if possible). When executing the statement, specify the actual values for these parameters in the `EXECUTE` statement.

Prepared statements only last for the duration of the current database session. When the session ends, the prepared statement is forgotten, so it must be recreated before being used again. This also means that a single prepared statement cannot be used by multiple simultaneous database clients; however, each client can create their own prepared statement to use. The prepared statement can be manually cleaned up using the `DEALLOCATE` command.

Prepared statements have the largest performance advantage when a single session is being used to execute a large number of similar statements. The performance difference will be particularly significant if the statements are complex to plan or rewrite, for example, if the query involves a join of many tables or requires the application of several rules. If the statement is relatively simple to plan and rewrite but relatively expensive to execute, the performance advantage of prepared statements will be less noticeable.

Parameters

name

An arbitrary name given to this particular prepared statement. It must be unique within a single session and is subsequently used to execute or deallocate a previously prepared statement.

datatype

The data type of a parameter to the prepared statement. If the data type of a particular parameter is unspecified or is specified as unknown, it will be inferred from the context in which the parameter is used. To refer to the parameters in the prepared statement itself, use `$1`, `$2`, etc.

statement

Any `SELECT`, `INSERT`, `UPDATE`, `DELETE`, or `VALUES` statement.

Notes

In some situations, the query plan produced for a prepared statement will be inferior to the query plan that would have been chosen if the statement had been submitted and executed normally. This is because when the statement is planned and the planner attempts to determine the optimal query plan, the actual values of any parameters specified in the statement are unavailable. HAWQ collects statistics on the distribution of data in the table, and can use constant values in a statement to make guesses about the likely result of executing the statement. Since this data is unavailable when planning prepared statements with parameters, the chosen plan may be suboptimal. To examine the query plan HAWQ has chosen for a prepared statement, use `EXPLAIN`.

For more information on query planning and the statistics collected by HAWQ for that purpose, see the `ANALYZE` documentation.

You can see all available prepared statements of a session by querying the *pg_prepared_statements* system view.

Examples

Create a prepared statement for an `INSERT` statement, and then execute it:

```
PREPARE fooplan (int, text, bool, numeric) AS INSERT INTO
foo VALUES($1, $2, $3, $4);
EXECUTE fooplan(1, 'Hunter Valley', 't', 200.00);
```

Create a prepared statement for a `SELECT` statement, and then execute it. Note that the data type of the second parameter is not specified, so it is inferred from the context in which `$2` is used:

```
PREPARE usrrptplan (int) AS SELECT * FROM users u, logs l
WHERE u.usrid=$1 AND u.usrid=l.usrid AND l.date = $2;
EXECUTE usrrptplan(1, current_date);
```

Compatibility

The SQL standard includes a `PREPARE` statement, but it is only for use in embedded SQL. This version of the `PREPARE` statement also uses a somewhat different syntax.

See Also

`EXECUTE`, `DEALLOCATE`

REASSIGN OWNED

Changes the ownership of database objects owned by a database role.

Synopsis

```
REASSIGN OWNED BY old_role [, ...] TO new_role
```

Description

`REASSIGN OWNED` reassigns all the objects in the current database that are owned by *`old_row`* to *`new_role`*. Note that it does not change the ownership of the database itself.

Parameters

old_role

The name of a role. The ownership of all the objects in the current database owned by this role will be reassigned to *`new_role`*.

new_role

The name of the role that will be made the new owner of the affected objects.

Notes

`REASSIGN OWNED` is often used to prepare for the removal of one or more roles. Because `REASSIGN OWNED` only affects the objects in the current database, it is usually necessary to execute this command in each database that contains objects owned by a role that is to be removed.

The `DROP OWNED` command is an alternative that drops all the database objects owned by one or more roles.

The `REASSIGN OWNED` command does not affect the privileges granted to the old roles in objects that are not owned by them. Use `DROP OWNED` to revoke those privileges.

Examples

Reassign any database objects owned by the role named *sally* and *bob* to *admin*;

```
REASSIGN OWNED BY sally, bob TO admin;
```

Compatibility

The `REASSIGN OWNED` statement is a HAWQ extension.

See Also

`DROP OWNED`, `DROP ROLE`

RELEASE SAVEPOINT

Destroys a previously defined savepoint.

Synopsis

```
RELEASE [SAVEPOINT] savepoint_name
```

Description

`RELEASE SAVEPOINT` destroys a savepoint previously defined in the current transaction.

Destroying a savepoint makes it unavailable as a rollback point, but it has no other user visible behavior. It does not undo the effects of commands executed after the savepoint was established. (To do that, see `ROLLBACK TO SAVEPOINT`.) Destroying a savepoint when it is no longer needed may allow the system to reclaim some resources earlier than transaction end.

`RELEASE SAVEPOINT` also destroys all savepoints that were established *after* the named savepoint was established.

Parameters

savepoint_name

The name of the savepoint to destroy.

Examples

To establish and later destroy a savepoint:

```
BEGIN;
    INSERT INTO table1 VALUES (3);
    SAVEPOINT my_savepoint;
    INSERT INTO table1 VALUES (4);
    RELEASE SAVEPOINT my_savepoint;
COMMIT;
```

The above transaction will insert both 3 and 4.

Compatibility

This command conforms to the SQL standard. The standard specifies that the key word `SAVEPOINT` is mandatory, but HAWQ allows it to be omitted.

See Also

`BEGIN`, `SAVEPOINT`, `ROLLBACK TO SAVEPOINT`, `COMMIT`

RESET

Restores the value of a system configuration parameter to the default value.

Synopsis

```
RESET configuration_parameter

RESET ALL
```

Description

`RESET` restores system configuration parameters to their default values. `RESET` is an alternative spelling for `SET configuration_parameter TO DEFAULT`.

The default value is defined as the value that the parameter would have had, had no `SET` ever been issued for it in the current session. The actual source of this value might be a compiled-in default, the master `postgresql.conf` configuration file, command-line options, or per-database or per-user default settings. See "Server Configuration Parameters" on page 368.

Parameters

configuration_parameter

The name of a system configuration parameter. See "Server Configuration Parameters" on page 368 for details.

ALL

Resets all settable configuration parameters to their default values.

Examples

Set the *work_mem* configuration parameter to its default value:

```
RESET work_mem;
```

Compatibility

`RESET` is a HAWQ extension.

See Also

`SET`

REVOKE

Removes access privileges.

Synopsis

```
REVOKE [GRANT OPTION FOR] { {SELECT | INSERT | UPDATE | DELETE
       | REFERENCES | TRIGGER} [,...] | ALL [PRIVILEGES] }
       ON [TABLE] tablename [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { {USAGE | SELECT | UPDATE} [,...]
       | ALL [PRIVILEGES] }
       ON SEQUENCE sequencename [, ...]
       FROM { rolename | PUBLIC } [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { {CREATE | CONNECT
       | TEMPORARY | TEMP} [,...] | ALL [PRIVILEGES] }
       ON DATABASE dbname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] {EXECUTE | ALL [PRIVILEGES]}
       ON FUNCTION funcname ( [[argmode] [argname] argtype
                              [, ...]] ) [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] {USAGE | ALL [PRIVILEGES]}
       ON LANGUAGE langname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [ CASCADE | RESTRICT ]

REVOKE [GRANT OPTION FOR] { {CREATE | USAGE} [,...]
       | ALL [PRIVILEGES] }
       ON SCHEMA schemaname [, ...]
       FROM {rolename | PUBLIC} [, ...]
       [CASCADE | RESTRICT]

REVOKE [GRANT OPTION FOR] { CREATE | ALL [PRIVILEGES] }
       ON TABLESPACE tablespacename [, ...]
       FROM { rolename | PUBLIC } [, ...]
       [CASCADE | RESTRICT]

REVOKE [ADMIN OPTION FOR] parent_role [, ...]
       FROM member_role [, ...]
       [CASCADE | RESTRICT]
```

Description

`REVOKE` command revokes previously granted privileges from one or more roles. The key word `PUBLIC` refers to the implicitly defined group of all roles.

See the description of the `GRANT` command for the meaning of the privilege types.

Note that any particular role will have the sum of privileges granted directly to it, privileges granted to any role it is presently a member of, and privileges granted to `PUBLIC`. Thus, for example, revoking `SELECT` privilege from `PUBLIC` does not necessarily mean that all roles have lost `SELECT` privilege on the object: those who have it granted directly or via another role will still have it.

If `GRANT OPTION FOR` is specified, only the grant option for the privilege is revoked, not the privilege itself. Otherwise, both the privilege and the grant option are revoked.

If a role holds a privilege with grant option and has granted it to other roles then the privileges held by those other roles are called dependent privileges. If the privilege or the grant option held by the first role is being revoked and dependent privileges exist, those dependent privileges are also revoked if `CASCADE` is specified, else the revoke action will fail. This recursive revocation only affects privileges that were granted through a chain of roles that is traceable to the role that is the subject of this `REVOKE` command. Thus, the affected roles may effectively keep the privilege if it was also granted through other roles.

When revoking membership in a role, `GRANT OPTION` is instead called `ADMIN OPTION`, but the behavior is similar.

Parameters

See `GRANT`.

Examples

Revoke insert privilege for the public on table *films*:

```
REVOKE INSERT ON films FROM PUBLIC;
```

Revoke all privileges from role *sally* on view *topten*. Note that this actually means revoke all privileges that the current role granted (if not a superuser).

```
REVOKE ALL PRIVILEGES ON topten FROM sally;
```

Revoke membership in role *admins* from user *joe*:

```
REVOKE admins FROM joe;
```

Compatibility

The compatibility notes of the `GRANT` command also apply to `REVOKE`.

One of `RESTRICT` or `CASCADE` is required according to the standard, but HAWQ assumes `RESTRICT` by default.

See Also

GRANT

ROLLBACK

Aborts the current transaction.

Synopsis

```
ROLLBACK [WORK | TRANSACTION]
```

Description

`ROLLBACK` rolls back the current transaction and causes all the updates made by the transaction to be discarded.

Parameters

WORK
TRANSACTION

Optional key words. They have no effect.

Notes

Use `COMMIT` to successfully end the current transaction.

Issuing `ROLLBACK` when not inside a transaction does no harm, but it will provoke a warning message.

Examples

To discard all changes made in the current transaction:

```
ROLLBACK;
```

Compatibility

The SQL standard only specifies the two forms `ROLLBACK` and `ROLLBACK WORK`. Otherwise, this command is fully conforming.

See Also

`BEGIN`, `COMMIT`, `SAVEPOINT`, `ROLLBACK TO SAVEPOINT`

ROLLBACK TO SAVEPOINT

Rolls back the current transaction to a savepoint.

Synopsis

```
ROLLBACK [WORK | TRANSACTION] TO [SAVEPOINT] savepoint_name
```

Description

This command will roll back all commands that were executed after the savepoint was established. The savepoint remains valid and can be rolled back to again later, if needed.

`ROLLBACK TO SAVEPOINT` implicitly destroys all savepoints that were established after the named savepoint.

Parameters

WORK
TRANSACTION

Optional key words. They have no effect.

savepoint_name

The name of a savepoint to roll back to.

Notes

Use `RELEASE SAVEPOINT` to destroy a savepoint without discarding the effects of commands executed after it was established.

Specifying a savepoint name that has not been established is an error.

Cursors have somewhat non-transactional behavior with respect to savepoints. Any cursor that is opened inside a savepoint will be closed when the savepoint is rolled back. If a previously opened cursor is affected by a `FETCH` command inside a savepoint that is later rolled back, the cursor position remains at the position that `FETCH` left it pointing to (that is, `FETCH` is not rolled back). Closing a cursor is not undone by rolling back, either. A cursor whose execution causes a transaction to abort is put in a can't-execute state, so while the transaction can be restored using `ROLLBACK TO SAVEPOINT`, the cursor can no longer be used.

Examples

To undo the effects of the commands executed after *my_savepoint* was established:

```
ROLLBACK TO SAVEPOINT my_savepoint;
```

Cursor positions are not affected by a savepoint rollback:

```
BEGIN;
DECLARE foo CURSOR FOR SELECT 1 UNION SELECT 2;
```

```
SAVEPOINT foo;
FETCH 1 FROM foo;
column
----------
        1
ROLLBACK TO SAVEPOINT foo;
FETCH 1 FROM foo;
column
----------
        2
COMMIT;
```

Compatibility

The SQL standard specifies that the key word `SAVEPOINT` is mandatory, but HAWQ (and Oracle) allow it to be omitted. SQL allows only `WORK`, not `TRANSACTION`, as a noise word after `ROLLBACK`. Also, SQL has an optional clause `AND [NO] CHAIN` which is not currently supported by HAWQ. Otherwise, this command conforms to the SQL standard.

See Also

`BEGIN`, `COMMIT`, `SAVEPOINT`, `RELEASE SAVEPOINT`, `ROLLBACK`

SAVEPOINT

Defines a new savepoint within the current transaction.

Synopsis

```
SAVEPOINT savepoint_name
```

Description

`SAVEPOINT` establishes a new savepoint within the current transaction.

A savepoint is a special mark inside a transaction that allows all commands that are executed after it was established to be rolled back, restoring the transaction state to what it was at the time of the savepoint.

Parameters

savepoint_name

The name of the new savepoint.

Notes

Use `ROLLBACK TO SAVEPOINT` to rollback to a savepoint. Use `RELEASE SAVEPOINT` to destroy a savepoint, keeping the effects of commands executed after it was established.

Savepoints can only be established when inside a transaction block. There can be multiple savepoints defined within a transaction.

Examples

To establish a savepoint and later undo the effects of all commands executed after it was established:

```
BEGIN;
    INSERT INTO table1 VALUES (1);
    SAVEPOINT my_savepoint;
    INSERT INTO table1 VALUES (2);
    ROLLBACK TO SAVEPOINT my_savepoint;
    INSERT INTO table1 VALUES (3);
COMMIT;
```

The above transaction will insert the values 1 and 3, but not 2.

To establish and later destroy a savepoint:

```
BEGIN;
    INSERT INTO table1 VALUES (3);
```

```
        SAVEPOINT my_savepoint;
        INSERT INTO table1 VALUES (4);
        RELEASE SAVEPOINT my_savepoint;
    COMMIT;
```

The above transaction will insert both 3 and 4.

Compatibility

SQL requires a savepoint to be destroyed automatically when another savepoint with the same name is established. In HAWQ, the old savepoint is kept, though only the more recent one will be used when rolling back or releasing. (Releasing the newer savepoint will cause the older one to again become accessible to `ROLLBACK TO SAVEPOINT` and `RELEASE SAVEPOINT`.) Otherwise, `SAVEPOINT` is fully SQL conforming.

See Also

`BEGIN`, `COMMIT`, `ROLLBACK`, `RELEASE SAVEPOINT`, `ROLLBACK TO SAVEPOINT`

SELECT

Retrieves rows from a table or view.

Synopsis

```
SELECT [ALL | DISTINCT [ON (expression [, ...])]]
  * | expression [[AS] output_name] [, ...]
  [FROM from_item [, ...]]
  [WHERE condition]
  [GROUP BY grouping_element [, ...]]
  [HAVING condition [, ...]]
  [WINDOW window_name AS (window_specification)]
  [{UNION | INTERSECT | EXCEPT} [ALL] select]
  [ORDER BY expression [ASC | DESC | USING operator] [, ...]]
  [LIMIT {count | ALL}]
  [OFFSET start]
```

where *grouping_element* can be one of:

```
  ()
  expression
  ROLLUP (expression [,...])
  CUBE (expression [,...])
  GROUPING SETS ((grouping_element [, ...]))
```

where *window_specification* can be:

```
  [window_name]
  [PARTITION BY expression [, ...]]
  [ORDER BY expression [ASC | DESC | USING operator] [, ...]
     [{RANGE | ROWS}
          { UNBOUNDED PRECEDING
          | expression PRECEDING
          | CURRENT ROW
          | BETWEEN window_frame_bound AND window_frame_bound }]]
```

where *window_frame_bound* can be one of:

```
    UNBOUNDED PRECEDING
    expression PRECEDING
    CURRENT ROW
    expression FOLLOWING
    UNBOUNDED FOLLOWING
```

where *from_item* can be one of:

```
[ONLY] table_name [[AS] alias [( column_alias [, ...] )]]
(select) [AS] alias [( column_alias [, ...] )]
function_name ( [argument [, ...]] ) [AS] alias
             [( column_alias [, ...]
                | column_definition [, ...] )]
function_name ( [argument [, ...]] ) AS
              ( column_definition [, ...] )
from_item [NATURAL] join_type from_item
```

```
[ON join_condition | USING ( join_column [, ...] )]
```

Description

`SELECT` retrieves rows from zero or more tables. The general processing of `SELECT` is as follows:

1. All elements in the `FROM` list are computed. (Each element in the `FROM` list is a real or virtual table.) If more than one element is specified in the `FROM` list, they are cross-joined together.
2. If the `WHERE` clause is specified, all rows that do not satisfy the condition are eliminated from the output.
3. If the `GROUP BY` clause is specified, the output is divided into groups of rows that match on one or more of the defined grouping elements. If the `HAVING` clause is present, it eliminates groups that do not satisfy the given condition.
4. If a window expression is specified (and optional `WINDOW` clause), the output is organized according to the positional (row) or value-based (range) window frame.
5. `DISTINCT` eliminates duplicate rows from the result. `DISTINCT ON` eliminates rows that match on all the specified expressions. `ALL` (the default) will return all candidate rows, including duplicates.
6. The actual output rows are computed using the `SELECT` output expressions for each selected row.
7. Using the operators `UNION`, `INTERSECT`, and `EXCEPT`, the output of more than one `SELECT` statement can be combined to form a single result set. The `UNION` operator returns all rows that are in one or both of the result sets. The `INTERSECT` operator returns all rows that are strictly in both result sets. The `EXCEPT` operator returns the rows that are in the first result set but not in the second. In all three cases, duplicate rows are eliminated unless `ALL` is specified.
8. If the `ORDER BY` clause is specified, the returned rows are sorted in the specified order. If `ORDER BY` is not given, the rows are returned in whatever order the system finds fastest to produce.
9. If the `LIMIT` or `OFFSET` clause is specified, the `SELECT` statement only returns a subset of the result rows.

You must have `SELECT` privilege on a table to read its values.

Parameters

The SELECT List

The `SELECT` list (between the key words `SELECT` and `FROM`) specifies expressions that form the output rows of the `SELECT` statement. The expressions can (and usually do) refer to columns computed in the `FROM` clause.

Using the clause `[AS] output_name`, another name can be specified for an output column. This name is primarily used to label the column for display. It can also be used to refer to the column's value in `ORDER BY` and `GROUP BY` clauses, but not in the `WHERE` or `HAVING` clauses; there you must write out the expression instead. The `AS` keyword is optional in most cases (such as when declaring an alias for column names, constants, function calls, and simple unary operator expressions). In cases where the declared alias is a reserved SQL keyword, the *`output_name`* must be enclosed in double quotes to avoid ambiguity.

An *`expression`* in the `SELECT` list can be a constant value, a column reference, an operator invocation, a function call, an aggregate expression, a window expression, a scalar subquery, and so on. There are a number of constructs that can be classified as an expression but do not follow any general syntax rules.

Instead of an expression, `*` can be written in the output list as a shorthand for all the columns of the selected rows. Also, one can write *`table_name`*`.*` as a shorthand for the columns coming from just that table.

The FROM Clause

The `FROM` clause specifies one or more source tables for the `SELECT`. If multiple sources are specified, the result is the Cartesian product (cross join) of all the sources. But usually qualification conditions are added to restrict the returned rows to a small subset of the Cartesian product. The `FROM` clause can contain the following elements:

table_name

The name (optionally schema-qualified) of an existing table or view. If `ONLY` is specified, only that table is scanned. If `ONLY` is not specified, the table and all its descendant tables (if any) are scanned.

alias

A substitute name for the `FROM` item containing the alias. An alias is used for brevity or to eliminate ambiguity for self-joins (where the same table is scanned multiple times). When an alias is provided, it completely hides the actual name of the table or function; for example given `FROM foo AS f`, the remainder of the `SELECT` must refer to this `FROM` item as `f` not `foo`. If an alias is written, a column alias list can also be written to provide substitute names for one or more columns of the table.

select

A sub-`SELECT` can appear in the `FROM` clause. This acts as though its output were created as a temporary table for the duration of this single `SELECT` command. Note that the sub-`SELECT` must be surrounded by parentheses, and an alias must be provided for it. A `VALUES` command can also be used here. See "Nonstandard Clauses" on page 209 for limitations of using correlated sub-selects in HAWQ.

function_name

Function calls can appear in the `FROM` clause. (This is especially useful for functions that return result sets, but any function can be used.) This acts as though its output were created as a temporary table for the duration of this single `SELECT` command. An alias may also be used. If an alias is written, a column alias list can also be written to provide substitute names for one or more attributes of the function's composite return type. If the function has been defined as returning the record data type, then an alias or the key word `AS` must be present, followed by a column definition list in the form `( column_name data_type [, ... ] )`. The column definition list must match the actual number and types of columns returned by the function.

join_type

One of:

- **[INNER] JOIN**
- **LEFT [OUTER] JOIN**
- **RIGHT [OUTER] JOIN**
- **FULL [OUTER] JOIN**
- **CROSS JOIN**

For the `INNER` and `OUTER` join types, a join condition must be specified, namely exactly one of `NATURAL`, `ON` *`join_condition`*, or `USING (`*`join_column`*` [, ...])`. See below for the meaning. For `CROSS JOIN`, none of these clauses may appear.

A `JOIN` clause combines two `FROM` items. Use parentheses if necessary to determine the order of nesting. In the absence of parentheses, `JOIN`s nest left-to-right. In any case `JOIN` binds more tightly than the commas separating `FROM` items.

`CROSS JOIN` and `INNER JOIN` produce a simple Cartesian product, the same result as you get from listing the two items at the top level of `FROM`, but restricted by the join condition (if any). `CROSS JOIN` is equivalent to `INNER JOIN ON (TRUE)`, that is, no rows are removed by qualification. These join types are just a notational convenience, since they do nothing you could not do with plain `FROM` and `WHERE`.

`LEFT OUTER JOIN` returns all rows in the qualified Cartesian product (i.e., all combined rows that pass its join condition), plus one copy of each row in the left-hand table for which there was no right-hand row that passed the join condition. This left-hand row is extended to the full width of the joined table by inserting null values for the right-hand columns. Note that only the `JOIN` clause’s own condition is considered while deciding which rows have matches. Outer conditions are applied afterwards.

Conversely, `RIGHT OUTER JOIN` returns all the joined rows, plus one row for each unmatched right-hand row (extended with nulls on the left). This is just a notational convenience, since you could convert it to a `LEFT OUTER JOIN` by switching the left and right inputs.

`FULL OUTER JOIN` returns all the joined rows, plus one row for each unmatched left-hand row (extended with nulls on the right), plus one row for each unmatched right-hand row (extended with nulls on the left).

ON *join_condition*

`join_condition` is an expression resulting in a value of type `boolean` (similar to a `WHERE` clause) that specifies which rows in a join are considered to match.

USING (*join_column* [, ...])

A clause of the form `USING ( a, b, ... )` is shorthand for `ON left_table.a = right_table.a AND left_table.b = right_table.b ....` Also, `USING` implies that only one of each pair of equivalent columns will be included in the join output, not both.

NATURAL

`NATURAL` is shorthand for a `USING` list that mentions all columns in the two tables that have the same names.

The WHERE Clause

The optional `WHERE` clause has the general form:

```
WHERE condition
```

Where *`condition`* is any expression that evaluates to a result of type `boolean`. Any row that does not satisfy this condition will be eliminated from the output. A row satisfies the condition if it returns true when the actual row values are substituted for any variable references.

The GROUP BY Clause

The optional `GROUP BY` clause has the general form:

```
GROUP BY grouping_element [, ...]
```

where *grouping_element* can be one of:

```
()
expression
ROLLUP (expression [,...])
CUBE (expression [,...])
GROUPING SETS ((grouping_element [, ...]))
```

`GROUP BY` will condense into a single row all selected rows that share the same values for the grouped expressions. *`expression`* can be an input column name, or the name or ordinal number of an output column (`SELECT` list item), or an arbitrary expression formed from input-column values. In case of ambiguity, a `GROUP BY` name will be interpreted as an input-column name rather than an output column name.

Aggregate functions, if any are used, are computed across all rows making up each group, producing a separate value for each group (whereas without `GROUP BY`, an aggregate produces a single value computed across all the selected rows). When `GROUP BY` is present, it is not valid for the `SELECT` list expressions to refer to ungrouped columns except within aggregate functions, since there would be more than one possible value to return for an ungrouped column.

HAWQ has the following additional OLAP grouping extensions (often referred to as *supergroups*):

ROLLUP

A ROLLUP grouping is an extension to the GROUP BY clause that creates aggregate subtotals that roll up from the most detailed level to a grand total, following a list of grouping columns (or expressions). ROLLUP takes an ordered list of grouping columns, calculates the standard aggregate values specified in the GROUP BY clause, then creates progressively higher-level subtotals, moving from right to left through the list. Finally, it creates a grand total. A ROLLUP grouping can be thought of as a series of grouping sets. For example:

```
GROUP BY ROLLUP (a,b,c)
```

is equivalent to:

```
GROUP BY GROUPING SETS( (a,b,c), (a,b), (a), () )
```

Notice that the *n* elements of a ROLLUP translate to *n*+1 grouping sets. Also, the order in which the grouping expressions are specified is significant in a ROLLUP.

CUBE

A CUBE grouping is an extension to the GROUP BY clause that creates subtotals for all of the possible combinations of the given list of grouping columns (or expressions). In terms of multidimensional analysis, CUBE generates all the subtotals that could be calculated for a data cube with the specified dimensions. For example:

```
GROUP BY CUBE (a,b,c)
```

is equivalent to:

```
GROUP BY GROUPING SETS( (a,b,c), (a,b), (a,c), (b,c), (a),
(b), (c), () )
```

Notice that *n* elements of a CUBE translate to 2^n grouping sets. Consider using CUBE in any situation requiring cross-tabular reports. CUBE is typically most suitable in queries that use columns from multiple dimensions rather than columns representing different levels of a single dimension. For instance, a commonly requested cross-tabulation might need subtotals for all the combinations of month, state, and product.

GROUPING SETS

You can selectively specify the set of groups that you want to create using a GROUPING SETS expression within a GROUP BY clause. This allows precise specification across multiple dimensions without computing a whole ROLLUP or CUBE. For example:

```
GROUP BY GROUPING SETS( (a,c), (a,b) )
```

If using the grouping extension clauses ROLLUP, CUBE, or GROUPING SETS, two challenges arise. First, how do you determine which result rows are subtotals, and then the exact level of aggregation for a given subtotal. Or, how do you differentiate between result rows that contain both stored NULL values and "NULL" values created by the ROLLUP or CUBE. Secondly, when duplicate grouping sets are specified in the GROUP BY clause, how do you determine which result rows are duplicates? There are two additional grouping functions you can use in the SELECT list to help with this:

- **`grouping(column [, ...])`** The `grouping` function can be applied to one or more grouping attributes to distinguish super-aggregated rows from regular grouped rows. This can be helpful in distinguishing a "NULL" representing the set of all values in a super-aggregated row from a `NULL` value in a regular row. Each argument in this function produces a bit — either `1` or `0`, where `1` means the result row is super-aggregated, and `0` means the result row is from a regular grouping. The `grouping` function returns an integer by treating these bits as a binary number and then converting it to a base-10 integer.
- **`group_id()`** For grouping extension queries that contain duplicate grouping sets, the `group_id` function is used to identify duplicate rows in the output. All *unique* grouping set output rows will have a group_id value of 0. For each duplicate grouping set detected, the `group_id` function assigns a group_id number greater than 0. All output rows in a particular duplicate grouping set are identified by the same group_id number.

The WINDOW Clause

The `WINDOW` clause is used to define a window that can be used in the `OVER()` expression of a window function such as `rank` or `avg`. For example:

```
SELECT vendor, rank() OVER (mywindow) FROM sale
GROUP BY vendor
WINDOW mywindow AS (ORDER BY sum(prc*qty));
```

A `WINDOW` clause is has this general form:

```
WINDOW window_name AS (window_specification)
```

where *window_specification* can be:

```
[window_name]
[PARTITION BY expression [, ...]]
[ORDER BY expression [ASC | DESC | USING operator] [, ...]
    [{RANGE | ROWS}
      { UNBOUNDED PRECEDING
      | expression PRECEDING
      | CURRENT ROW
      | BETWEEN window_frame_bound AND window_frame_bound }]]
```

where *window_frame_bound* can be one of:

```
UNBOUNDED PRECEDING
expression PRECEDING
CURRENT ROW
expression FOLLOWING
UNBOUNDED FOLLOWING
```

window_name

Gives a name to the window specification.

PARTITION BY

The `PARTITION BY` clause organizes the result set into logical groups based on the unique values of the specified expression. When used with window functions, the functions are applied to each partition independently. For example, if you follow `PARTITION BY` with a column name, the result set is partitioned by the distinct values of that column. If omitted, the entire result set is considered one partition.

ORDER BY

The `ORDER BY` clause defines how to sort the rows in each partition of the result set. If omitted, rows are returned in whatever order is most efficient and may vary. **Note:** Columns of data types that lack a coherent ordering, such as `time`, are not good candidates for use in the `ORDER BY` clause of a window specification. Time, with or without time zone, lacks a coherent ordering because addition and subtraction do not have the expected effects. For example, the following is not generally true: `x::time < x::time + '2 hour'::interval`

ROWS | RANGE

Use either a `ROWS` or `RANGE` clause to express the bounds of the window. The window bound can be one, many, or all rows of a partition. You can express the bound of the window either in terms of a range of data values offset from the value in the current row (`RANGE`), or in terms of the number of rows offset from the current row (`ROWS`). When using the `RANGE` clause, you must also use an `ORDER BY` clause. This is because the calculation performed to produce the window requires that the values be sorted. Additionally, the `ORDER BY` clause cannot contain more than one expression, and the expression must result in either a date or a numeric value. When using the `ROWS` or `RANGE` clauses, if you specify only a starting row, the current row is used as the last row in the window.

PRECEDING

The `PRECEDING` clause defines the first row of the window using the current row as a reference point. The starting row is expressed in terms of the number of rows preceding the current row. For example, in the case of `ROWS` framing, `5 PRECEDING` sets the window to start with the fifth row preceding the current row. In the case of `RANGE` framing, it sets the window to start with the first row whose ordering column value precedes that of the current row by 5 in the given order. If the specified order is ascending by date, this will be the first row within 5 days before the current row. `UNBOUNDED PRECEDING` sets the first row in the window to be the first row in the partition.

BETWEEN

The `BETWEEN` clause defines the first and last row of the window, using the current row as a reference point. First and last rows are expressed in terms of the number of rows preceding and following the current row, respectively. For example, `BETWEEN 3 PRECEDING AND 5 FOLLOWING` sets the window to start with the third row preceding the current row, and end with the fifth row following the current row. Use `BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING` to set the first and last rows in the window to be the first and last row in the partition, respectively. This is equivalent to the default behavior if no `ROW` or `RANGE` clause is specified.

FOLLOWING

The `FOLLOWING` clause defines the last row of the window using the current row as a reference point. The last row is expressed in terms of the number of rows following the current row. For example, in the case of `ROWS` framing, `5 FOLLOWING` sets the window to end with the fifth row following the current row. In the case of `RANGE` framing, it sets the window to end with the last row whose ordering column value follows that of the current row by 5 in the given order. If the specified order is ascending by date, this will be the last row within 5 days after the current row. Use `UNBOUNDED FOLLOWING` to set the last row in the window to be the last row in the partition.

If you do not specify a `ROW` or a `RANGE` clause, the window bound starts with the first row in the partition (`UNBOUNDED PRECEDING`) and ends with the current row (`CURRENT ROW`) if `ORDER BY` is used. If an `ORDER BY` is not specified, the window starts with the first row in the partition (`UNBOUNDED PRECEDING`) and ends with last row in the partition (`UNBOUNDED FOLLOWING`).

The HAVING Clause

The optional `HAVING` clause has the general form:

```
HAVING condition
```

Where *`condition`* is the same as specified for the `WHERE` clause. `HAVING` eliminates group rows that do not satisfy the condition. `HAVING` is different from `WHERE`: `WHERE` filters individual rows before the application of `GROUP BY`, while `HAVING` filters group rows created by `GROUP BY`. Each column referenced in *`condition`* must unambiguously reference a grouping column, unless the reference appears within an aggregate function.

The presence of `HAVING` turns a query into a grouped query even if there is no `GROUP BY` clause. This is the same as what happens when the query contains aggregate functions but no `GROUP BY` clause. All the selected rows are considered to form a single group, and the `SELECT` list and `HAVING` clause can only reference table columns from within aggregate functions. Such a query will emit a single row if the `HAVING` condition is true, zero rows if it is not true.

The UNION Clause

The `UNION` clause has this general form:

```
select_statement UNION [ALL] select_statement
```

Where *`select_statement`* is any `SELECT` statement without an `ORDER BY`, `LIMIT`, `FOR UPDATE`, or `FOR SHARE` clause. (`ORDER BY` and `LIMIT` can be attached to a subquery expression if it is enclosed in parentheses. Without parentheses, these clauses will be taken to apply to the result of the `UNION`, not to its right-hand input expression.)

The `UNION` operator computes the set union of the rows returned by the involved `SELECT` statements. A row is in the set union of two result sets if it appears in at least one of the result sets. The two `SELECT` statements that represent the direct operands of the `UNION` must produce the same number of columns, and corresponding columns must be of compatible data types.

The result of UNION does not contain any duplicate rows unless the ALL option is specified. ALL prevents elimination of duplicates. (Therefore, UNION ALL is usually significantly quicker than UNION; use ALL when you can.)

Multiple UNION operators in the same SELECT statement are evaluated left to right, unless otherwise indicated by parentheses.

Currently, FOR UPDATE and FOR SHARE may not be specified either for a UNION result or for any input of a UNION.

The INTERSECT Clause

The INTERSECT clause has this general form:

```
select_statement INTERSECT [ALL] select_statement
```

Where *select_statement* is any SELECT statement without an ORDER BY, LIMIT, FOR UPDATE, or FOR SHARE clause.

The INTERSECT operator computes the set intersection of the rows returned by the involved SELECT statements. A row is in the intersection of two result sets if it appears in both result sets.

The result of INTERSECT does not contain any duplicate rows unless the ALL option is specified. With ALL, a row that has *m* duplicates in the left table and *n* duplicates in the right table will appear min(*m*, *n*) times in the result set.

Multiple INTERSECT operators in the same SELECT statement are evaluated left to right, unless parentheses dictate otherwise. INTERSECT binds more tightly than UNION. That is, A UNION B INTERSECT C will be read as A UNION (B INTERSECT C).

Currently, FOR UPDATE and FOR SHARE may not be specified either for an INTERSECT result or for any input of an INTERSECT.

The EXCEPT Clause

The EXCEPT clause has this general form:

```
select_statement EXCEPT [ALL] select_statement
```

Where *select_statement* is any SELECT statement without an ORDER BY, LIMIT, FOR UPDATE, or FOR SHARE clause.

The EXCEPT operator computes the set of rows that are in the result of the left SELECT statement but not in the result of the right one.

The result of EXCEPT does not contain any duplicate rows unless the ALL option is specified. With ALL, a row that has *m* duplicates in the left table and *n* duplicates in the right table will appear max(*m*-*n*,0) times in the result set.

Multiple EXCEPT operators in the same SELECT statement are evaluated left to right, unless parentheses dictate otherwise. EXCEPT binds at the same level as UNION.

Currently, FOR UPDATE and FOR SHARE may not be specified either for an EXCEPT result or for any input of an EXCEPT.

The ORDER BY Clause

The optional ORDER BY clause has this general form:

```
ORDER BY expression [ASC | DESC | USING operator] [, ...]
```

Where *expression* can be the name or ordinal number of an output column (SELECT list item), or it can be an arbitrary expression formed from input-column values.

The ORDER BY clause causes the result rows to be sorted according to the specified expressions. If two rows are equal according to the left-most expression, they are compared according to the next expression and so on. If they are equal according to all specified expressions, they are returned in an implementation-dependent order.

The ordinal number refers to the ordinal (left-to-right) position of the result column. This feature makes it possible to define an ordering on the basis of a column that does not have a unique name. This is never absolutely necessary because it is always possible to assign a name to a result column using the AS clause.

It is also possible to use arbitrary expressions in the ORDER BY clause, including columns that do not appear in the SELECT result list. Thus the following statement is valid:

```
SELECT name FROM distributors ORDER BY code;
```

A limitation of this feature is that an ORDER BY clause applying to the result of a UNION, INTERSECT, or EXCEPT clause may only specify an output column name or number, not an expression.

If an ORDER BY expression is a simple name that matches both a result column name and an input column name, ORDER BY will interpret it as the result column name. This is the opposite of the choice that GROUP BY will make in the same situation. This inconsistency is made to be compatible with the SQL standard.

Optionally one may add the key word ASC (ascending) or DESC (descending) after any expression in the ORDER BY clause. If not specified, ASC is assumed by default. Alternatively, a specific ordering operator name may be specified in the USING clause. ASC is usually equivalent to USING < and DESC is usually equivalent to USING >. (But the creator of a user-defined data type can define exactly what the default sort ordering is, and it might correspond to operators with other names.)

The null value sorts higher than any other value. In other words, with ascending sort order, null values sort at the end, and with descending sort order, null values sort at the beginning.

Character-string data is sorted according to the locale-specific collation order that was established when the HAWQ system was initialized.

The DISTINCT Clause

If DISTINCT is specified, all duplicate rows are removed from the result set (one row is kept from each group of duplicates). ALL specifies the opposite: all rows are kept. ALL is the default.

DISTINCT ON (*expression* [, ...]) keeps only the first row of each set of rows where the given expressions evaluate to equal. The DISTINCT ON expressions are interpreted using the same rules as for ORDER BY. Note that the ‘first row’ of each set is unpredictable unless ORDER BY is used to ensure that the desired row appears first. For example:

```
SELECT DISTINCT ON (location) location, time, report FROM
weather_reports ORDER BY location, time DESC;
```

retrieves the most recent weather report for each location. But if we had not used `ORDER BY` to force descending order of time values for each location, we would have gotten a report from an unpredictable time for each location.

The `DISTINCT ON` expression(s) must match the left-most `ORDER BY` expression(s). The `ORDER BY` clause will normally contain additional expression(s) that determine the desired precedence of rows within each `DISTINCT ON` group.

The LIMIT Clause

The `LIMIT` clause consists of two independent sub-clauses:

```
LIMIT {count | ALL}
OFFSET start
```

Where *`count`* specifies the maximum number of rows to return, while *`start`* specifies the number of rows to skip before starting to return rows. When both are specified, start rows are skipped before starting to count the count rows to be returned.

When using `LIMIT`, it is a good idea to use an `ORDER BY` clause that constrains the result rows into a unique order. Otherwise you will get an unpredictable subset of the query's rows — you may be asking for the tenth through twentieth rows, but tenth through twentieth in what ordering? You don't know what ordering unless you specify `ORDER BY`.

The query planner takes `LIMIT` into account when generating a query plan, so you are very likely to get different plans (yielding different row orders) depending on what you use for `LIMIT` and `OFFSET`. Thus, using different `LIMIT/OFFSET` values to select different subsets of a query result will give inconsistent results unless you enforce a predictable result ordering with `ORDER BY`. This is not a defect; it is an inherent consequence of the fact that SQL does not promise to deliver the results of a query in any particular order unless `ORDER BY` is used to constrain the order.

Examples

To join the table *films* with the table *distributors*:

```
SELECT f.title, f.did, d.name, f.date_prod, f.kind FROM
distributors d, films f WHERE f.did = d.did
```

To sum the column *length* of all films and group the results by *kind*:

```
SELECT kind, sum(length) AS total FROM films GROUP BY kind;
```

To sum the column *length* of all films, group the results by *kind* and show those group totals that are less than 5 hours:

```
SELECT kind, sum(length) AS total FROM films GROUP BY kind
HAVING sum(length) < interval '5 hours';
```

Calculate the subtotals and grand totals of all sales for movie *kind* and *distributor*.

```
SELECT kind, distributor, sum(prc*qty) FROM sales
GROUP BY ROLLUP(kind, distributor)
ORDER BY 1,2,3;
```

Calculate the rank of movie distributors based on total sales:

```
SELECT distributor, sum(prc*qty),
       rank() OVER (ORDER BY sum(prc*qty) DESC)
FROM sale
GROUP BY distributor ORDER BY 2 DESC;
```

The following two examples are identical ways of sorting the individual results according to the contents of the second column (*name*):

```
SELECT * FROM distributors ORDER BY name;
SELECT * FROM distributors ORDER BY 2;
```

The next example shows how to obtain the union of the tables *distributors* and *actors*, restricting the results to those that begin with the letter *W* in each table. Only distinct rows are wanted, so the key word `ALL` is omitted:

```
SELECT distributors.name FROM distributors WHERE
distributors.name LIKE 'W%' UNION SELECT actors.name FROM
actors WHERE actors.name LIKE 'W%';
```

This example shows how to use a function in the `FROM` clause, both with and without a column definition list:

```
CREATE FUNCTION distributors(int) RETURNS SETOF distributors
AS $$ SELECT * FROM distributors WHERE did = $1; $$ LANGUAGE
SQL;
SELECT * FROM distributors(111);


CREATE FUNCTION distributors_2(int) RETURNS SETOF record AS
$$ SELECT * FROM distributors WHERE did = $1; $$ LANGUAGE
SQL;
SELECT * FROM distributors_2(111) AS (dist_id int, dist_name
text);
```

Compatibility

The `SELECT` statement is compatible with the SQL standard, but there are some extensions and some missing features.

Omitted FROM Clauses

HAWQ allows one to omit the `FROM` clause. It has a straightforward use to compute the results of simple expressions. For example:

```
SELECT 2+2;
```

Some other SQL databases cannot do this except by introducing a dummy one-row table from which to do the `SELECT`.

Note that if a `FROM` clause is not specified, the query cannot reference any database tables. For compatibility with applications that rely on this behavior the *add_missing_from* configuration variable can be enabled.

The AS Key Word

In the SQL standard, the optional key word `AS` is just noise and can be omitted without affecting the meaning. The HAWQ parser requires this key word when renaming output columns because the type extensibility features lead to parsing ambiguities without it. `AS` is optional in `FROM` items, however.

Namespace Available to GROUP BY and ORDER BY

In the SQL-92 standard, an `ORDER BY` clause may only use result column names or numbers, while a `GROUP BY` clause may only use expressions based on input column names. HAWQ extends each of these clauses to allow the other choice as well (but it uses the standard's interpretation if there is ambiguity). HAWQ also allows both clauses to specify arbitrary expressions. Note that names appearing in an expression will always be taken as input-column names, not as result-column names.

SQL:1999 and later use a slightly different definition which is not entirely upward compatible with SQL-92. In most cases, however, HAWQ will interpret an `ORDER BY` or `GROUP BY` expression the same way SQL:1999 does.

Nonstandard Clauses

The clauses `DISTINCT ON`, `LIMIT`, and `OFFSET` are not defined in the SQL standard.

Limited Use of STABLE and VOLATILE Functions

To prevent data from becoming out-of-sync across the segments in HAWQ, any function classified as `STABLE` or `VOLATILE` cannot be executed at the segment database level if it contains SQL or modifies the database in any way.

See Also

`EXPLAIN`

SELECT INTO

Defines a new table from the results of a query.

Synopsis

```
SELECT [ALL | DISTINCT [ON ( expression [, ...] )]]
    * | expression [AS output_name] [, ...]
    INTO [TEMPORARY | TEMP] [TABLE] new_table
    [FROM from_item [, ...]]
    [WHERE condition]
    [GROUP BY expression [, ...]]
    [HAVING condition [, ...]]
    [{UNION | INTERSECT | EXCEPT} [ALL] select]
    [ORDER BY expression [ASC | DESC | USING operator] [, ...]]
    [LIMIT {count | ALL}]
    [OFFSET start]
[...]]
```

Description

`SELECT INTO` creates a new table and fills it with data computed by a query. The data is not returned to the client, as it is with a normal `SELECT`. The new table's columns have the names and data types associated with the output columns of the `SELECT`.

Parameters

The majority of parameters for `SELECT INTO` are the same as `SELECT`.

TEMPORARY
TEMP

If specified, the table is created as a temporary table.

new_table

The name (optionally schema-qualified) of the table to be created.

Examples

Create a new table *films_recent* consisting of only recent entries from the table *films*:

```
SELECT * INTO films_recent FROM films WHERE date_prod >=
'2006-01-01';
```

Compatibility

The SQL standard uses `SELECT INTO` to represent selecting values into scalar variables of a host program, rather than creating a new table. The HAWQ usage of `SELECT INTO` to represent table creation is historical. It is best to use `CREATE TABLE AS` for this purpose in new applications.

See Also

`SELECT`, `CREATE TABLE AS`

SET

Changes the value of a HAWQ configuration parameter.

Synopsis

```
SET [SESSION | LOCAL] configuration_parameter {TO | =} value |
'value' | DEFAULT}

SET [SESSION | LOCAL] TIME ZONE {timezone | LOCAL | DEFAULT}
```

Description

The `SET` command changes server configuration parameters. Any configuration parameter classified as a *session* parameter can be changed on-the-fly with `SET` (see "Server Configuration Parameters" on page 368 for details). `SET` only affects the value used by the current session.

If `SET` or `SET SESSION` is issued within a transaction that is later aborted, the effects of the `SET` command disappear when the transaction is rolled back. Once the surrounding transaction is committed, the effects will persist until the end of the session, unless overridden by another `SET`.

The effects of `SET LOCAL` last only till the end of the current transaction, whether committed or not. A special case is `SET` followed by `SET LOCAL` within a single transaction: the `SET LOCAL` value will be seen until the end of the transaction, but afterwards (if the transaction is committed) the `SET` value will take effect.

Parameters

SESSION

Specifies that the command takes effect for the current session. This is the default.

LOCAL

Specifies that the command takes effect for only the current transaction. After `COMMIT` or `ROLLBACK`, the session-level setting takes effect again. Note that `SET LOCAL` will appear to have no effect if it is executed outside of a transaction.

configuration_parameter

The name of a HAWQ configuration parameter. Only parameters classified as *session* can be changed with `SET`. See "Server Configuration Parameters" on page 368 for details.

value

New value of parameter. Values can be specified as string constants, identifiers, numbers, or comma-separated lists of these. `DEFAULT` can be used to specify resetting the parameter to its default value. If specifying memory sizing or time units, enclose the value in single quotes.

TIME ZONE

`SET TIME ZONE` value is an alias for `SET timezone TO` *`value`*. The syntax `SET TIME ZONE` allows special syntax for the time zone specification. Here are examples of valid values:

`'PST8PDT'`

`'Europe/Rome'`

`-7` (time zone 7 hours west from UTC)

`INTERVAL '-08:00' HOUR TO MINUTE` (time zone 8 hours west from UTC).

LOCAL
DEFAULT

Set the time zone to your local time zone (the one that the server's operating system defaults to). See the Time zone section of the PostgreSQL documentation for more information about time zones in HAWQ.

Examples

Set the schema search path:

```
SET search_path TO my_schema, public;
```

Increase work memory to 200 MB:

```
SET work_mem TO '200MB';
```

Set the style of date to traditional POSTGRES with "day before month" input convention:

```
SET datestyle TO postgres, dmy;
```

Set the time zone for San Mateo, California:

```
SET TIME ZONE 'PST8PDT';
```

Set the time zone for Italy:

```
SET TIME ZONE 'Europe/Rome';
```

Compatibility

`SET TIME ZONE` extends syntax defined in the SQL standard. The standard allows only numeric time zone offsets while HAWQ allows more flexible time-zone specifications. All other `SET` features are HAWQ extensions.

See Also

`RESET`, `SHOW`

SET ROLE

Sets the current role identifier of the current session.

Synopsis

```
SET [SESSION | LOCAL] ROLE rolename

SET [SESSION | LOCAL] ROLE NONE

RESET ROLE
```

Description

This command sets the current role identifier of the current SQL-session context to be *rolename*. The role name may be written as either an identifier or a string literal. After `SET ROLE`, permissions checking for SQL commands is carried out as though the named role were the one that had logged in originally.

The specified *rolename* must be a role that the current session user is a member of. If the session user is a superuser, any role can be selected.

The `NONE` and `RESET` forms reset the current role identifier to be the current session role identifier. These forms may be executed by any user.

Parameters

SESSION

Specifies that the command takes effect for the current session. This is the default.

LOCAL

Specifies that the command takes effect for only the current transaction. After `COMMIT` or `ROLLBACK`, the session-level setting takes effect again. Note that `SET LOCAL` will appear to have no effect if it is executed outside of a transaction.

rolename

The name of a role to use for permissions checking in this session.

NONE
RESET

Reset the current role identifier to be the current session role identifier (that of the role used to log in).

Notes

Using this command, it is possible to either add privileges or restrict privileges. If the session user role has the `INHERITS` attribute, then it automatically has all the privileges of every role that it could `SET ROLE` to; in this case `SET ROLE` effectively drops all the privileges assigned directly to the session user and to the other roles it is a member of, leaving only the privileges available to the named role. On the other hand, if the session user role has the `NOINHERITS` attribute, `SET ROLE` drops the privileges assigned directly to the session user and instead acquires the privileges available to the named role.

In particular, when a superuser chooses to `SET ROLE` to a non-superuser role, she loses her superuser privileges.

`SET ROLE` has effects comparable to `SET SESSION AUTHORIZATION`, but the privilege checks involved are quite different. Also, `SET SESSION AUTHORIZATION` determines which roles are allowable for later `SET ROLE` commands, whereas changing roles with `SET ROLE` does not change the set of roles allowed to a later `SET ROLE`.

Examples

```
SELECT SESSION_USER, CURRENT_USER;
 session_user | current_user
--------------+--------------
 peter        | peter

SET ROLE 'paul';

SELECT SESSION_USER, CURRENT_USER;
 session_user | current_user
--------------+--------------
 peter        | paul
```

Compatibility

HAWQ allows identifier syntax (*rolename*), while the SQL standard requires the role name to be written as a string literal. SQL does not allow this command during a transaction; HAWQ does not make this restriction. The `SESSION` and `LOCAL` modifiers are a HAWQ extension, as is the `RESET` syntax.

See Also

`SET SESSION AUTHORIZATION`

SET SESSION AUTHORIZATION

Sets the session role identifier and the current role identifier of the current session.

Synopsis

```
SET [SESSION | LOCAL] SESSION AUTHORIZATION rolename

SET [SESSION | LOCAL] SESSION AUTHORIZATION DEFAULT

RESET SESSION AUTHORIZATION
```

Description

This command sets the session role identifier and the current role identifier of the current SQL-session context to be *rolename*. The role name may be written as either an identifier or a string literal. Using this command, it is possible, for example, to temporarily become an unprivileged user and later switch back to being a superuser.

The session role identifier is initially set to be the (possibly authenticated) role name provided by the client. The current role identifier is normally equal to the session user identifier, but may change temporarily in the context of `setuid` functions and similar mechanisms; it can also be changed by `SET ROLE`. The current user identifier is relevant for permission checking.

The session user identifier may be changed only if the initial session user (the authenticated user) had the superuser privilege. Otherwise, the command is accepted only if it specifies the authenticated user name.

The `DEFAULT` and `RESET` forms reset the session and current user identifiers to be the originally authenticated user name. These forms may be executed by any user.

Parameters

SESSION

Specifies that the command takes effect for the current session. This is the default.

LOCAL

Specifies that the command takes effect for only the current transaction. After `COMMIT` or `ROLLBACK`, the session-level setting takes effect again. Note that `SET LOCAL` will appear to have no effect if it is executed outside of a transaction.

rolename

The name of the role to assume.

NONE
RESET

Reset the session and current role identifiers to be that of the role used to log in.

Examples

```
SELECT SESSION_USER, CURRENT_USER;
 session_user | current_user
--------------+--------------
 peter        | peter

SET SESSION AUTHORIZATION 'paul';

SELECT SESSION_USER, CURRENT_USER;
 session_user | current_user
--------------+--------------
 paul         | paul
```

Compatibility

The SQL standard allows some other expressions to appear in place of the literal *rolename*, but these options are not important in practice. HAWQ allows identifier syntax ("*rolename*"), which SQL does not. SQL does not allow this command during a transaction; HAWQ does not make this restriction. The SESSION and LOCAL modifiers are a HAWQ extension, as is the RESET syntax.

See Also

SET ROLE

SHOW

Shows the value of a system configuration parameter.

Synopsis

```
SHOW configuration_parameter

SHOW ALL
```

Description

`SHOW` will display the current settings of HAWQ system configuration parameters. These parameters can be set using the `SET` statement, or by editing the `postgresql.conf` configuration file of the HAWQ master. Note that some parameters viewable by `SHOW` are read-only — their values can be viewed but not set. See "Server Configuration Parameters" on page 368 for details.

Parameters

configuration_parameter

The name of a system configuration parameter. See "Server Configuration Parameters" on page 368.

ALL

Shows the current value of all configuration parameters.

Examples

Show the current setting of the parameter *search_path*:

```
SHOW search_path;
```

Show the current setting of all parameters:

```
SHOW ALL;
```

Compatibility

`SHOW` is a HAWQ extension.

See Also

`SET`, `RESET`

TRUNCATE

Empties a table of all rows.

Synopsis

```
TRUNCATE [TABLE] name [, ...] [CASCADE | RESTRICT]
```

Description

`TRUNCATE` quickly removes all rows from a table or set of tables. This is most useful on large tables.

Parameters

name

The name (optionally schema-qualified) of a table to be truncated.

CASCADE

Since this key word applies to foreign key references (which are not supported in HAWQ) it has no effect.

RESTRICT

Since this key word applies to foreign key references (which are not supported in HAWQ) it has no effect.

Notes

Only the owner of a table may `TRUNCATE` it.

`TRUNCATE` will not run any user-defined `ON DELETE` triggers that might exist for the tables.

`TRUNCATE` will not truncate any tables that inherit from the named table. Only the named table is truncated, not its child tables.

Examples

Empty the table films:

```
TRUNCATE films;
```

Compatibility

There is no `TRUNCATE` command in the SQL standard.

See Also

`DROP TABLE`

VACUUM

Garbage-collects and optionally analyzes a database.

Synopsis

```
VACUUM [FULL] [FREEZE] [VERBOSE] [table]

VACUUM [FULL] [FREEZE] [VERBOSE] ANALYZE
              [table [(column [, ...] )]]
```

Description

`VACUUM` reclaims storage occupied by deleted tuples. In normal HAWQ operation, tuples that are deleted or obsoleted by an update are not physically removed from their table; they remain present on disk until a `VACUUM` is done. Therefore it is necessary to do `VACUUM` periodically, especially on frequently-updated tables.

With no parameter, `VACUUM` processes every table in the current database. With a parameter, `VACUUM` processes only that table.

`VACUUM ANALYZE` performs a `VACUUM` and then an `ANALYZE` for each selected table. This is a handy combination form for routine maintenance scripts. See `ANALYZE` for more details about its processing.

Plain `VACUUM` (without `FULL`) simply reclaims space and makes it available for re-use. This form of the command can operate in parallel with normal reading and writing of the table, as an exclusive lock is not obtained. `VACUUM FULL` does more extensive processing, including moving of tuples across blocks to try to compact the table to the minimum number of disk blocks. This form is much slower and requires an exclusive lock on each table while it is being processed.

Outputs

When `VERBOSE` is specified, `VACUUM` emits progress messages to indicate which table is currently being processed. Various statistics about the tables are printed as well.

Parameters

FULL

Selects a full vacuum, which may reclaim more space, but takes much longer and exclusively locks the table.
Warning: A `VACUUM FULL` is not recommended in HAWQ. See the "Notes" section.

FREEZE

Specifying `FREEZE` is equivalent to performing `VACUUM` with the *vacuum_freeze_min_age* server configuration parameter set to zero. The `FREEZE` option is deprecated and will be removed in a future release. Set the parameter in the master `postgresql.conf` file instead.

VERBOSE

Prints a detailed vacuum activity report for each table.

ANALYZE

Updates statistics used by the planner to determine the most efficient way to execute a query.

table

The name (optionally schema-qualified) of a specific table to vacuum. Defaults to all tables in the current database.

column

The name of a specific column to analyze. Defaults to all columns.

Notes

`VACUUM` cannot be executed inside a transaction block.

Greenplum recommends that active production databases be vacuumed frequently (at least nightly), in order to remove expired rows. After adding or deleting a large number of rows, it may be a good idea to issue a `VACUUM ANALYZE` command for the affected table. This will update the system catalogs with the results of all recent changes, and allow the HAWQ query planner to make better choices in planning queries.

`VACUUM` causes a substantial increase in I/O traffic, which can cause poor performance for other active sessions. Therefore, it is advisable to vacuum the database at low usage times.

Regular PostgreSQL has a separate optional server process called the *autovacuum daemon*, whose purpose is to automate the execution of `VACUUM` and `ANALYZE` commands. This feature is currently disabled in HAWQ.

Expired rows are held in what is called the *free space map*. The free space map must be sized large enough to cover the dead rows of all tables in your database. If not sized large enough, space occupied by dead rows that overflow the free space map cannot be reclaimed by a regular `VACUUM` command.

A `VACUUM FULL` will reclaim all expired row space, but is a very expensive operation and may take an unacceptably long time to finish on large, distributed HAWQ tables. If you do get into a situation where the free space map has overflowed, it may be more timely to recreate the table with a `CREATE TABLE AS` statement and drop the old table. A `VACUUM FULL` is not recommended in HAWQ.

It is best to size the free space map appropriately. The free space map is configured with the following server configuration parameters:

`max_fsm_pages`

`max_fsm_relations`

Examples

Vacuum all tables in the current database:

```
VACUUM;
```

Vacuum a specific table only:

```
VACUUM mytable;
```

Vacuum all tables in the current database and collect statistics for the query planner:

```
VACUUM ANALYZE;
```

Compatibility

There is no `VACUUM` statement in the SQL standard.

See Also

`ANALYZE`

B. Management Utility Reference

This appendix provides references for the command-line management utilities provided with HAWQ. HAWQ utilizes the standard PostgreSQL client and server programs, and also has additional management utilities to facilitate the administration of a distributed HAWQ DBMS.

The following HAWQ management utilities are located in `$GPHOME/bin`:

- gpactivatestandby
- gpcheck
- gpcheckperf
- gpconfig
- gpextract
- gpfdist
- gpfilespace
- gpinitstandby
- gpinitsystem
- gpload
- gplogfilter
- gprecoverseg
- gpscp
- gpssh
- gpssh-exkeys
- gpstart
- gpstate
- gpstop

Backend Server Programs

The following server programs are also located in `$GPHOME/bin` of your HAWQ installation. These are the standard PostgreSQL server programs, which have been modified to handle the parallelism and distribution of a HAWQ system. Keep in mind that HAWQ is essentially several PostgreSQL database instances working together as a single DBMS, so HAWQ relies on PostgreSQL for its underlying functionality. Users and administrators do not access these programs directly, but do so through the HAWQ management tools and utilities.

Table B.1 HAWQ Backend Server Programs

Program Name	Description	Use Instead
`initdb`	This program is called by `gpinitsystem` when initializing a HAWQ array. It is used internally to create the individual segment instances and the master instance.	gpinitsystem
`ipcclean`	Cleans up shared memory and semaphores from aborted PostgreSQL backends.	N/A
`gpsyncmaster`	This is the HAWQ program that starts the `gpsyncagent` process on the standby master host. Administrators do not call this program directly, but do so through the management scripts that initialize and/or activate a standby master for a HAWQ system. This process is responsible for keeping the standby master up to date with the primary master via a transaction log replication process.	gpinitstandby, gpactivatestandby
`pg_controldata`	Displays control information of a PostgreSQL database cluster.	gpstate
`pg_ctl`	This program is called by `gpstart` and `gpstop` when starting or stopping a HAWQ array. It is used internally to stop and start the individual segment instances and the master instance in parallel and with the correct options.	gpstart, gpstop
`pg_resetxlog`	Resets the PostgreSQL transaction log.	N/A
`postgres`	The `postgres` executable is the actual PostgreSQL server process that processes queries.	The main `postgres` process (postmaster) creates other `postgres` subprocesses and `postgres` session as needed to handle client connections.
`postmaster`	`postmaster` starts the `postgres` database server listener process that accepts client connections. In HAWQ, a `postgres` database listener process runs on the HAWQ Master Instance and on each Segment Instance.	In HAWQ, you use gpstart and gpstop to start all postmasters (`postgres` processes) in the system at once in the correct order and with the correct options.

Management Utility Summary

gpconfig 248

Sets server configuration parameters on all segments within a HAWQ system. 248

```
gpconfig -c param_name -v value [-m master_value | --masteronly] 248
       | -r param_name [--masteronly] 248
       | -l 248
   [--skipvalidation] [--verbose] [--debug] 248
```

```
gpconfig -s param_name [--verbose] [--debug] 248
```

```
gpconfig --help 248
```

-c | --change *param_name 249*

-v | --value *value 249*

-m | --mastervalue ***master_value 249***

--masteronly 249

-r | --remove *param_name 249*

-l | --list 249

-s | --show ***param_name 249***

--skipvalidation 249

--verbose 250

--debug 250

-? | -h | --help 250

250

gpextract 251

```
gpextract [-h hostname] [-p port] [-U username] [-d database] [-o output_file] [-W]
<tablename> 251
```

```
gpextract -?  251
```

```
gpextract --version 251
```

<tablename> 251

-o output_file 251

-v (verbose mode) 251

-? (help) 251

--version 251

-d database 252

-h hostname 252

-p port 252

-U username 252

-W (force password prompt) 252

```
$ gpextract -o rank_table.yaml rank 253
```

gpfdist 256

Serves data files to or writes data files out from HAWQ segments. 256

```
gpfdist [-d directory] [-p http_port] [-l log_file] [-t timeout] [-S] [-v | -V]
```

gpstate 303

gpstop 306

gpactivatestandby

Activates a standby master host and makes it the active master for the HAWQ system.

Synopsis

```
gpactivatestandby -d standby_master_datadir
[-c new_standby_master] [-f] [-a] [-q] [-l logfile_directory]

gpactivatestandby -? | -h | --help

gpactivatestandby -v
```

Description

The `gpactivatestandby` utility activates a backup master host and brings it into operation as the active master instance for a HAWQ system. The activated standby master effectively becomes the HAWQ master, accepting client connections on the master port. The port number must be set to the same on the master host and the backup master host.

You must run this utility from the master host you want to activate and not from the host you need to disable. Running this utility assumes you have a backup master host configured for the system (see `gpinitstandby`).

The utility performs the following steps:

- Stops the synchronization process (`gpsyncagent`) on the backup master.
- Updates the system catalog tables of the backup master using the logs.
- Activates the backup master to be the new active master for the system.
- (optional) Makes the host specified with the `-c` option the new standby master host.
- Restarts the HAWQ system with the new master host.

A backup HAWQ master host serves as a 'warm standby' in the event of the primary HAWQ master host becoming unoperational. The backup master is kept up to date by a transaction log replication process (`gpsyncagent`), which runs on the backup master host and keeps the data between the primary and backup master hosts synchronized.

If the primary master fails, the log replication process is shutdown, and the backup master can be activated in its place by using the `gpactivatestandby` utility. Upon activation of the backup master, the replicated logs are used to reconstruct the state of the HAWQ master host at the time of the last successfully committed transaction. To specify a new standby master host after making your current standby master active, use the `-c` option.

In order to use `gpactivatestandby` to activate a new primary master host, the master host that was previously serving as the primary master cannot be running. The utility checks for a `postmaster.pid` file in the data directory of the disabled master host, and if it finds it there, it will assume the old master host is still active. In some cases, you may need to remove the `postmaster.pid` file from the disabled master host data directory before running `gpactivatestandby` (for example, if the disabled master host process was terminated unexpectedly).

After activating a standby master, run `ANALYZE` to update the database query statistics. For example:

```
psql dbname -c 'ANALYZE;'
```

Options

-a (do not prompt)

Do not prompt the user for confirmation.

-c *new_standby_master_hostname*

Optional. After you activate your standby master you may want to specify another host to be the new standby, otherwise your HAWQ system will no longer have a standby master configured. Use this option to specify the hostname of the new standby master host. You can also use `gpinitstandby` at a later time to configure a new standby master host.

-d *standby_master_datadir*

Required. The absolute path of the data directory for the master host you are activating.

-f (force activation)

Use this option to force activation of the backup master host when the synchronization process (`gpsyncagent`) is not running. Only use this option if you are sure that the backup and primary master hosts are consistent, and you know the `gpsyncagent` process is not running on the backup master host. This option may be useful if you have just initialized a new backup master using `gpinitstandby`, and want to activate it immediately.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-v (show utility version)

Displays the version, status, last updated date, and check sum of this utility.

-? | -h | --help (help)

Displays the online help.

Examples

Activate the backup master host and make it the active master instance for a HAWQ system (run from backup master host you are activating):

```
gpactivatestandby -d /gpdata
```

Activate the backup master host and at the same time configure another host to be your new standby master:

```
gpactivatestandby -d /gpdata -c new_standby_hostname
```

See Also

gpinitsystem, gpinitstandby

gpcheck

Verifies and validates HAWQ platform settings.

Synopsis

```
gpcheck -f <hostfile_gpcheck> [--hadoop <hadoop_home>]
        [--stdout | --zipout] [--config <config_file>]

gpcheck --zipin gpcheck_zipfile

gpcheck -?

gpcheck --version
```

Description

The `gpcheck` utility determines the platform on which you are running HAWQ and validates various platform-specific configuration settings as well as HAWQ and HDFS specific configuration settings. To perform HAWQ configuration checks, make sure HAWQ has been already started and `gpconfig` works. For HDFS checks, you should either set the `HADOOP_HOME` environment variable or give the hadoop installation location using `--hadoop` option.

`gpcheck` can use a host file or a file previously created with the `--zipout` option to validate platform settings. If a `GPCHECK_ERROR` displays, one or more validation checks failed. You can use also `gpcheck` to gather and view platform settings on hosts without running validation checks.

`gpcheck` can use a host file or a file previously created with the `--zipout` option to validate platform settings. If `GPCHECK_ERROR` displays, one or more validation checks failed. You can also use `gpcheck` to gather and view platform settings on hosts without running validation checks.

When running checks, `gpcheck` compares your actual configuration setting with expected value listed in a config file (`$GPHOME/etc/gpcheck.cnf`). Modify the values for "`mount.points`" and "`diskusage.monitor.mounts`" to the mount points you want to check. Use commas to separate the values, otherwise `gpcheck` only checks the root directory. For example:

```
 [linux.mount]
    mount.points = /,/data1,/data2
[linux.diskusage]
    diskusage.monitor.mounts = /,/data1,/data2
```

Pivotal recommends that you run `gpcheck` as `root`. If you do not run `gpcheck` as `root`, the utility displays a warning message and will not be able to validate all configuration settings; Only some of these settings will be validated.

Options

--config *config_file*

The name of a configuration file to use instead of the default file `$GPHOME/etc/gpcheck.cnf` (or `~/gpconfigs/gpcheck_dca_config` on the EMC Greenplum Data Computing Appliance). This file specifies the OS-specific checks to run.

-f *hostfile_gpcheck*

The name of a file that contains a list of hosts that `gpcheck` uses to validate platform-specific settings. This file should contain a single host name for all hosts in your HAWQ system (master, standby master, and segments).

-hadoop hadoop_home

Use this option to specify your hadoop installation location so that `gpcheck` can validate HDFS settings. This option is not needed when `HADOOP_HOME` environment variable is set.

--stdout

Display collected host information from `gpcheck`. No checks or validations are performed.

--zipout

Save all collected data to a `.zip` file in the current working directory. `gpcheck` automatically creates the `.zip` file and names it `gpcheck_`*`timestamp`*`.tar.gz`. No checks or validations are performed.

--zipin file

Use this option to decompress and check a `.zip` file created with the `--zipout` option. `gpcheck` performs validation tasks against the file you specify in this option.

-? (help)

Displays the online help.

--version

Displays the version of this utility.

Examples

To verify and validate the HAWQ platform settings, enter a host file and specify the master host and the standby master host:

```
# gpcheck -f hostfile_gpcheck -m mdw -s smdw
```

Save HAWQ platform settings to a zip file, when `HADOOP_HOME` environment variable is set::

```
# gpcheck -f hostfile_gpcheck -m mdw -s smdw --zipout
```

Verify and validate the HAWQ platform settings using a zip file created with the `--zipout` option:

```
# gpcheck --zipin gpcheck_timestamp.tar.gz
```

View collected HAWQ platform settings:

```
# gpcheck -f hostfile_gpcheck -m mdw -s smdw --stdout
```

See Also

`gpcheckperf`

gpcheckperf

Verifies the baseline hardware performance of the specified hosts.

Synopsis

```
gpcheckperf -d test_directory [-d test_directory ...]
        {-f hostfile_gpcheckperf | - h hostname [-h hostname ...]}
        [-r ds] [-B block_size] [-S file_size] [-D] [-v|-V]

gpcheckperf -d temp_directory
         {-f hostfile_gpchecknet | - h hostname [-h hostname ...]}
         [ -r n|N|M [--duration time] [--netperf] ] [-D] [-v|-V]

gpcheckperf -?

gpcheckperf --version
```

Description

The `gpcheckperf` utility starts a session on the specified hosts and runs the following performance tests:

- **Disk I/O Test (`dd` test)** — To test the sequential throughput performance of a logical disk or file system, the utility uses the **`dd`** command, which is a standard UNIX utility. It times how long it takes to write and read a large file to and from disk and calculates your disk I/O performance in megabytes (MB) per second. By default, the file size that is used for the test is calculated at two times the total random access memory (RAM) on the host. This ensures that the test is truly testing disk I/O and not using the memory cache.
- **Memory Bandwidth Test (`stream`)** — To test memory bandwidth, the utility uses the STREAM benchmark program to measure sustainable memory bandwidth (in MB/s). This tests that your system is not limited in performance by the memory bandwidth of the system in relation to the computational performance of the CPU. In applications where the data set is large (as in HAWQ), low memory bandwidth is a major performance issue. If memory bandwidth is significantly lower than the theoretical bandwidth of the CPU, then it can cause the CPU to spend significant amounts of time waiting for data to arrive from system memory.
- **Network Performance Test (`gpnetbench*`)** — To test network performance including theHAWQ interconnect, the utility runs a network benchmark program that transfers a 5 second stream of data from the current host to each remote host included in the test. The data is transferred in parallel to each remote host and the minimum, maximum, average and median network transfer rates are reported in megabytes (MB) per second. If the summary transfer rate is slower than expected (less than 100 MB/s), you can run the network test serially using the `-r n` option to obtain per-host results. To run a full-matrix bandwidth test, you can specify `-r M` which will cause every host to send and receive data from every other host specified. This test is best used to validate if the switch fabric can tolerate a full-matrix workload.

To specify the hosts to test, use the `-f` option to specify a file containing a list of host names, or use the `-h` option to name single host names on the command-line. If running the network performance test, all entries in the host file must be for network interfaces within the same subnet. If your segment hosts have multiple network interfaces configured on different subnets, run the network test once for each subnet.

You must also specify at least one test directory (with `-d`). The user who runs `gpcheckperf` must have write access to the specified test directories on all remote hosts. For the disk I/O test, the test directories should correspond to your segment data directories (primary and/or mirrors). For the memory bandwidth and network tests, a temporary directory is required for the test program files.

Before using `gpcheckperf`, you must have a trusted host setup between the hosts involved in the performance test. Use the utility `gpssh-exkeys` to update the known host files and exchange public keys between hosts. Note that `gpcheckperf` calls to `gpssh` and `gpscp`, so these HAWQ utilities must also be in your `$PATH`.

Options

-B *block_size*

Specifies the block size (in KB or MB) to use for disk I/O test. The default is 32KB, the same as the HAWQ page size. The maximum block size is 1 MB.

-d *test_directory*

For the disk I/O test, specifies the file system directory locations to test. You must have write access to the test directory on all hosts involved in the performance test. You can use the `-d` option multiple times to specify multiple test directories (for example, to test disk I/O of your primary and mirror data directories).

-d *temp_directory*

For the network and stream tests, specifies a single directory where the test program files will be copied for the duration of the test. You must have write access to this directory on all hosts involved in the test.

-D (display per-host results)

Reports performance results for each host for the disk I/O tests. The default is to report results for just the hosts with the minimum and maximum performance, as well as the total and average performance of all hosts.

--duration *time*

Specifies the duration of the network test in seconds (s), minutes (m), hours (h), or days (d). The default is 15 seconds.

-f *hostfile_gpcheckperf*

For the disk I/O and stream tests, specifies the name of a file that contains one host name per host that will participate in the performance test. The host name is required, and you can optionally specify an alternate user name and/or SSH port number per host. The syntax of the host file is one host per line as follows:

`[`*`username`*`@]`*`hostname`*`[:`*`ssh_port`*`]`

-f *hostfile_gpchecknet*

For the network performance test, all entries in the host file must be for host adresses within the same subnet. If your segment hosts have multiple network interfaces configured on different subnets, run the network test once for each subnet. For example (a host file containing segment host address names for interconnect subnet 1):

```
sdw1-1
sdw2-1
sdw3-1
```

-h *hostname*

Specifies a single host name (or host address) that will participate in the performance test. You can use the `-h` option multiple times to specify multiple host names.

--netperf

Specifies that the `netperf` binary should be used to perform the network test instead of the HAWQ network test. To use this option, you must download `netperf` from www.netperf.org and install it into `$GPHOME/bin/lib` on all HAWQ hosts (master and segments).

-r ds{n|N|M}

Specifies which performance tests to run. The default is `dsn`:

- Disk I/O test (`d`)
- Stream test (`s`)
- Network performance test in sequential (`n`), parallel (`N`), or full-matrix (`M`) mode. The optional `--duration` option specifies how long (in seconds) to run the network test. To use the parallel (`N`) mode, you must run the test on an *even* number of hosts.

  If you would rather use `netperf` (www.netperf.org) instead of the HAWQ network test, you can download it and install it into `$GPHOME/bin/lib` on all HAWQ hosts (master and segments). You would then specify the optional `--netperf` option to use the `netperf` binary instead of the default `gpnetbench*` utilities.

-S *file_size*

Specifies the total file size to be used for the disk I/O test for all directories specified with `-d`. *file_size* should equal two times total RAM on the host. If not specified, the default is calculated at two times the total RAM on the host where `gpcheckperf` is executed. This ensures that the test is truly testing disk I/O and not using the memory cache. You can specify sizing in KB, MB, or GB.

-v (verbose) | -V (very verbose)

Verbose mode shows progress and status messages of the performance tests as they are run. Very verbose mode shows all output messages generated by this utility.

--version

Displays the version of this utility.

-? (help)

Displays the online help.

Examples

Run the disk I/O and memory bandwidth tests on all the hosts in the file *host_file* using the test directory of */data1* and */data2*:

```
$ gpcheckperf -f hostfile_gpcheckperf -d /data1 -d /data2 -r
ds
```

Run only the disk I/O test on the hosts named *sdw1* and *sdw2* using the test directory of */data1*. Show individual host results and run in verbose mode:

```
$ gpcheckperf -h sdw1 -h sdw2 -d /data1 -r d -D -v
```

Run the parallel network test using the test directory of */tmp,* where *hostfile_gpcheck_ic** specifies all network interface host address names within the same interconnect subnet:

```
$ gpcheckperf -f hostfile_gpchecknet_ic1 -r N -d /tmp
$ gpcheckperf -f hostfile_gpchecknet_ic2 -r N -d /tmp
```

Run the same test as above, but use `netperf` instead of the HAWQ network test (note that `netperf` must be installed in `$GPHOME/bin/lib` on all HAWQ hosts):

```
$ gpcheckperf -f hostfile_gpchecknet_ic1 -r N --netperf -d
/tmp
$ gpcheckperf -f hostfile_gpchecknet_ic2 -r N --netperf -d
/tmp
```

gpconfig

Sets server configuration parameters on all segments within a HAWQ system.

Synopsis

```
gpconfig -c param_name -v value [-m master_value | --masteronly]
       | -r param_name [--masteronly]
       | -l
   [--skipvalidation] [--verbose] [--debug]

gpconfig -s param_name [--verbose] [--debug]

gpconfig --help
```

Description

The `gpconfig` utility allows you to set, unset, or view configuration parameters from the `postgresql.conf` files of all instances (master, segments, and mirrors) in your HAWQ system. When setting a parameter, you can also specify a different value for the master if necessary. For example, parameters such as `max_connections` require a different setting on the master than what is used for the segments. If you want to set or unset a global or master only parameter, use the `--masteronly` option.

`gpconfig` can not change the configuration parameters if there are failed segments in the system.

`gpconfig` can only be used to manage certain parameters. For example, you cannot use it to set parameters such as `port`, which is required to be distinct for every segment instance. Use the `-l` (list) option to see a complete list of configuration parameters supported by `gpconfig`.

When `gpconfig` sets a configuration parameter in a segment `postgresql.conf` file, the new parameter setting always displays at the bottom of the file. When you use `gpconfig` to remove a configuration parameter setting, `gpconfig` comments out the parameter in all segment `postgresql.conf` files, thereby restoring the system default setting. For example, if you use `gpconfig` to remove (comment out) a parameter and later add it back (set a new value), there will be two instances of the parameter; one that is commented out, and one that is enabled and inserted at the bottom of the `postgresql.conf` file.

After setting a parameter, you must restart your HAWQ system or reload the `postgresql.conf` files for the change to take effect. Whether you require a restart or a reload depends on the parameter. See the Server Configuration Parameters reference for more information about the server configuration parameters.

To show the currently set values for a parameter across the system, use the `-s` option.

`gpconfig` uses the following environment variables to connect to the HAWQ master instance and obtain system configuration information:

- `PGHOST`
- `PGPORT`
- `PGUSER`

- `PGPASSWORD`
- `PGDATABASE`

Options

-c | --change *param_name*

Changes a configuration parameter setting by adding the new setting to the bottom of the `postgresql.conf` files.

-v | --value *value*

The value to use for the configuration parameter you specified with the `-c` option. By default, this value is applied to all segments, their mirrors, the master, and the standby master.

-m | --mastervalue *master_value*

The master value to use for the configuration parameter you specified with the `-c` option. If specified, this value only applies to the master and standby master. This option can only be used with `-v`.

--masteronly

When specified, `gpconfig` will only edit the master `postgresql.conf` file.

-r | --remove *param_name*

Removes a configuration parameter setting by commenting out the entry in the `postgresql.conf` files.

-l | --list

Lists all configuration parameters supported by the `gpconfig` utility.

-s | --show *param_name*

Shows the value for a specified configuration parameter used on all instances (master and segments) of the HAWQ system. If there is a discrepancy in a parameter value between instances, the `gpconfig` utility displays an error message. The `gpconfig` utility reads parameter values directly from the database, and not the `postgresql.conf` file. If you are using `gpconfig` to set configuration parameters across all segments, then running `gpconfig -s` to verify the changes, you might still see the previous (old) values. You must reload the configuration files (`gpstop -u`) or restart the system (`gpstop -r`) for changes to take effect.

--skipvalidation

Overrides the system validation checks of `gpconfig` and allows you to operate on any server configuration parameter, including hidden parameters and restricted parameters that cannot be changed by `gpconfig`. When used with the `-l` option (list), it shows the list of restricted parameters. This option should only be used to set parameters when directed by HAWQ Customer Support.

--verbose

Displays additional log information during gpconfig command execution.

--debug

Sets logging output to debug level.

-? | -h | --help

Displays the online help.

Examples

Set the max_connections setting to 100 on all segments and 10 on the master:

```
gpconfig -c max_connections -v 100 -m 10
```

Comment out all instances of the default_statistics_target configuration parameter, and restore the system default:

```
gpconfig -r default_statistics_target
```

List all configuration parameters supported by gpconfig:

```
gpconfig -l
```

Show the values of a particular configuration parameter across the system:

```
gpconfig -s max_connections
```

See Also

gpstop

gpextract

Extracts the metadata of a specified table into a YAML file.

Synopsis

```
gpextract [-h hostname] [-p port] [-U username] [-d database]
[-o output_file] [-W] <tablename>

gpextract -?

gpextract --version
```

Description

`gpextract` is a utility that extracts a table's metadata into a YAML formatted file. HAWQ's InputFormat uses this YAML-formatted file to read a HAWQ file stored on HDFS directly into the MapReduce program.

Note: `gpextract` is bound by the following rules:

You must start up HAWQ to use `gpextract`.

`gpextract` supports AO table only.

`gpextract` supports partitioned tables, but does not support sub-partitions.

Arguments

<tablename>

Name of the table that you need to extract metadata. You can use `'namespace_name.table_name'`.

Options

-o output_file

Is the name of a file that `gpextract` uses to write the metadata. If you do not specify a name, `gpextract` writes to `stdout`.

-v (verbose mode)

Optional. Displays the verbose output of the extraction process.

-? (help)

Displays the online help.

--version

Displays the version of this utility.

Connection Options

-d *database*

The database to connect to. If not specified, reads from the environment variable `$PGDATABASE` or defaults to `'template1'`.

-h hostname

Specifies the host name of the machine on which the HAWQ master database server is running. If not specified, reads from the environment variable `$PGHOST` or defaults to localhost.

-p port

Specifies the TCP port on which the HAWQ master database server is listening for connections. If not specified, reads from the environment variable `$PGPORT` or defaults to 5432.

-U username

The database role name to connect as. If not specified, reads from the environment variable `$PGUSER` or defaults to the current system user name.

-W (force password prompt)

Force a password prompt. If not specified, reads the password from the environment variable `$PGPASSWORD` or from a password file specified by `$PGPASSFILE` or in `~/.pgpass`.

Metadata File Format

The `gpextract` exports the table metadata into a file using YAML 1.1 document format. The file contains various key information about the table, such as table schema, data file locations and sizes, partition constraints and so on.

The basic structure of the metadata file is as follows:

```
Version: string (1.0.0)

FileFormat: string (AO/Parquet)

TableName: string (schemaname.tablename)

DFS_URL: string (hdfs://127.0.0.1:9000)

Encoding: UTF8

AO_Schema:
   - name: string
     type: string


AO_FileLocations:
     Blocksize: int
     Checksum: boolean
     CompressionType: string
```

```
    CompressionLevel: int
    PartitionBy: string ('PARTITION BY ...')
    Files:
    - path: string (/gpseg0/16385/35469/35470.1)
     size: long

    Partitions:
    - Blocksize: int
      Checksum: boolean
      CompressionType: string
      CompressionLevel: int
      Name: string
      Constraint: string (PARTITION Jan08 START (date
  '2008-01-01') INCLUSIVE)
      Files:
      - path: string
        size: long
```

Examples

Run `gpextract` to extract 'rank' table's metadata into a file `'rank_table.yaml'`.

```
$ gpextract -o rank_table.yaml rank
```

Output content in rank_table.yaml

```
AO_FileLocations:
    Blocksize: 32768
    Checksum: false
    CompressionLevel: 0
    CompressionType: null
    Files:
    - path: /gpseg0/16385/35469/35692.1
      size: 0
    - path: /gpseg1/16385/35469/35692.1
      size: 0
    PartitionBy: PARTITION BY list (gender)
    Partitions:
    - Blocksize: 32768
      Checksum: false
      CompressionLevel: 0
      CompressionType: null
      Constraint: PARTITION girls VALUES('F') WITH
  (appendonly=true)
      Files:
      - path: /gpseg0/16385/35469/35697.1
```

```
          size: 0
        - path: /gpseg1/16385/35469/35697.1
          size: 0
        Name: girls
      - Blocksize: 32768
        Checksum: false
        CompressionLevel: 0
        CompressionType: null
        Constraint: PARTITION boys VALUES('M') WITH
    (appendonly=true)
        Files:
        - path: /gpseg0/16385/35469/35703.1
          size: 0
        - path: /gpseg1/16385/35469/35703.1
          size: 0
        Name: boys
      - Blocksize: 32768
        Checksum: false
        CompressionLevel: 0
        CompressionType: null
        Constraint: DEFAULT PARTITION other  WITH
    (appendonly=true)
        Files:
        - path: /gpseg0/16385/35469/35709.1
          size: 90071728
        - path: /gpseg1/16385/35469/35709.1
          size: 90071512
        Name: other
AO_Schema:
- name: id
  type: int4
- name: rank
  type: int4
- name: year
  type: int4
- name: gender
  type: bpchar
- name: count
  type: int4
DFS_URL: hdfs://127.0.0.1:9000
```

```
Encoding: UTF8
FileFormat: AO
TableName: public.rank
Version: 1.0.0
```

See Also

gpload

gpfdist

Serves data files to or writes data files out from HAWQ segments.

Synopsis

gpfdist [**-d** *directory*] [**-p** *http_port*] [**-l** *log_file*] [**-t** *timeout*] [**-S**] [**-v** | **-V**] [**-m** *max_length*] [**--ssl** certificate_path]

gpfdist -?

gpfdist --version

Description

`gpfdist` is HAWQ's parallel file distribution program. It is used by readable external tables and `gpload` to serve external table files to all HAWQ segments in parallel. It is used by writable external tables to accept output streams from HAWQ segments in parallel and write them out to a file.

In order for `gpfdist` to be used by an external table, the `LOCATION` clause of the external table definition must specify the correct file location using the `gpfdist://` protocol (see `CREATE EXTERNAL TABLE`).

Note: If the `--ssl` option is specified to enable SSL security, create the external table with the `gpfdists://` protocol.

The benefit of using `gpfdist` is that you are guaranteed maximum parallelism while reading from or writing to external tables, thereby offering the best performance as well as easier administration of external tables.

For readable external tables, `gpfdist` parses and serves data files evenly to all the segment instances in the HAWQ system when users `SELECT` from the external table. For writable external tables, `gpfdist` accepts parallel output streams from the segments when users `INSERT` into the external table, and writes to an output file.

For readable external tables, if load files are compressed using `gzip` or `bzip2` (have a `.gz` or `.bz2` file extension), `gpfdist` will uncompress the files automatically before loading provided that `gunzip` or `bunzip2` is in your path.

Note: Currently, readable external tables do not support compression on Windows platforms, and writable external tables do not support compression on any platforms.

Most likely, you will want to run `gpfdist` on your ETL machines rather than the hosts where HAWQ is installed. To install `gpfdist` on another host, simply copy the utility over to that host and add `gpfdist` to your `$PATH`.

You can also run `gpfdist` as a Windows Service. See "Running gpfdist as a Windows Service" on page 258 for more details.

Options

-d *directory*

The directory from which `gpfdist` will serve files for readable external tables or create output files for writable external tables. If not specified, defaults to the current directory.

-l *log_file*

The fully qualified path and log file name where standard output messages are to be logged.

-p *http_port*

The HTTP port on which `gpfdist` will serve files. Defaults to 8080.

-t *timeout*

Sets the time allowed for HAWQ to establish a connection to a `gpfdist` process. Default is 5 seconds. Allowed values are 2 to 30 seconds. May need to be increased on systems with a lot of network traffic.

-S (use O_SYNC)

Opens the file for synchronous I/O with the `O_SYNC` flag. Any writes to the resulting file descriptor block gpfdist until the data is physically written to the underlying hardware.

-v (verbose)

Verbose mode shows progress and status messages.

-V (very verbose)

Verbose mode shows all output messages generated by this utility.

-m *max_length*

Sets the maximum allowed data row length in bytes. Default is 32768. Should be used when user data includes very wide rows (or when `line too long` error message occurs). Should not be used otherwise as it increases resource allocation. Valid range is 32K to 256MB. (The upper limit is 1MB on Windows systems.)

--ssl certificate_path

Adds SSL encryption to data transferred with `gpfdist`. After executing `gpfdist` with the `-ssl <certificate_path>` option, the only way to load data from this file server is with the *gpfdists* protocol.

The location specified in `certificate_path` must contain the following files:

- The server certificate file, `server.crt`
- The server private key file, `server.key`
- The trusted certificate authorities, `root.crt`

The root directory (`/`) cannot be specified as `certificate_path`.

-? (help)

Displays the online help.

--version

Displays the version of this utility.

Running gpfdist as a Windows Service

HAWQ Loaders allow `gpfdist` to run as a Windows Service.

Follow the instructions below to download, register and activate `gpfdist` as a service:

1. Update your HAWQ Loader package to the latest version. This package is available from the EMC Download Center.
2. Register `gpfdist` as a Windows service:
   a. Open a Windows command window
   b. Run the following command:

      ```
      sc create gpfdist binpath= "path_to_gpfdist.exe -p 8081 -d
      External\load\files\path -l Log\file\path"
      ```

      You can create multiple instances of `gpfdist` by running the same command again, with a unique name and port number for each instance, for example:

      ```
      sc create gpfdistN binpath= "path_to_gpfdist.exe -p 8082
      -d External\load\files\path -l Log\file\path"
      ```

3. Activate the `gpfdist` service:
   a. Open the Windows Control Panel and select **Administrative Tools>Services**.
   b. Highlight then right-click on the `gpfdist` service in the list of services.
   c. Select **Properties** from the right-click menu, the Service Properties window opens.

      Note that you can also stop this service from the Service Properties window.
   d. Optional: Change the **Startup Type** to **Automatic** (after a system restart, this service will be running), then under **Service** status, click **Start**.
   e. Click **OK**.

Repeat the above steps for each instance of `gpfdist` that you created.

Examples

Serve files from a specified directory using port 8081 (and start `gpfdist` in the background):

```
gpfdist -d /var/load_files -p 8081 &
```

Start `gpfdist` in the background and redirect output and errors to a log file:

```
gpfdist -d /var/load_files -p 8081 -l /home/gpadmin/log &
```

To stop `gpfdist` when it is running in the background:

--First find its process id:

```
ps ax | grep gpfdist
```

OR on Solaris

```
ps -ef | grep gpfdist
```

--Then kill the process, for example:

```
kill 3456
```

See Also

`CREATE EXTERNAL TABLE`, `gpload`

gpfilespace

Creates a filespace using a configuration file that defines per-segment file system locations. Filespaces describe the physical file system resources to be used by a tablespace.

Synopsis

gpfilespace [*connection_option* ...] [**-l** *logfile_directory*] [**-o** [*output_file_name*]]

gpfilespace [*connection_option* ...] [**-l** *logfile_directory*] **-c** *fs_config_file*

gpfilespace -v | **-?**

Description

A tablespace requires a file system location to store its database files. In HAWQ, the master and each segment needs its own distinct storage location. This collection of file system locations for all components in a HAWQ system is referred to as a *filespace*. Once a filespace is defined, it can be used by one or more tablespaces.

When used with the `-o` option, the `gpfilespace` utility looks up your system configuration information in the HAWQ catalog tables and prompts you for the appropriate file system locations needed to create the filespace. It then outputs a configuration file that can be used to create a filespace. If a file name is not specified, a `gpfilespace_config_#` file will be created in the current directory by default.

Once you have a configuration file, you can run `gpfilespace` with the `-c` option to create the filespace in HAWQ.

Options

-c | --config *fs_config_file*

A configuration file containing:

- An initial line denoting the new filespace name. For example:

  `filespace:`*`myfs`*

- One line each for the master, the primary segments, and the mirror segments. A line describes a file system location that a particular segment database instance should use as its data directory location to store database files associated with a tablespace. Each line is in the format of:

  `hostname``:`*`dbid`*`:/`*`filesystem_dir`*`/`*`seg_datadir_name`*

-l | --logdir *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-o | --output *output_file_name*

The directory location and file name to output the generated filespace configuration file. You will be prompted to enter a name for the filespace, a master file system location, the primary segment file system locations, and the mirror segment file system locations. For example, if your configuration has 2 primary and 2 mirror segments per host, you will be prompted for a total of 5 locations (including the master). The file system locations must exist on all hosts in your system prior to running the `gpfilespace` utility. The utility will designate segment-specific data directories within the location(s) you specify, so it is possible to use the same location for multiple segments. However, primaries and mirrors cannot use the same location. After the utility creates the configuration file, you can manually edit the file to make any required changes to the filespace layout before creating the filespace in HAWQ.

-v | --version (show utility version)

Displays the version of this utility.

-? | --help (help)

Displays the utility usage and syntax.

Connection Options

-h *host* | --host *host*

The host name of the machine where the HAWQ master database server is running. If not specified, reads from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port on which the HAWQ master database server is listening for connections. If not specified, reads from the environment variable `PGPORT` or defaults to 5432.

-U *username* | --username *superuser_name*

The database superuser role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system user name. Only database superusers are allowed to create filespaces.

-W | --password

Force a password prompt.

Note: gpfilespace, showfilespace, showtempfilespace, movetransfilespace, showtransfilespace, movetempfilespace are not supported.

Examples

Create a filespace configuration file. You will be prompted to enter a name for the filespace, choose a file system name, file replica number, and a DFS URL for store data.

```
$ gpfilespace -o .
```

```
Enter a name for this filespace
> example_hdfs

Available filesystem name:
filesystem: hdfs
Choose filesystem name for this filespace

> hdfs

Enter replica num for filespace. If 0, default replica num is
used (default=3)
>3

Checking your configuration:
Your system has 1 hosts with 2 segments per host.

Configuring hosts: [sdw1]

Please specify the DFS location for the segments (for
example: localhost:9000/fs)
location> 127.0.0.1:9000/hdfs
```

Example filespace configuration file:

```
filespace:example_hdfs
fsysname:hdfs
fsreplica:3
sdw1:1:/data1/master/hdfs_b/gpseg-1
sdw1:2:[127.0.0.1:9000/hdfs/gpseg0]
sdw1:3:[127.0.0.1:9000/hdfs/gpseg1]
```

Execute the configuration file to create the filespace in HAWQ:

```
$ gpfilespace -c gpfilespace_config_1
```

gpinitstandby

Adds and/or initializes a standby master host for a HAWQ system.

Synopsis

```
gpinitstandby { -s standby_hostname | -r | -n }
[-M smart | -M fast] [-a] [-q] [-D] [-L]
[-l logfile_directory]
```

```
gpinitstandby -? | -v
```

Description

The `gpinitstandby` utility adds a backup master host to your HAWQ system. If your system has an existing backup master host configured, use the `-r` option to remove it before adding the new standby master host.

Before running this utility, make sure that the HAWQ software is installed on the backup master host and that you have exchanged SSH keys between hosts. Also make sure that the master port is set to the same port number on the master host and the backup master host.

See the *HAWQ Installation Guide* for instructions. This utility should be run on the currently active *primary* master host.

The utility will perform the following steps:

- Shutdown your HAWQ system
- Update the HAWQ system catalog to remove the existing backup master host information (if the `-r` option is supplied)
- Update the HAWQ system catalog to add the new backup master host information (use the `-n` option to skip this step)
- Edit the `pg_hba.conf` files of the segment instances to allow access from the newly added standby master.
- Setup the backup master instance on the alternate master host
- Start the synchronization process
- Restart your HAWQ system

A backup master host serves as a 'warm standby' in the event of the primary master host becoming unoperational. The backup master is kept up to date by a transaction log replication process (`gpsyncagent`), which runs on the backup master host and keeps the data between the primary and backup master hosts synchronized. If the primary master fails, the log replication process is shut down, and the backup master can be activated in its place by using the utility. Upon activation of the backup master, the replicated logs are used to reconstruct the state of the master host at the time of the last successfully committed transaction.

The activated standby master effectively becomes the HAWQ master, accepting client connections on the master port and performing normal master operations such as SQL command processing and workload management.

Options

-a (do not prompt)

Do not prompt the user for confirmation.

-D (debug)

Sets logging level to debug.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-L (leave database stopped)

Leave HAWQ in a stopped state after removing the warm standby master.

-M fast (fast shutdown - rollback)

Use fast shut down when stopping HAWQ at the beginning of the standby initialization process. Any transactions in progress are interrupted and rolled back.

-M smart (smart shutdown - warn)

Use smart shut down when stopping HAWQ at the beginning of the standby initialization process. If there are active connections, this command fails with a warning. This is the default shutdown mode.

-n (resynchronize)

Use this option if you already have a standby master configured, and just want to resynchronize the data between the primary and backup master host. The HAWQ system catalog tables will not be updated.

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-r (remove standby master)

Removes the currently configured standby master host from your HAWQ system.

-s *standby_hostname*

The host name of the standby master host.

-v (show utility version)

Displays the version, status, last updated date, and check sum of this utility.

-? (help)

Displays the online help.

Examples

Add a backup master host to your HAWQ system and start the synchronization process:

```
gpinitstandby -s host09
```

Remove the existing backup master from your HAWQ system configuration:

```
gpinitstandby -r
```

Start an existing backup master host and synchronize the data with the primary master host - do not add a new HAWQ backup master host to the system catalog:

```
gpinitstandby -n
```

Note: Do not specify the `-n` and `-s` options in the same command.

gpinitsystem

Initializes a HAWQ system using configuration parameters specified in the `gpinitsystem_config` file.

Synopsis

```
gpinitsystem -c gpinitsystem_config
             [-h hostfile_gpinitsystem]
             [-B parallel_processes]
             [-p postgresql_conf_param_file]
             [-s standby_master_host]
             [--max_connections=number] [--shared_buffers=size]
             [--locale=locale] [--lc-collate=locale]
             [--lc-ctype=locale] [--lc-messages=locale]
             [--lc-monetary=locale] [--lc-numeric=locale]
             [--lc-time=locale] [--su_password=password]
             [-a] [-q] [-l logfile_directory] [-D]
```

gpinitsystem -?

gpinitsystem -v

Description

The `gpinitsystem` utility will create a HAWQ instance using the values defined in a configuration file. See “Initialization Configuration File Format” on page 270 for more information about this configuration file. Before running this utility, make sure that you have installed the HAWQ software on all the hosts in the array.

In a HAWQ DBMS, each database instance (the master and all segments) must be initialized across all of the hosts in the system in such a way that they can all work together as a unified DBMS. The `gpinitsystem` utility takes care of initializing the HAWQ master and each segment instance, and configuring the system as a whole.

Before running `gpinitsystem`, you must set the `$GPHOME` environment variable to point to the location of your HAWQ installation on the master host and exchange SSH keys between all host addresses in the array using `gpssh-exkeys`.

This utility performs the following tasks:

- Verifies that the parameters in the configuration file are correct.
- Ensures that a connection can be established to each host address. If a host address cannot be reached, the utility will exit.
- Verifies the locale settings.
- Displays the configuration that will be used and prompts the user for confirmation.
- Initializes the master instance.
- Initializes the standby master instance (if specified).
- Initializes the primary segment instances.

- Configures the HAWQ system and checks for errors.
- Starts the HAWQ system.

Options

-a (do not prompt)

Do not prompt the user for confirmation.

-B *parallel_processes*

The number of segments to create in parallel. If not specified, the utility will start up to 4 parallel processes at a time.

-c *gpinitsystem_config*

Required. The full path and filename of the configuration file, which contains all of the defined parameters to configure and initialize a new HAWQ system. See "Initialization Configuration File Format" on page 270 for a description of this file.

-D (debug)

Sets log output level to debug.

-h *hostfile_gpinitsystem*

Optional. The full path and filename of a file that contains the host addresses of your segment hosts. If not specified on the command line, you can specify the host file using the `MACHINE_LIST_FILE` parameter in the `gpinitsystem_config` file.

--locale=*locale* | -n *locale*

Sets the default locale used by HAWQ. If not specified, the `LC_ALL`, `LC_COLLATE`, or `LANG` environment variable of the master host determines the locale. If these are not set, the default locale is `C` (`POSIX`). A locale identifier consists of a language identifier and a region identifier, and optionally a character set encoding. For example, `sv_SE` is Swedish as spoken in Sweden, `en_US` is U.S. English, and `fr_CA` is French Canadian. If more than one character set can be useful for a locale, then the specifications look like this: `en_US.UTF-8` (locale specification and character set encoding). On most systems, the command `locale` will show the locale environment settings and `locale -a` will show a list of all available locales.

--lc-collate=*locale*

Similar to `--locale`, but sets the locale used for collation (sorting data). The sort order cannot be changed after HAWQ is initialized, so it is important to choose a collation locale that is compatible with the character set encodings that you plan to use for your data. There is a special collation name of `C` or `POSIX` (byte-order sorting as opposed to dictionary-order sorting). The `C` collation can be used with any character encoding.

--lc-ctype=*locale*

Similar to `--locale`, but sets the locale used for character classification (what character sequences are valid and how they are interpreted). This cannot be changed after HAWQ is initialized, so it is important to choose a character classification locale that is compatible with the data you plan to store in HAWQ.

--lc-messages=*locale*

Similar to `--locale`, but sets the locale used for messages output by HAWQ. The current version of HAWQ does not support multiple locales for output messages (all messages are in English), so changing this setting will not have any effect.

--lc-monetary=*locale*

Similar to `--locale`, but sets the locale used for formatting currency amounts.

--lc-numeric=*locale*

Similar to `--locale`, but sets the locale used for formatting numbers.

--lc-time=*locale*

Similar to `--locale`, but sets the locale used for formatting dates and times.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

--max_connections=*number* | -m *number*

Sets the maximum number of client connections allowed to the master. The default is 250.

-p *postgresql_conf_param_file*

Optional. The name of a file that contains `postgresql.conf` parameter settings that you want to set for HAWQ. These settings will be used when the individual master and segment instances are initialized. You can also set parameters after initialization using the `gpconfig` utility.

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

--shared_buffers=*size* | -b *size*

Sets the amount of memory a HAWQ server instance uses for shared memory buffers. You can specify sizing in kilobytes (kB), megabytes (MB) or gigabytes (GB). The default is 125MB.

-s *standby_master_host*

Optional. If you wish to configure a backup master host, specify the host name using this option. The HAWQ software must already be installed and configured on this host.

--su_password=*superuser_password* | -e *superuser_password*

Use this option to specify the password to set for the HAWQ superuser account (such as `gpadmin`). If this option is not specified, the default password `gparray` is assigned to the superuser account. You can use the `ALTER ROLE` command to change the password at a later time.

Recommended security best practices:

- Do not use the default password option for production environments.
- Change the password immediately after installation.

-v (show utility version)

Displays the version of this utility.

-? (help)

Displays the online help.

Initialization Configuration File Format

`gpinitsystem` requires a configuration file with the following parameters defined. An example initialization configuration file can be found in `$GPHOME/docs/cli_help/gpconfigs/gpinitsystem_config`.

ARRAY_NAME

Required. A name for the array you are configuring. You can use any name you like. Enclose the name in quotes if the name contains spaces.

MACHINE_LIST_FILE

Optional. Can be used in place of the `-h` option. This specifies the file that contains the list of segment host address names that comprise the HAWQ system. The master host is assumed to be the host from which you are running the utility and should not be included in this file. If your segment hosts have multiple network interfaces, then this file would include all addresses for the host. Give the absolute path to the file.

SEG_PREFIX

Required. This specifies a prefix that will be used to name the data directories on the master and segment instances. The naming convention for data directories in a HAWQ system is *`SEG_PREFIXnumber`* where *`number`* starts with 0 for segment instances (the master is always -1). So for example, if you choose the prefix `gpseg`, your master instance data directory would be named `gpseg-1`, and the segment instances would be named `gpseg0`, `gpseg1`, `gpseg2`, `gpseg3`, and so on.

PORT_BASE

Required. This specifies the base number by which primary segment port numbers are calculated. The first primary segment port on a host is set as `PORT_BASE`, and then incremented by one for each additional primary segment on that host. Valid values range from 1 through 65535.

DATA_DIRECTORY

Required. This specifies the data storage location(s) where the utility will create the primary segment data directories. The number of locations in the list dictate the number of primary segments that will get created per physical host (if multiple addresses for a host are listed in the host file, the number of segments will be spread evenly across the specified interface addresses). It is OK to list the same data storage area multiple times if you want your data directories created in the same location. The user who runs `gpinitsystem` (for example, the `gpadmin` user) must have permission to write to these directories. For example, this will create six primary segments per host:

```
declare -a DATA_DIRECTORY=(/data1/primary /data1/primary
/data1/primary /data2/primary /data2/primary /data2/primary)
```

MASTER_HOSTNAME

Required. The host name of the master instance. This host name must exactly match the configured host name of the machine (run the `hostname` command to determine the correct hostname).

MASTER_DIRECTORY

Required. This specifies the location where the data directory will be created on the master host. You must make sure that the user who runs `gpinitsystem` (for example, the `gpadmin` user) has permissions to write to this directory.

MASTER_PORT

Required. The port number for the master instance. This is the port number that users and client connections will use when accessing the HAWQ system.

DFS_NAME

Required. The distributed file system name for the HAWQ storing files. Currently, HAWQ only supported hdfs

DFS_URL

Required. The hostname, port, and relative path of distributed file system. Currently, HAWQ only supported HDFS.

TRUSTED_SHELL

Required. The shell the `gpinitsystem` utility uses to execute commands on remote hosts. Allowed values are `ssh`. You must set up your trusted host environment before running the `gpinitsystem` utility (you can use `gpssh-exkeys` to do this).

CHECK_POINT_SEGMENTS

Required. Maximum distance between automatic write ahead log (WAL) checkpoints, in log file segments (each segment is normally 16 megabytes). This will set the `checkpoint_segments` parameter in the `postgresql.conf` file for each segment instance in the HAWQ system.

ENCODING

Required. The character set encoding to use. This character set must be compatible with the `--locale` settings used, especially `--lc-collate` and `--lc-ctype`. HAWQ supports the same character sets as PostgreSQL.

DATABASE_NAME

Optional. The name of a HAWQ database to create after the system is initialized. You can always create a database later using the `CREATE DATABASE` command or the `createdb` utility.

Examples

Initialize a HAWQ array and set the superuser remote password:

```
$ gpinitsystem -c gpinitsystem_config -h
hostfile_gpinitsystem --su-password=mypassword
```

Initialize a HAWQ array with an optional standby master host:

```
$ gpinitsystem -c gpinitsystem_config -h
hostfile_gpinitsystem -s host09
```

See Also

gpssh-exkeys

gpload

Runs a load job as defined in a YAML formatted control file.

Synopsis

gpload -f *control_file* [**-l** *log_file*] [**-h** *hostname*] [**-p** *port*] [**-U** *username*] [**-d** *database*] [**-W**] [**--gpfdist_timeout** *seconds*] [[**-v** | **-V**] [**-q**]] [**-D**]

gpload -?

gpload --version

Prerequisites

The client machine where `gpload` is executed must have the following:

- Python 2.6.2 or later, `pygresql` (the Python interface to PostgreSQL), and `pyyaml`. Note that Python and the required Python libraries are included with the HAWQ server installation, so if you have HAWQ installed on the machine where `gpload` is running, you do not need a separate Python installation.

  Note: HAWQ Loaders for Windows supports only Python 2.5 (available from www.python.org).
- The `gpfdist` parallel file distribution program installed and in your `$PATH`. This program is located in `$GPHOME/bin` of your HAWQ server installation.
- Network access to and from all hosts in your HAWQ array (master and segments).
- Network access to and from the hosts where the data to be loaded resides (ETL servers).

Description

`gpload` is a data loading utility that acts as an interface to HAWQ's external table parallel loading feature. Using a load specification defined in a YAML formatted control file, `gpload` executes a load by invoking the HAWQ parallel file server (`gpfdist`), creating an external table definition based on the source data defined, and executing an `INSERT`, `UPDATE` or `MERGE` operation to load the source data into the target table in the database.

Options

-f *control_file*

Required. A YAML file that contains the load specification details. See "Control File Format" on page 275.

--gpfdist_timeout *seconds*

Sets the timeout for the `gpfdist` parallel file distribution program to send a response. Enter a value from `0` to `30` seconds (entering "`0`" to disables timeouts). Note that you might need to increase this value when operating on high-traffic networks.

-l *log_file*

Specifies where to write the log file. Defaults to `~/gpAdminLogs/gpload_`*`YYYYMMDD`*. See also, "Log File Format" on page 283.

-v (verbose mode)

Show verbose output of the load steps as they are executed.

-V (very verbose mode)

Shows very verbose output.

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-D (debug mode)

Check for error conditions, but do not execute the load.

-? (show help)

Show help, then exit.

--version

Show the version of this utility, then exit.

Connection Options

-d *database*

The database to load into. If not specified, reads from the load control file, the environment variable `$PGDATABASE` or defaults to the current system user name.

-h *hostname*

Specifies the host name of the machine on which the HAWQ master database server is running. If not specified, reads from the load control file, the environment variable `$PGHOST` or defaults to `localhost`.

-p *port*

Specifies the TCP port on which the HAWQ master database server is listening for connections. If not specified, reads from the load control file, the environment variable `$PGPORT` or defaults to 5432.

-U *username*

The database role name to connect as. If not specified, reads from the load control file, the environment variable `$PGUSER` or defaults to the current system user name.

-W (force password prompt)

Force a password prompt. If not specified, reads the password from the environment variable `$PGPASSWORD` or from a password file specified by `$PGPASSFILE` or in `~/.pgpass`. If these are not set, then `gpload` will prompt for a password even if `-W` is not supplied.

Control File Format

The `gpload` control file uses the YAML 1.1 document format and then implements its own schema for defining the various steps of a HAWQ load operation. The control file must be a valid YAML document.

The `gpload` program processes the control file document in order and uses indentation (spaces) to determine the document hierarchy and the relationships of the sections to one another. The use of white space is significant. White space should not be used simply for formatting purposes, and tabs should not be used at all.

The basic structure of a load control file is:

```
---
VERSION: 1.0.0.1
DATABASE: db_name
USER: db_username
HOST: master_hostname
PORT: master_port
GPLOAD:
   INPUT:
    - SOURCE:
         LOCAL_HOSTNAME:
           - hostname_or_ip
         PORT: http_port
       | PORT_RANGE: [start_port_range, end_port_range]
         FILE:
           - /path/to/input_file
         SSL: true | false
         CERTIFICATES_PATH: /path/to/certificates
    - COLUMNS:
           - field_name: data_type
```

```
    - TRANSFORM: 'transformation'
    - TRANSFORM_CONFIG: 'configuration-file-path'
    - MAX_LINE_LENGTH: integer
    - FORMAT: text | csv
    - DELIMITER: 'delimiter_character'
    - ESCAPE: 'escape_character' | 'OFF'
    - NULL_AS: 'null_string'
    - FORCE_NOT_NULL: true | false
    - QUOTE: 'csv_quote_character'
    - HEADER: true | false
    - ENCODING: database_encoding
   OUTPUT:
    - TABLE: schema.table_name
    - MODE: insert | update | merge
    - MATCH_COLUMNS:
           - target_column_name
    - UPDATE_COLUMNS:
           - target_column_name
    - UPDATE_CONDITION: 'boolean_condition'
    - MAPPING:
            target_column_name: source_column_name |
'expression'
   PRELOAD:
    - TRUNCATE: true | false
    - REUSE_TABLES: true | false
   SQL:
    - BEFORE: "sql_command"
    - AFTER: "sql_command"
```

VERSION

Optional. The version of the `gpload` control file schema. The current version is 1.0.0.1.

DATABASE

Optional. Specifies which database in HAWQ to connect to. If not specified, defaults to `$PGDATABASE` if set or the current system user name. You can also specify the database on the command line using the `-d` option.

USER

Optional. Specifies which database role to use to connect. If not specified, defaults to the current user or `$PGUSER` if set. You can also specify the database role on the command line using the `-U` option.

If the user running `gpload` is not a HAWQ superuser, then the server configuration parameter `gp_external_grant_privileges` must be set to `on` in order for the load to be processed.

HOST

Optional. Specifies HAWQ master host name. If not specified, defaults to localhost or `$PGHOST` if set. You can also specify the master host name on the command line using the `-h` option.

PORT

Optional. Specifies HAWQ master port. If not specified, defaults to 5432 or `$PGPORT` if set. You can also specify the master port on the command line using the `-p` option.

GPLOAD

Required. Begins the load specification section. A `GPLOAD` specification must have an `INPUT` and an `OUTPUT` section defined.

INPUT

Required. Defines the location and the format of the input data to be loaded. `gpload` will start one or more instances of the `gpfdist` file distribution program on the current host and create the required external table definition(s) in HAWQ that point to the source data. Note that the host from which you run `gpload` must be accessible over the network by all HAWQ hosts (master and segments).

SOURCE

Required. The `SOURCE` block of an `INPUT` specification defines the location of a source file. An `INPUT` section can have more than one `SOURCE` block defined. Each `SOURCE` block defined corresponds to one instance of the `gpfdist` file distribution program that will be started on the local machine. Each `SOURCE` block defined must have a `FILE` specification.

LOCAL_HOSTNAME

Optional. Specifies the host name or IP address of the local machine on which `gpload` is running. If this machine is configured with multiple network interface cards (NICs), you can specify the host name or IP of each individual NIC to allow network traffic to use all NICs simultaneously. The default is to use the local machine’s primary host name or IP only.

PORT

Optional. Specifies the specific port number that the gpfdist file distribution program should use. You can also supply a PORT_RANGE to select an available port from the specified range. If both PORT and PORT_RANGE are defined, then PORT takes precedence. If neither PORT or PORT_RANGE are defined, the default is to select an available port between 8000 and 9000.

If multiple host names are declared in LOCAL_HOSTNAME, this port number is used for all hosts. This configuration is desired if you want to use all NICs to load the same file or set of files in a given directory location.

PORT_RANGE

Optional. Can be used instead of PORT to supply a range of port numbers from which gpload can choose an available port for this instance of the gpfdist file distribution program.

FILE

Required. Specifies the location of a file, named pipe, or directory location on the local file system that contains data to be loaded. You can declare more than one file so long as the data is of the same format in all files specified.

If the files are compressed using gzip or bzip2 (have a .gz or .bz2 file extension), the files will be uncompressed automatically (provided that gunzip or bunzip2 is in your path).

When specifying which source files to load, you can use the wildcard character (*) or other C-style pattern matching to denote multiple files. The files specified are assumed to be relative to the current directory from which gpload is executed (or you can declare an absolute path).

SSL

Optional. Specifies usage of SSL encryption.

CERTIFICATES_PATH

Required when SSL is true; cannot be specified when SSL is false or unspecified. The location specified in CERTIFICATES_PATH must contain the following files:

- The server certificate file, server.crt
- The server private key file, server.key
- The trusted certificate authorities, root.crt

The root directory (/) cannot be specified as CERTIFICATES_PATH.

COLUMNS

Optional. Specifies the schema of the source data file(s) in the format of `field_name: data_type`. The `DELIMITER` character in the source file is what separates two data value fields (columns). A row is determined by a line feed character (`0x0a`).

If the input `COLUMNS` are not specified, then the schema of the output `TABLE` is implied, meaning that the source data must have the same column order, number of columns, and data format as the target table.

The default source-to-target mapping is based on a match of column names as defined in this section and the column names in the target `TABLE`. This default mapping can be overridden using the `MAPPING` section.

TRANSFORM

Optional. Specifies the name of the input XML transformation passed to `gpload`.

TRANSFORM_CONFIG

Optional. Specifies the location of the XML transformation configuration file that is specified in the TRANSFORM parameter, above.

MAX_LINE_LENGTH

Optional. An integer that specifies the maximum length of a line in the XML transformation data passed to `gpload`.

FORMAT

Optional. Specifies the format of the source data file(s) - either plain text (`TEXT`) or comma separated values (`CSV`) format. Defaults to `TEXT` if not specified.

DELIMITER

Optional. Specifies a single ASCII character that separates columns within each row (line) of data. The default is a tab character in `TEXT` mode, a comma in `CSV` mode. You can also specify a non-printable ASCII character via an escape sequence using the decimal representation of the ASCII character. For example, `\014` represents the shift out character.

ESCAPE

Specifies the single character that is used for C escape sequences (such as `\n`,`\t`,`\100`, and so on) and for escaping data characters that might otherwise be taken as row or column delimiters. Make sure to choose an escape character that is not used anywhere in your actual column data. The default escape character is a \ (backslash) for text-formatted files and a `"` (double quote) for csv-formatted files, however it is possible to specify another character to represent an escape. It is also possible to disable escaping in text-formatted files by specifying the value `'OFF'` as the escape value. This is very useful for data such as text-formatted web log data that has many embedded backslashes that are not intended to be escapes.

NULL_AS

Optional. Specifies the string that represents a null value. The default is `\N` (backslash-N) in `TEXT` mode, and an empty value with no quotations in `CSV` mode. You might prefer an empty string even in `TEXT` mode for cases where you do not want to distinguish nulls from empty strings. Any source data item that matches this string will be considered a null value.

FORCE_NOT_NULL

Optional. In CSV mode, processes each specified column as though it were quoted and hence not a NULL value. For the default null string in CSV mode (nothing between two delimiters), this causes missing values to be evaluated as zero-length strings.

QUOTE

Required when `FORMAT` is `CSV`. Specifies the quotation character for `CSV` mode. The default is double-quote (`"`).

HEADER

Optional. Specifies that the first line in the data file(s) is a header row (contains the names of the columns) and should not be included as data to be loaded. If using multiple data source files, all files must have a header row. The default is to assume that the input files do not have a header row.

ENCODING

Optional. Character set encoding of the source data. Specify a string constant (such as `'SQL_ASCII'`), an integer encoding number, or `'DEFAULT'` to use the default client encoding.

ERROR_LIMIT

Optional. Enables single row error isolation mode for this load operation. When enabled, input rows that have format errors will be discarded provided that the error limit count is not reached on any HAWQ segment instance during input processing. If the error limit is not reached, all good rows will be loaded and any error rows will either be discarded or logged to the table specified in `ERROR_TABLE`. The default is to abort the load operation on the first error encountered. Note that single row error isolation only applies to data rows with format errors; for example, extra or missing attributes, attributes of a wrong data type, or invalid client encoding sequences. Constraint errors, such as primary key violations, will still cause the load operation to abort if encountered.

ERROR_TABLE

Optional when ERROR_LIMIT is declared. Specifies an error table where rows with formatting errors will be logged when running in single row error isolation mode. You can then examine this error table to see error rows that were not loaded (if any). If the *error_table* specified already exists, it will be used. If it does not exist, it will be automatically generated.

OUTPUT

Required. Defines the target table and final data column values that are to be loaded into the database.

TABLE

Required. The name of the target table to load into.

MODE

Optional. Defaults to INSERT if not specified. There are three available load modes:

INSERT - Loads data into the target table using the following method:
INSERT INTO *target_table* SELECT * FROM *input_data*;

UPDATE - Updates the UPDATE_COLUMNS of the target table where the rows have MATCH_COLUMNS attribute values equal to those of the input data, and the optional UPDATE_CONDITION is true.

MERGE - Inserts new rows and updates the UPDATE_COLUMNS of existing rows where MATCH_COLUMNS attribute values are equal to those of the input data, and the optional UPDATE_CONDITION is true. New rows are identified when the MATCH_COLUMNS value in the source data does not have a corresponding value in the existing data of the target table. In those cases, the **entire row** from the source file is inserted, not only the MATCH and UPDATE columns. If there are multiple new MATCH_COLUMNS values that are the same, only one new row for that value will be inserted. Use UPDATE_CONDITION to filter out the rows to discard.

MATCH_COLUMNS

Required if MODE is UPDATE or MERGE. Specifies the column(s) to use as the join condition for the update. The attribute value in the specified target column(s) must be equal to that of the corresponding source data column(s) in order for the row to be updated in the target table.

UPDATE_COLUMNS

Required if MODE is UPDATE or MERGE. Specifies the column(s) to update for the rows that meet the MATCH_COLUMNS criteria and the optional UPDATE_CONDITION.

UPDATE_CONDITION

Optional. Specifies a Boolean condition (similar to what you would declare in a WHERE clause) that must be met in order for a row in the target table to be updated (or inserted in the case of a MERGE).

MAPPING

Optional. If a mapping is specified, it overrides the default source-to-target column mapping. The default source-to-target mapping is based on a match of column names as defined in the source COLUMNS section and the column names of the target TABLE. A mapping is specified as either:

```
target_column_name: source_column_name
```

or

```
target_column_name: 'expression'
```

Where *expression* is any expression that you would specify in the SELECT list of a query, such as a constant value, a column reference, an operator invocation, a function call, and so on.

PRELOAD

Optional. Specifies operations to run prior to the load operation. Right now the only preload operation is TRUNCATE.

TRUNCATE

Optional. If set to true, gpload will remove all rows in the target table prior to loading it.

REUSE_TABLES

Optional. If set to true, gpload will not drop the external table objects and staging table objects it creates. These objects will be reused for future load operations that use the same load specifications. This improves performance of trickle loads (ongoing small loads to the same target table).

SQL

Optional. Defines SQL commands to run before and/or after the load operation. You can specify multiple BEFORE and/or AFTER commands. List commands in the order of desired execution.

BEFORE

Optional. An SQL command to run before the load operation starts. Enclose commands in quotes.

AFTER

Optional. An SQL command to run after the load operation completes. Enclose commands in quotes.

Notes

If your database object names were created using a double-quoted identifier (delimited identifier), you must specify the delimited name within single quotes in the `gpload` control file. For example, if you create a table as follows:

```
CREATE TABLE "MyTable" ("MyColumn" text);
```

Your YAML-formatted `gpload` control file would refer to the above table and column names as follows:

```
- COLUMNS:
   - '"MyColumn"': text
OUTPUT:
   - TABLE: public.'"MyTable"'
```

Log File Format

Log files output by `gpload` have the following format:

```
timestamp|level|message
```

Where *`timestamp`* takes the form: `YYYY-MM-DD HH:MM:SS`, *`level`* is one of `DEBUG`, `LOG`, `INFO`, `ERROR`, and *`message`* is a normal text message.

Some `INFO` messages that may be of interest in the log files are (where `#` corresponds to the actual number of seconds, units of data, or failed rows):

```
INFO|running time: #.## seconds
INFO|transferred #.# kB of #.# kB.
INFO|gpload succeeded
INFO|gpload succeeded with warnings
INFO|gpload failed
INFO|1 bad row
INFO|# bad rows
```

Examples

Run a load job as defined in *my_load.yml*:

```
gpload -f my_load.yml
```

Example load control file:

```
---
VERSION: 1.0.0.1
DATABASE: ops
USER: gpadmin
HOST: mdw-1
PORT: 5432
GPLOAD:
   INPUT:
```

```
      - SOURCE:
           LOCAL_HOSTNAME:
             - etl1-1
             - etl1-2
             - etl1-3
             - etl1-4
           PORT: 8081
           FILE:
             - /var/load/data/*
      - COLUMNS:
             - name: text
             - amount: float4
             - category: text
             - desc: text
             - date: date
      - FORMAT: text
      - DELIMITER: '|'
OUTPUT:
      - TABLE: payables.expenses
      - MODE: INSERT
   SQL:
   - BEFORE: "INSERT INTO audit VALUES('start',
current_timestamp)"
   - AFTER: "INSERT INTO audit VALUES('end',
current_timestamp)"
```

See Also

gpfdist, CREATE EXTERNAL TABLE

gplogfilter

Searches through HAWQ log files for specified entries.

Synopsis

gplogfilter [*timestamp_options*] [*pattern_options*]
[*output_options*] [*input_options*] [*input_file*]

gplogfilter --help

gplogfilter --version

Description

The `gplogfilter` utility can be used to search through a HAWQ log file for entries matching the specified criteria. If an input file is not supplied, then `gplogfilter` will use the `$MASTER_DATA_DIRECTORY` environment variable to locate the HAWQ master log file in the standard logging location. To read from standard input, use a dash (-) as the input file name. Input files may be compressed using `gzip`. In an input file, a log entry is identified by its timestamp in `YYYY-MM-DD [hh:mm[:ss]]` format.

You can also use `gplogfilter` to search through all segment log files at once by running it through the `gpssh` utility. For example, to display the last three lines of each segment log file:

```
gpssh -f seg_host_file
=> source /usr/local/greenplum-db/greenplum_path.sh
=> gplogfilter -n 3 /gpdata/*/pg_log/gpdb*.log
```

By default, the output of `gplogfilter` is sent to standard output. Use the `-o` option to send the output to a file or a directory. If you supply an output file name ending in `.gz`, the output file will be compressed by default using maximum compression. If the output destination is a directory, the output file is given the same name as the input file.

Options

Timestamp Options

-b *datetime* | --begin=*datetime*

Specifies a starting date and time to begin searching for log entries in the format of `YYYY-MM-DD [hh:mm[:ss]]`.

-e *datetime* | --end=*datetime*

Specifies an ending date and time to stop searching for log entries in the format of `YYYY-MM-DD [hh:mm[:ss]]`.

-d *time* | --duration=*time*

Specifies a time duration to search for log entries in the format of `[hh][:mm[:ss]]`. If used without either the `-b` or `-e` option, will use the current time as a basis.

Pattern Matching Options

-c i[gnore]|r[espect] | --case=i[gnore]|r[espect]

Matching of alphabetic characters is case sensitive by default unless proceeded by the `--case=ignore` option.

-C '<string>' | --columns='<string>'

Selects specific columns from the log file. Specify the desired columns as a comma-delimited string of column numbers beginning with 1, where the second column from left is 2, the third is 3, and so on.

-f '*string*' | --find='*string*'

Finds the log entries containing the specified string.

-F '*string*' | --nofind='*string*'

Rejects the log entries containing the specified string.

-m *regex* | --match=*regex*

Finds log entries that match the specified Python regular expression. See http://docs.python.org/library/re.html for Python regular expression syntax.

-M *regex* | --nomatch=*regex*

Rejects log entries that match the specified Python regular expression. See http://docs.python.org/library/re.html for Python regular expression syntax.

-t | --trouble

Finds only the log entries that have `ERROR:`, `FATAL:`, or `PANIC:` in the first line.

Output Options

-n *integer* | --tail=*integer*

Limits the output to the last *`integer`* of qualifying log entries found.

-s *offset* [*limit*] | --slice=*offset* [*limit*]

From the list of qualifying log entries, returns the *`limit`* number of entries starting at the *`offset`* entry number, where an *`offset`* of zero (`0`) denotes the first entry in the result set and an *`offset`* of any number greater than zero counts back from the end of the result set.

-o *output_file* | --out=*output_file*

Writes the output to the specified file or directory location instead of `STDOUT`.

-z 0-9 | --zip=0-9

Compresses the output file to the specified compression level using `gzip`, where `0` is no compression and `9` is maximum compression. If you supply an output file name ending in `.gz`, the output file will be compressed by default using maximum compression.

-a | --append

If the output file already exists, appends to the file instead of overwriting it.

Input Options

input_file

The name of the input log file(s) to search through. If an input file is not supplied, `gplogfilter` will use the `$MASTER_DATA_DIRECTORY` environment variable to locate the HAWQ master log file. To read from standard input, use a dash (-) as the input file name.

-u | --unzip

Uncompress the input file using `gunzip`. If the input file name ends in `.gz`, it will be uncompressed by default.

--help

Displays the online help.

--version

Displays the version of this utility.

Examples

Display the last three error messages in the master log file:

```
gplogfilter -t -n 3
```

Display all log messages in the master log file timestamped in the last 10 minutes:

```
gplogfilter -d :10
```

Display log messages in the master log file containing the string `|con6 cmd11|`:

```
gplogfilter -f '|con6 cmd11|'
```

Using `gpssh`, run `gplogfilter` on the segment hosts and search for log messages in the segment log files containing the string `con6` and save output to a file.

```
gpssh -f seg_hosts_file -e 'source
/usr/local/greenplum-db/greenplum_path.sh ; gplogfilter -f
con6 /gpdata/*/pg_log/gpdb.log' > seglog.out
```

See Also

`gpssh`, `gpscp`

gprecoverseg

Recovers a segment instance that has been marked as down.

Synopsis

```
gprecoverseg [-p new_recover_host[,...] | -i recover_config_file
| -s filespace_config_file] [-d master_data_directory] [-B
parallel_processes] [-F] [-a] [-q] [-l logfile_directory]

gprecoverseg -o output_recover_config_file
          | -S output_filespace_config_file
            [-p new_recover_host[,...]

gprecoverseg -?

gprecoverseg --version
```

Description

The gprecoverseg utility reactivates a failed segment instance.Once gprecoverseg completes this process, the system will be recovered.

A segment instance can fail for several reasons, such as a host failure, network failure, or disk failure. When a segment instance fails, its status is marked as down in the HAWQ system catalog, and the master will random pickup a segment to process query for a session. In order to bring the failed segment instance back into operation again, you must first correct the problem that made it fail in the first place, and then recover the segment instance in HAWQ using `gprecoverseg`.

Segment recovery using gprecoverseg requires that you have at least one alive segment to recover from. For systems that do not have alive segment do a system restart to bring the segments back online (`gpstop -r`).

By default, a failed segment is recovered in place, meaning that the system brings the segment back online on the same host and data directory location on which it was originally configured. In this case, use the following format for the recovery configuration file (using `-i`).

```
filespaceOrder=<failed_host_address>:<port>:<data_directory>
```

If the data directory was removed or damaged, gprecoverseg can recover the data directory (using -F). This requires that you have at least one alive segment to recover from.

In some cases, this may not be possible (for example, if a host was physically damaged and cannot be recovered). In this situation, `gprecoverseg` allows you to recover failed segments to a completely new host (using `-p`), on an alternative data directory location on your remaining live segment hosts (using `-s`), or by supplying a recovery configuration file (using `-i`) in the following format. The word `SPACE` indicates the location of a required space. Do not add additional spaces.

```
filespaceOrder=[filespace1_fsname[, filespace2_fsname[, ...]]
<failed_host_address>:<port>:<data_directory>SPACE
<recovery_host_address>:<port>:<replication_port>:<data_directory>
[:<fselocation>:...]
```

See the `-i` option below for details and examples of a recovery configuration file.

The new recovery segment host must be pre-installed with the HAWQ software and configured exactly the same as the existing segment hosts. A spare data directory location must exist on all currently configured segment hosts and have enough disk space to accommodate the failed segments.

If you do not have mirroring enabled or if you have both a primary and its mirror down, you must take manual steps to recover the failed segment instances and then restart the system, for example:

```
gpstop -r
```

Options

-a (do not prompt)

Do not prompt the user for confirmation.If gprecovery -a can not recovery successfully, HAWQ will raise an exception and tell user to use -F or -p option.

-B *parallel_processes*

The number of segments to recover in parallel. If not specified, the utility will start up to four parallel processes depending on how many segment instances it needs to recover.

-d *master_data_directory*

Optional. The master host data directory. If not specified, the value set for `$MASTER_DATA_DIRECTORY` will be used.

-F (full recovery)

Optional. Perform a full copy of the active segment instance in order to recover the failed segment. The default is to only restart the failed segment in-place.

-i *recover_config_file*

Specifies the name of a file with the details about failed segments to recover. Each line in the file is in the following format. The word `SPACE` indicates the location of a required space. Do not add additional spaces.

```
filespaceOrder=[filespace1_fsname[, filespace2_fsname[, ...]]
<failed_host_address>:<port>:<data_directory>SPACE
<recovery_host_address>:<port>:<replication_port>:<data_directory>
[:<fselocation>:...]
```

Comments

Lines beginning with `#` are treated as comments and ignored.

Filespace Order

The first comment line that is not a comment specifies filespace ordering. This line starts with `filespaceOrder=` and is followed by list of filespace names delimited by a colon. For example:

```
filespaceOrder=raid1:raid2
```

The default `pg_system` filespace should not appear in this list. The list should be left empty on a system with no filespaces other than the default `pg_system` filespace. For example:

```
filespaceOrder=
```

Segments to Recover

Each line after the first specifies a segment to recover. This line can have one of two formats. In the event of in-place recovery, enter one group of colon delimited fields in the line:

```
failedAddress:failedPort:failedDataDirectory
```

For recovery to a new location, enter two groups of fields separated by a space in the line. The required space is indicated by `SPACE`. Do not add additional spaces.

```
failedAddress:failedPort:failedDataDirectorySPACEnewAddre
ss:newPort:newReplicationPort:newDataDirectory
```

On a system with additional filespaces, the second group of fields is expected to be followed with a list of the corresponding filespace locations separated by additional colons. For example, on a system with two additional filespaces, enter two additional directories in the second group, as follows. The required space is indicated by `SPACE`. Do not add additional spaces.

```
failedAddress:failedPort:failedDataDirectory
newAddress:newPort:newReplicationPort:newDataDirectory:locat
ion1:location2
```

Examples

In-place recovery of a single mirror

```
filespaceOrder=
sdw1-1:50001:/data1/mirror/gpseg16
```

Recovery of a single mirror to a new host

```
filespaceOrder=
sdw1-1:50001:/data1/mirror/gpseg16SPACE
sdw4-1:50001:51001:/data1/recover1/gpseg16
```

Recovery of a single mirror to a new host on a system with an extra filespace

```
filespaceOrder=fs1
sdw1-1:50001:/data1/mirror/gpseg16SPACE
sdw4-1:50001:51001:/data1/recover1/gpseg16:/data1/fs1/gps
eg16
```

Obtaining a Sample File

You can use the `-o` option to output a sample recovery configuration file to use as a starting point.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-o *output_recover_config_file*

Specifies a file name and location to output a sample recovery configuration file. The output file lists the currently invalid segments and their default recovery location in the format that is required by the `-i` option. Use together with the `-p` option to output a sample file for recovering on a different host. This file can be edited to supply alternate recovery locations if needed.

-p *new_recover_host*[,...]

Specifies a spare host outside of the currently configured HAWQ array on which to recover invalid segments. In the case of multiple failed segment hosts, you can specify a comma-separated list. The spare host must have the HAWQ software installed and configured, and have the same hardware and OS configuration as the current segment hosts (same OS version, locales, `gpadmin` user account, data directory locations created, ssh keys exchanged, number of network interfaces, network interface naming convention, and so on.).

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-s *filespace_config_file*

Specifies the name of a configuration file that contains file system locations on the currently configured segment hosts where you can recover failed segment instances. The filespace configuration file is in the format of:

```
pg_system=default_fselocation
```

If your system does have additional filespaces configured, this file will only have one location for the default filespace, *pg_system*. These file system locations must exist on all segment hosts in the array and have sufficient disk space to accommodate recovered segments.

-S *output_filespace_config_file*

Specifies a file name and location to output a sample filespace configuration file in the format that is required by the `-s` option. This file should be edited to supply the correct alternate filespace locations.

-v (verbose)

Sets logging output to verbose.

--version (version)

Displays the version of this utility.

-? (help)

Displays the online help.

Examples

Recover any failed segment instances in place:

```
$ gprecoverseg
```

Recover any failed segment instances to a newly configured spare segment host:

```
$ gprecoverseg -i recover_config_file
```

Output the default recovery configuration file:

```
$ gprecoverseg -o /home/gpadmin/recover_config_file
```

See Also

`gpstart`, `gpstop`

gpscp

Copies files between multiple hosts at once.

Synopsis

```
gpscp { -f hostfile_gpssh | - h hostname [-h hostname ...] }
[-J character] [-v] [[user@]hostname:]file_to_copy [...]
[[user@]hostname:]copy_to_path
```

```
gpscp -?
```

```
gpscp --version
```

Description

The `gpscp` utility allows you to copy one or more files from the specified hosts to other specified hosts in one command using SCP (secure copy). For example, you can copy a file from the HAWQ master host to all of the segment hosts at the same time.

To specify the hosts involved in the SCP session, use the `-f` option to specify a file containing a list of host names, or use the `-h` option to name single host names on the command-line. At least one host name (`-h`) or a host file (`-f`) is required. The `-J` option allows you to specify a single character to substitute for the *hostname* in the copy from and to destination strings. If `-J` is not specified, the default substitution character is an equal sign (`=`). For example, the following command will copy *.bashrc* from the local host to `/home/gpadmin` on all hosts named in *hostfile_gpssh*:

```
gpscp -f hostfile_gpssh .bashrc =:/home/gpadmin
```

If a user name is not specified in the host list or with *`user@`* in the file path, `gpscp` will copy files as the currently logged in user. To determine the currently logged in user, do a `whoami` command. By default, `gpscp` goes to `$HOME` of the session user on the remote hosts after login. To ensure the file is copied to the correct location on the remote hosts, it is recommended that you use absolute paths.

Before using `gpscp`, you must have a trusted host setup between the hosts involved in the SCP session. You can use the utility `gpssh-exkeys` to update the known host files and exchange public keys between hosts if you have not done so already.

Options

-f *hostfile_gpssh*

Specifies the name of a file that contains a list of hosts that will participate in this SCP session. The syntax of the host file is one host per line as follows:

```
<hostname>
```

-h *hostname*

Specifies a single host name that will participate in this SCP session. You can use the `-h` option multiple times to specify multiple host names.

-J *character*

The `-J` option allows you to specify a single character to substitute for the *hostname* in the copy from and to destination strings. If `-J` is not specified, the default substitution character is an equal sign (`=`).

-v (verbose mode)

Optional. Reports additional messages in addition to the SCP command output.

file_to_copy

Required. The file name (or absolute path) of a file that you want to copy to other hosts (or file locations). This can be either a file on the local host or on another named host.

copy_to_path

Required. The path where you want the file(s) to be copied on the named hosts. If an absolute path is not used, the file will be copied relative to `$HOME` of the session user. You can also use the equal sign '`=`' (or another character that you specify with the `-J` option) in place of a *hostname*. This will then substitute in each host name as specified in the supplied host file (`-f`) or with the `-h` option.

-? (help)

Displays the online help.

--version

Displays the version of this utility.

Examples

Copy the file named *installer.tar* to `/` on all the hosts in the file *hostfile_gpssh*.

```
gpscp -f hostfile_gpssh installer.tar =:/
```

Copy the file named *myfuncs.so* to the specified location on the hosts named *sdw1* and *sdw2*:

```
gpscp -h sdw1 -h sdw2 myfuncs.so \
=:/usr/local/greenplum-db/lib
```

gpssh

Provides ssh access to multiple hosts at once.

Synopsis

gpssh { **-f** *hostfile_gpssh* | **- h** *hostname* [**-h** *hostname* ...] } [-u userid] [**-v**] [**-e**] [*bash_command*]

gpssh -?

gpssh --version

Description

The `gpssh` utility allows you to run bash shell commands on multiple hosts at once using SSH (secure shell). You can execute a single command by specifying it on the command-line, or omit the command to enter into an interactive command-line session.

To specify the hosts involved in the SSH session, use the `-f` option to specify a file containing a list of host names, or use the `-h` option to name single host names on the command-line. At least one host name (`-h`) or a host file (`-f`) is required. Note that the current host is *not* included in the session by default — to include the local host, you must explicitly declare it in the list of hosts involved in the session.

Before using `gpssh`, you must have a trusted host setup between the hosts involved in the SSH session. You can use the utility `gpssh-exkeys` to update the known host files and exchange public keys between hosts if you have not done so already.

If you do not specify a command on the command-line, `gpssh` will go into interactive mode. At the `gpssh` command prompt (`=>`), you can enter a command as you would in a regular bash terminal command-line, and the command will be executed on all hosts involved in the session. To end an interactive session, press `CTRL+D` on the keyboard or type `exit` or `quit`.

If a user name is not specified in the host file, `gpssh` will execute commands as the currently logged in user. To determine the currently logged in user, do a `whoami` command. By default, `gpssh` goes to `$HOME` of the session user on the remote hosts after login. To ensure commands are executed correctly on all remote hosts, you should always enter absolute paths.

Options

bash_command

A bash shell command to execute on all hosts involved in this session (optionally enclosed in quotes). If not specified, `gpssh` will start an interactive session.

-e (echo)

Optional. Echoes the commands passed to each host and their resulting output while running in non-interactive mode.

-f *hostfile_gpssh*

Specifies the name of a file that contains a list of hosts that will participate in this SSH session. The host name is required, and you can optionally specify an alternate user name and/or SSH port number per host. The syntax of the host file is one host per line as follows:

```
[username@]hostname[:ssh_port]
```

-h *hostname*

Specifies a single host name that will participate in this SSH session. You can use the `-h` option multiple times to specify multiple host names.

-u *<userid>*

Specifies the userid for this SSH session.

-v (verbose mode)

Optional. Reports additional messages in addition to the command output when running in non-interactive mode.

--version

Displays the version of this utility.

-? (help)

Displays the online help.

Examples

Start an interactive group SSH session with all hosts listed in the file *hostfile_gpssh*:

```
$ gpssh -f hostfile_gpssh
```

At the `gpssh` interactive command prompt, run a shell command on all the hosts involved in this session.

```
=> ls -a /data/primary/*
```

Exit an interactive session:

```
=> exit
```

Start a non-interactive group SSH session with the hosts named *dw1* and *dw2* and pass a file containing several commands named *command_file* to `gpssh`:

```
$ gpssh -h sdw1 -h sdw2 -v -e < command_file
```

Execute single commands in non-interactive mode on hosts *sdw2* and *localhost*:

```
$ gpssh -h sdw2 -h localhost -v -e 'ls -a /data/primary/*'
$ gpssh -h sdw2 -h localhost -v -e 'echo $GPHOME'
$ gpssh -h sdw2 -h localhost -v -e 'ls -1 | wc -l'
```

gpssh-exkeys

Exchanges SSH public keys between hosts.

Synopsis

gpssh-exkeys `-f <hostfile_exkeys> [-p <password>] | -h <hostname> [-h <hostname> ...] [-p <password>]`

gpssh-exkeys -e *hostfile_exkeys* **-x** *hostfile_gpexpand*

gpssh-exkeys -?

gpssh-exkeys --version

Description

The `gpssh-exkeys` utility exchanges SSH keys between the specified host names (or host addresses). This allows SSH connections between HAWQ hosts and network interfaces without a password prompt. The utility is used to initially prepare a HAWQ system for password-free SSH access, and also to add additional ssh keys when expanding a HAWQ system.

To specify the hosts involved in an initial SSH key exchange, use the `-f` option to specify a file containing a list of host names (recommended), or use the `-h` option to name single host names on the command-line. At least one host name (`-h`) or a host file is required. Note that the local host is included in the key exchange by default.

To specify new expansion hosts to be added to an existing HAWQ system, use the `-e` and `-x` options. The `-e` option specifies a file containing a list of existing hosts in the system that already have SSH keys. The `-x` option specifies a file containing a list of new hosts that need to participate in the SSH key exchange.

Keys are exchanged as the currently logged in user. Greenplum recommends performing the key exchange process twice: once as `root` and once as the `gpadmin` user (the user designated to own your HAWQ installation). The HAWQ management utilities require that the same non-root user be created on all hosts in the HAWQ system, and the utilities must be able to connect as that user to all hosts without a password prompt.

The `gpssh-exkeys` utility performs key exchange using the following steps:

- Creates an RSA identification key pair for the current user if one does not already exist. The public key of this pair is added to the `authorized_keys` file of the current user.
- Updates the `known_hosts` file of the current user with the host key of each host specified using the `-h`, `-f`, `-e`, and `-x` options.
- Connects to each host using `ssh` and obtains the `authorized_keys`, `known_hosts`, and `id_rsa.pub` files to set up password-free access.
- Adds keys from the `id_rsa.pub` files obtained from each host to the `authorized_keys` file of the current user.

- Updates the `authorized_keys`, `known_hosts`, and `id_rsa.pub` files on all hosts with new host information (if any).

Options

-e *hostfile_exkeys*

When doing a system expansion, this is the name and location of a file containing all configured host names and host addresses (interface names) for each host in your *current* HAWQ system (master, standby master and segments), one name per line without blank lines or extra spaces. Hosts specified in this file cannot be specified in the host file used with `-x`.

-f *hostfile_exkeys*

Specifies the name and location of a file containing all configured host names and host addresses (interface names) for each host in your HAWQ system (master, standby master and segments), one name per line without blank lines or extra spaces.

-h *hostname*

Specifies a single host name (or host address) that will participate in the SSH key exchange. You can use the `-h` option multiple times to specify multiple host names and host addresses.

-p *<password>*

Specifies the password used to login to the hosts. The hosts should share the same password.

--version

Displays the version of this utility.

-x *hostfile_gpexpand*

When doing a system expansion, this is the name and location of a file containing all configured host names and host addresses (interface names) for each *new segment host* you are adding to your HAWQ system, one name per line without blank lines or extra spaces. Hosts specified in this file cannot be specified in the host file used with `-e`.

-? (help)

Displays the online help.

Examples

Exchange SSH keys between all host names and addresses listed in the file *hostfile_exkeys*:

```
$ gpssh-exkeys -f hostfile_exkeys
```

Exchange SSH keys between the hosts *sdw1*, *sdw2*, and *sdw3*:

```
$ gpssh-exkeys -h sdw1 -h sdw2 -h sdw3
```

Exchange SSH keys between existing hosts *sdw1*, *sdw2* and *sdw3,* and new hosts *sdw4* and *sdw5* as part of a system expansion operation:

```
$ cat hostfile_exkeys
   mdw
   mdw-1
   mdw-2
   smdw
   smdw-1
   smdw-2
   sdw1
   sdw1-1
   sdw1-2
   sdw2
   sdw2-1
   sdw2-2
   sdw3
   sdw3-1
   sdw3-2
$ cat hostfile_gpexpand
   sdw4
   sdw4-1
   sdw4-2
   sdw5
   sdw5-1
   sdw5-2
$ gpssh-exkeys -e hostfile_exkeys -x hostfile_gpexpand
```

See Also

gpssh, gpscp

gpstart

Starts a HAWQ system.

Synopsis

gpstart [**-d** *master_data_directory*] [**-B** *parallel_processes*] [**-R**] [**-m**] [**-y**] [**-a**] [**-t** *timeout_seconds*] [**-l** *logfile_directory*] [**-v** | **-q**]

gpstart -? | **-h** | **--help**

gpstart --version

Description

The `gpstart` utility is used to start the HAWQ server processes. When you start a HAWQ system, you are actually starting several `postgres` database server listener processes at once (the master and all of the segment instances). The `gpstart` utility handles the startup of the individual instances. Each instance is started in parallel.

The first time an administrator runs `gpstart`, the utility creates a hosts cache file named `.gphostcache` in the user's home directory. Subsequently, the utility uses this list of hosts to start the system more efficiently. If new hosts are added to the system, you must manually remove this file from the `gpadmin` user's home directory. The utility will create a new hosts cache file at the next startup.

Before you can start a HAWQ system, you must have initialized the system using `gpinitsystem` first.

Options

-a (do not prompt)

Do not prompt the user for confirmation.

-B *parallel_processes*

The number of segments to start in parallel. If not specified, the utility will start up to 60 parallel processes depending on how many segment instances it needs to start.

-d *master_data_directory*

Optional. The master host data directory. If not specified, the value set for `$MASTER_DATA_DIRECTORY` will be used.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-m (master only)

Optional. Starts the master instance only, which may be useful for maintenance tasks. This mode only allows connections to the master in utility mode. For example:

```
PGOPTIONS='-c gp_session_role=utility' psql
```

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-R (restricted mode)

Starts HAWQ in restricted mode (only database superusers are allowed to connect).

-t *timeout_seconds*

Specifies a timeout in seconds to wait for a segment instance to start up. If a segment instance was shutdown abnormally (due to power failure or killing its `postgres` database listener process, for example), it may take longer to start up due to the database recovery and validation process. If not specified, the default timeout is 60 seconds.

-v (verbose output)

Displays detailed status, progress and error messages output by the utility.

-y (do not start standby master)

Optional. Do not start the standby master host. The default is to start the standby master host and synchronization process.

-? | -h | --help (help)

Displays the online help.

--version (show utility version)

Displays the version of this utility.

Examples

Start a HAWQ system:

```
gpstart
```

Start a HAWQ system in restricted mode (only allow superuser connections):

```
gpstart -R
```

Start the HAWQ master instance only and connect in utility mode:

```
gpstart -m
PGOPTIONS='-c gp_session_role=utility' psql
```

Display the online help for the `gpstart` utility:

```
gpstart -?
```

See Also

gpstop

gpstate

Shows the status of a running HAWQ system.

Synopsis

```
gpstate [-d master_data_directory] [-B parallel_processes]
[-s | -b | -Q] [-p] [-i] [-f] [-v | -q] [-l log_directory]

gpstate -? | -h | --help
```

Description

The `gpstate` utility displays information about a running HAWQ instance. There is additional information you may want to know about a HAWQ system, since it is comprised of multiple PostgreSQL database instances (segments) spanning multiple machines. The `gpstate` utility provides additional status information for a HAWQ system, such as:

- Which segments are down.
- Master and segment configuration information (hosts, data directories, etc.).
- The ports used by the system.

Options

-b (brief status)

Optional. Display a brief summary of the state of the HAWQ system. This is the default option.

-B *parallel_processes*

The number of segments to check in parallel. If not specified, the utility will start up to 60 parallel processes depending on how many segment instances it needs to check.

-d *master_data_directory*

Optional. The master data directory. If not specified, the value set for `$MASTER_DATA_DIRECTORY` will be used.

-f (show standby master details)

Display details of the standby master host if configured.

-i (show HAWQ version)

Display the HAWQ software version information for each instance.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-p (show ports)

List the port numbers used throughout the HAWQ system.

-q (no screen output)

Optional. Run in quiet mode. Except for warning messages, command output is not displayed on the screen. However, this information is still written to the log file.

-Q (quick status)

Optional. Checks segment status in the system catalog on the master host. Does not poll the segments for status.

-s (detailed status)

Optional. Displays detailed status information for the HAWQ system.

-v (verbose output)

Optional. Displays error messages and outputs detailed status and progress information.

-? | -h | --help (help)

Displays the online help.

Output Field Definitions

The following output fields are reported by `gpstate -s` for the master:

Table B.1 gpstate output data for the master

Output Data	Description
Master host	host name of the master
Master postgres process ID	PID of the master database listener process
Master data directory	file system location of the master data directory
Master port	port of the master `postgres` database listener process
Master current role	dispatch = regular operating mode utility = maintenance mode
HAWQ array configuration type	Standard = one NIC per host Multi-Home = multiple NICs per host
HAWQ initsystem version	version of HAWQ when system was first initialized
HAWQ current version	current version of HAWQ
Postgres version	version of PostgreSQL that HAWQ is based on
HAWQ mirroring status	physical mirroring, SAN or none
Master standby	host name of the standby master
Standby master state	status of the standby master: active or passive

The following output fields are reported by `gpstate -s` for each segment:

Table B.2 gpstate output data for segments

Output Data	Description
Hostname	system-configured host name
Address	network address host name (NIC name)
Datadir	file system location of segment data directory
Port	port number of segment `postgres` database listener process
Current Role	current role of a segment: *Primary*
Preferred Role	role at system initialization time: *Primary*
File `postmaster.pid`	status of `postmaster.pid` lock file: *Found* or *Missing*
PID from `postmaster.pid` file	PID found in the `postmaster.pid` file
Lock files in `/tmp`	a segment port lock file for its `postgres` process is created in `/tmp` (file is removed when a segment shuts down)
Active PID	active process ID of a segment
Master reports status as	segment status as reported in the system catalog: *Up* or *Down*
Database status	status of HAWQ to incoming requests: *Up*, *Down*, or *Suspended*. A *Suspended* state means database activity is temporarily paused while a segment transitions from one state to another.

Examples

Show detailed status information of a HAWQ system:

```
gpstate -s
```

Do a quick check for down segments in the master host system catalog:

```
gpstate -Q
```

Show information about the standby master configuration:

```
gpstate -f
```

Display the HAWQ software version information:

```
gpstate -i
```

See Also

`gpstart`, `gplogfilter`

gpstop

Stops or restarts a HAWQ system.

Synopsis

gpstop [**-d** *master_data_directory*] [**-B** *parallel_processes*]
[**-M** smart | fast | immediate] [**-t** *timeout_seconds*] [**-r**] [**-y**] [**-a**]
[**-l** *logfile_directory*] [**-v** | **-q**]

gpstop -m [**-d** *master_data_directory*] [**-y**] [**-l** *logfile_directory*]
[**-v** | **-q**]

gpstop -u [**-d** *master_data_directory*] [**-l** *logfile_directory*] [**-v** |
-q]

gpstop --version

gpstop -? | **-h** | **--help**

Description

The `gpstop` utility is used to stop the database servers that comprise a HAWQ system. When you stop a HAWQ system, you are actually stopping several `postgres` database server processes at once (the master and all of the segment instances). The `gpstop` utility handles the shutdown of the individual instances. Each instance is shutdown in parallel.

By default, you are not allowed to shut down HAWQ if there are any client connections to the database. Use the `-M fast` option to roll back all in progress transactions and terminate any connections before shutting down. If there are any transactions in progress, the default behavior is to wait for them to commit before shutting down.

With the `-u` option, the utility uploads changes made to the master `pg_hba.conf` file or to *runtime* configuration parameters in the master `postgresql.conf` file without interruption of service. Note that any active sessions will not pickup the changes until they reconnect to the database.

Options

-a (do not prompt)

Do not prompt the user for confirmation.

-B *parallel_processes*

The number of segments to stop in parallel. If not specified, the utility will start up to 60 parallel processes depending on how many segment instances it needs to stop.

-d *master_data_directory*

Optional. The master host data directory. If not specified, the value set for `$MASTER_DATA_DIRECTORY` will be used.

-l *logfile_directory*

The directory to write the log file. Defaults to `~/gpAdminLogs`.

-m (master only)

Optional. Shuts down a HAWQ master instance that was started in maintenance mode.

-M fast (fast shutdown - rollback)

Fast shut down. Any transactions in progress are interrupted and rolled back.

-M immediate (immediate shutdown - abort)

Immediate shut down. Any transactions in progress are aborted. This shutdown mode is not recommended. This mode kills all `postgres` processes without allowing the database server to complete transaction processing or clean up any temporary or in-process work files.

-M smart (smart shutdown - warn)

Smart shut down. If there are active connections, this command fails with a warning. This is the default shutdown mode.

-q (no screen output)

Run in quiet mode. Command output is not displayed on the screen, but is still written to the log file.

-r (restart)

Restart after shutdown is complete.

-t *timeout_seconds*

Specifies a timeout threshold (in seconds) to wait for a segment instance to shutdown. If a segment instance does not shutdown in the specified number of seconds, `gpstop` displays a message indicating that one or more segments are still in the process of shutting down and that you cannot restart HAWQ until the segment instance(s) are stopped. This option is useful in situations where `gpstop` is executed and there are very large transactions that need to rollback. These large transactions can take over a minute to rollback and surpass the default timeout period of 600 seconds.

-u (reload pg_hba.conf and postgresql.conf files only)

This option reloads the `pg_hba.conf` files of the master and segments and the runtime parameters of the `postgresql.conf` files but does not shutdown the HAWQ array. Use this option to make new configuration settings active after editing `postgresql.conf` or `pg_hba.conf`. Note that this only applies to configuration parameters that are designated as *runtime* parameters. In HAWQ if there are some failed segments, this option can not be executed.

-v (verbose output)

Displays detailed status, progress and error messages output by the utility.

--version (show utility version)

Displays the version of this utility.

-y (do not stop standby master)

Do not stop the standby master process. The default is to stop the standby master.

-? | -h | --help (help)

Displays the online help.

Examples

Stop a HAWQ system in smart mode:

```
gpstop
```

Stop a HAWQ system in fast mode:

```
gpstop -M fast
```

Stop all segment instances and then restart the system:

```
gpstop -r
```

Stop a master instance that was started in maintenance mode:

```
gpstop -m
```

Reload the `postgresql.conf` and `pg_hba.conf` files after making configuration changes but do not shutdown the HAWQ array:

```
gpstop -u
```

See Also

gpstart

C. Client Utility Reference

This appendix provides references for the command-line client utilities provided with HAWQ. HAWQ uses standard PostgreSQL client programs, but also provides additional management utilities to administer a distributed HAWQ DBMS.

The following HAWQ client programs are located in `$GPHOME/bin`:

- createdb
- createuser
- dropdb
- dropuser
- pg_dump
- pg_dumpall
- pg_restore
- psql
- vacuumdb

Client Utility Summary

createdb

Creates a new database.

createdb [*connection_option* ...] [**-D** *tablespace*] [**-E** *encoding*] [**-O** *owner*] [**-T** *template*] [**-e**] [*dbname* ['*description*']]

createdb --help | **--version**

dbname

description

-D *tablespace* | --tablespace *tablespace*

-e *echo*

-E *encoding* | --encoding *encoding*

-O *owner* | --owner *owner*

-T *template* | --template *template*

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-w | --no-password

-W | --password

createuser

Creates a new database role.

createuser [*connection_option* ...] [*role_attribute* ...] [**-e**] *role_name*

createuser --help | **--version**

role_name

-c *number* | --connection-limit *number*

-D | --no-createdb

-d | --createdb

-e | --echo

-E | --encrypted

-i | --inherit

-I | --no-inherit

-l | --login

-L | --no-login

-N | --unencrypted

-P | --pwprompt

-r | --createrole

-R | --no-createrole

-s | --superuser

-S | --no-superuser

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-w | --no-password

-W | --password

dropdb

Removes an existing database.

dropdb [*connection_option* ...] [**-e**] [**-i**] *dbname*

dropdb --help | --version

dbname

-e | --echo

-i | --interactive

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-w | --no-password

-W | --password

dropuser

Removes a database role.

dropuser [*connection_option* ...] [**-e**] [**-i**] *role_name*

dropuser --help | --version

role_name

-e | --echo

-i | --interactive

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-w | --no-password

-W | --password

pg_dump

Extracts a database into a single script file or other archive file.

pg_dump [*connection_option* ...] [*dump_option* ...] *dbname*

dbname

-a | **--data-only**

-b | **--blobs**

-c | **--clean**

-C | **--create**

-d | **--inserts**

-D | **--column-inserts** | **--attribute-inserts**

-E ***encoding*** | **--encoding**=***encoding***

-f ***file*** | **--file**=***file***

-F p|c|t | **--format**=plain|custom|tar

-i | **--ignore-version**

-n ***schema*** | **--schema**=***schema***

-N ***schema*** | **--exclude-schema**=***schema***

-o | **--oids**

-O | **--no-owner**

-s | **--schema-only**

-S ***username*** | **--superuser**=***username***

-t ***table*** | **--table**=***table***

-T ***table*** | **--exclude-table**=***table***

-v | **--verbose**

-x | **--no-privileges** | **--no-acl**

--disable-dollar-quoting

--disable-triggers

--use-set-session-authorization

--gp-syntax | **--no-gp-syntax**

-Z 0..9 | **--compress**=0..9

-h ***host*** **| --host** ***host***

-p ***port*** **| --port** ***port***

-U ***username*** **| --username** ***username***

-W | --password

pg_dumpall

Extracts all databases in a HAWQ system to a single script file or other archive file.

pg_dumpall [*connection_option* ...] [*dump_option* ...]

-a | --data-only

-c | --clean

-d | --inserts

-D | --column-inserts | --attribute-inserts

-F | --filespaces

-g | --globals-only

-i | --ignore-version

-o | --oids

-O | --no-owner

-r | --resource-queues

-s | --schema-only

-S *username* | --superuser=*username*

-v | --verbose

-x | --no-privileges | --no-acl

--disable-dollar-quoting

--disable-triggers

--use-set-session-authorization

--gp-syntax

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-W | --password

pg_restore

Restores a database from an archive file created by `pg_dump`.

pg_restore [*connection_option* ...] [*restore_option* ...] *filename*

filename

-a | --data-only

-c | --clean

-C | --create

-d *dbname* | --dbname=*dbname*

-e | --exit-on-error

-f *outfilename* | --file=*outfilename*

-F t|c | **--format**=tar|custom

-i | --ignore-version

-l | --list

-L *list-file* | --use-list=*list-file*

-n *schema* | --schema=*schema*

-O | --no-owner

-P '***function-name***(***argtype*** [, ...])' | **--function**='***function-name***(***argtype*** [, ...])'

-s | --schema-only

-S *username* | --superuser=*username*

-t *table* | --table=*table*

-T *trigger* | --trigger=*trigger*

-v | --verbose

-x | --no-privileges | --no-acl

--disable-triggers

--no-data-for-failed-tables

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-W | --password

-1 | --single-transaction

psql

Interactive command-line interface for HAWQ

psql [*option*...] [*dbname* [*username*]]

-a | --echo-all

-A | --no-align

-c '*command*' | --command '*command*'

-d dbname* | --dbname *dbname

-e | --echo-queries

-E | --echo-hidden

-f *filename* | --file *filename*

-F *separator* | --field-separator *separator*

-H | --html

-l | --list

-L *filename* | --log-file *filename*

-o *filename* | --output *filename*

-P *assignment* | --pset *assignment*

-q | --quiet

-R *separator* | --record-separator *separator*

-s | --single-step

-S | --single-line

-t | --tuples-only

-T *table_options* | --table-attr *table_options*

-v *assignment* | --set *assignment* | --variable *assignment*

-V | --version

-x | --expanded

-X | --no-psqlrc

-1 | --single-transaction

-? | --help

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-W | --password

-w
--no-password

vacuumdb

Garbage-collects and analyzes a database.

vacuumdb [*connection-option*...] [--full | -f] [**-F**] [**--verbose** | **-v**] [**--analyze** | **-z**] [**--table** | **-t** *table* [(*column* [,...])]] [*dbname*]

vacuumdb [*connection-options*...] [**--all** | **-a**] [--full | -f] [**-F**] [**--verbose** | **-v**]

[**--analyze** | **-z**]

vacuumdb --help | --version

-a | **--all**

[**-d**] ***dbname*** | [**--dbname**] ***dbname***

-f | **--full**

-F | --freeze

-q | **--quiet**

-t *table* [(***column***)] | **--table *table*** [(***column***)]

-v | **--verbose**

-z | **--analyze**

-h *host* | --host *host*

-p *port* | --port *port*

-U *username* | --username *username*

-w | **--no-password**

-W | **--password**

createdb

Creates a new database.

Synopsis

```
createdb [connection_option ...] [-D tablespace] [-E encoding]
[-O owner] [-T template] [-e] [dbname ['description']]

createdb --help | --version
```

Description

`createdb` creates a new database in a HAWQ system. It is a wrapper around the SQL command `CREATE DATABASE`.

When you create a database with this command you will own the new database. You can specify a different owner using the `-O` option, if you have the appropriate privileges. **(Privs necessary to make this change)**

Options

dbname

Select a unique name for the new database in the HAWQ system. If you do not specify a name, the utility reads the environment variables `PGDATABASE`, `PGUSER` , or defaults to the current system user.

description

Describe the newly created database. Enclose white space within quotes.

-D *tablespace* | --tablespace *tablespace*

The default tablespace for the database.

-e *echo*

Echo the commands that `createdb` generates and sends to the server.

-E *encoding* | --encoding *encoding*

Character set encoding used in the new database. Specify a string constant (such as `'UTF8'`), an integer encoding number, or `DEFAULT` to use the default encoding.

-O *owner* | --owner *owner*

The name of the database owner. Defaults to the user executing the command.

-T *template* | --template *template*

The name of the template used to create the new database. Defaults to *template1*.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT,` or defaults to 5432.

-U *username* | --username *username*

Specifies the database role name used to connect. If not specified, reads the environment variable `PGUSER` or defaults to the current system role name.

-w | --no-password

Use this to run automated batch jobs and scripts. In general, if the server requires password authentication ensure that it can be accessed through a `.pgpass` file. Otherwise the connection attempt will fail.

-W | --password

Force a password prompt.

Examples

To create the database *test* using the default options:

```
createdb test
```

To create the database, *demo,* on *gpmaster* using port *54321*, with the *LATIN1* encoding scheme:

```
createdb -p 54321 -h gpmaster -E LATIN1 demo
```

See Also

`CREATE DATABASE`

createuser

Creates a new database role.

Synopsis

createuser [*connection_option* ...] [*role_attribute* ...] [**-e**] *role_name*

createuser --help | **--version**

Description

`createuser` creates a new HAWQ role. You must be a superuser or user with `CREATEROLE` privileges.

To create a new superuser, you must be a superuser.

Note: Making someone a superuser grants privileges such as bypassing access permission checks within the database.

`createuser` is a wrapper around the SQL command `CREATE ROLE`.

Options

role_name

Select a unique name for the role to be created. This name must be different from all existing roles in this HAWQ installation.

-c *number* | --connection-limit *number*

Set a maximum number of connections for the new role. The default is no limit.

-D | --no-createdb

By default, the new role cannot create databases.

-d | --createdb

The new role can create databases.

-e | --echo

Echo the commands that `createuser` generates and sends to the server.

-E | --encrypted

Encrypts and stores the password for the role. If not specified, uses the default password.

-i | --inherit

By default, the new role inherits the privileges of the groups to which it belongs.

-I | --no-inherit

The new role will not inherit the privileges of the groups to which it belongs.

-l | --login

By default, the new role can log in to HAWQ.

-L | --no-login

The new role cannot log in to HAWQ (a group-level role).

-N | --unencrypted

Does not encrypt the stored password for the role. If not specified, the default password behavior is used.

-P | --pwprompt

If given, `createuser` prompts you for the password for the new role. Use this only if you want to enforce password authentication.

-r | --createrole

The new role can create new roles (`CREATEROLE` privilege).

-R | --no-createrole

The new role cannot create new roles. This is the default.

-s | --superuser

Create the new role as superuser.

-S | --no-superuser

Do not create the new role to be a superuser. This is the default.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

Specifies the database role name used to connect. If not specified, reads the environment variable `PGUSER` or defaults to the current system role name.

-w | --no-password

Use this to run automated batch jobs and scripts. In general, if the server requires password authentication ensure that it can be accessed through a `.pgpass` file. Otherwise the connection attempt will fail.

-W | --password

Force a password prompt.

Examples

To create the role, joe, with default options:

```
createuser joe
Shall the new role be a superuser? (y/n) n
Shall the new role be allowed to create databases? (y/n) n
Shall the new role be allowed to create more new roles? (y/n)
n
CREATE ROLE
```

To create the role, *joe,* with default connection options:

```
createuser -h masterhost -p 54321 -S -D -R -e joe
CREATE ROLE joe NOSUPERUSER NOCREATEDB NOCREATEROLE INHERIT
LOGIN;
CREATE ROLE
```

To create the role, *joe* as a superuser, and provide password prompts:

```
createuser -P -s -e joe
Enter password for new role: admin123
Enter it again: admin123
CREATE ROLE joe PASSWORD 'admin123' SUPERUSER CREATEDB
CREATEROLE INHERIT LOGIN;
CREATE ROLE
```

Note: The example shows how the new password echoed if the `-e` option is used.

See Also

CREATE ROLE

dropdb

Removes an existing database.

Synopsis

dropdb [*connection_option* ...] [**-e**] [**-i**] *dbname*

dropdb --help | --version

Description

`dropdb` removes an existing database. The user who executes this command must be a superuser or own the database being dropped.

`dropdb` is a wrapper around the SQL command `DROP DATABASE`

Options

dbname

The unique name of the database being removed.

-e | --echo

Echoes and sends commands `dropdb` generates to the server.

-i | --interactive

Presents verification prompts to ensure that you want to perform this process.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

Specifies the database role name used to connect. If not specified, reads the environment variable `PGUSER` or defaults to the current system role name.

-w | --no-password

Use this to run automated batch jobs and scripts. In general, if the server requires password authentication ensure that it can be accessed through a `.pgpass` file. Otherwise the connection attempt will fail.

-W | --password

Force a password prompt.

Examples

To destroy the database, *demo* using default connection parameters:

```
dropdb demo
```

To destroy the database, *demo* using verification prompts:

```
dropdb -p 54321 -h masterhost -i -e demo
Database "demo" will be permanently deleted.
Are you sure? (y/n) y
DROP DATABASE "demo"
DROP DATABASE
```

See Also

DROP DATABASE

dropuser

Removes a database role.

Synopsis

```
dropuser [connection_option ...] [-e] [-i] role_name

dropuser --help | --version
```

Description

`dropuser` removes an existing role from HAWQ. Only superusers and users with `CREATEROLE` privilege can remove roles. To remove a superuser role, you must be a superuser.

`dropuser` is a wrapper around the SQL command `DROP ROLE`.

Options

role_name

Specifies the name of the role to be removed. If you do not specify the name, you will be prompted on the command line.

-e | --echo

Echo and send the commands that `dropuser` generates to the server.

-i | --interactive

Prompt for confirmation before removing the role.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-w | --no-password

Use this to run automated batch jobs and scripts. In general, if the server requires password authentication ensure that it can be accessed through a `.pgpass` file. Otherwise the connection attempt will fail.

-W | --password

Force a password prompt.

Examples

To remove the role, *joe* using default connection options:

```
dropuser joe
DROP ROLE
```

To remove the role, *joe* using verification prompts:

```
dropuser -p 54321 -h masterhost -i -e joe
Role "joe" will be permanently removed.
Are you sure? (y/n) y
DROP ROLE "joe"
DROP ROLE
```

See Also

DROP ROLE

pg_dump

Extracts a database into a single script file or other archive file.

Synopsis

pg_dump [*connection_option* ...] [*dump_option* ...] *dbname*

Description

pg_dump is a standard PostgreSQL utility for backing up a database, and is also supported in HAWQ. It creates a single (non-parallel) dump file.

Use pg_dump if you are migrating your data to a different database vendor, or to a HAWQ system with a different segment configuration. For example, a different HAWQ system configuration may have more or fewer segment instances.

To restore dump files:

- From archive format you must use the pg_restore utility.
- From plain text format you can use a client program such as psql.

About using pg_dump utility with HAWQ:

- The dump operation can take a several hours for very large databases. Make sure you have sufficient disk space to create the dump file.
- To migrate data from one HAWQ system to another, use the --gp-syntax command-line option to include the DISTRIBUTED BY clause in CREATE TABLE statements. This ensures that HAWQ table data is distributed with the correct distribution key columns upon restore.
- pg_dump makes consistent backups even if the database is being used concurrently.
- pg_dump does not block other users accessing the database (readers or writers).

When used with one of the archive file formats and combined with pg_restore, pg_dump provides a flexible archival and transfer mechanism. Once pg_dump backs up the entire database, you can use pg_restore to examine the archive and select the parts of the database you want to restore.

The *custom* format (-Fc) is flexible. You can select and reorder all the archived items, and compresses the archive by default.

The tar format (-Ft) is not compressed and does not reorder data when loading. It can be manipulated with standard UNIX tools such as tar.

Options

dbname

Specifies the name of the database to be dumped. If this is not specified, the environment variable PGDATABASE is used. If that is not set, the user name specified for the connection is used.

Dump Options

-a | --data-only

Dumps the data, not the schema (data definitions). This option is only meaningful for plain-text format. For archive formats, specify the option when you call `pg_restore`.

-b | --blobs

Include large objects in the dump. This is the default behavior except when `--schema`, `--table`, or `--schema-only` is specified.

-c | --clean

Adds commands to the text output file to drop database objects before creating them. Objects are not dropped before the dump operation begins. The `DROP` commands are added to the DDL dump output files so that when you restore, the `DROP` commands run before the `CREATE` commands. This option is only works with plain-text format. For archive formats, you may specify the option when you call `pg_restore`.

-C | --create

Begin the output with a command to create the database itself and reconnect to the created database. With a script of this form, it doesn't matter which database you connect to before running the script. This option is only meaningful for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`.

-d | --inserts

Dump data as `INSERT` commands (rather than `COPY`). This will make restoration very slow; it is mainly useful for making dumps that can be loaded into non-PostgreSQL-based databases. Also, since this option generates a separate command for each row, an error in reloading a row causes only that row to be lost rather than the entire table contents. Note that the restore may fail altogether if you have rearranged column order. The `-D` option is safe against column order changes, though even slower.

-D | --column-inserts | --attribute-inserts

Dump data as `INSERT` commands with explicit column names `(INSERT INTO` *`table`* `(`*`column`*`, ...) VALUES ...)`. This will make restoration very slow; it is useful for making dumps that can be loaded into non-PostgreSQL-based databases. Also, since this option generates a separate command for each row, an error in reloading a row causes only that row to be lost rather than the entire table contents.

-E *encoding* | --encoding=*encoding*

Create the dump in the specified character set encoding. By default, the dump is created in the database encoding, or you can set the `PGCLIENTENCODING` environment variable to the desired dump encoding.

-f *file* | --file=*file*

Send output to the specified file. If this is omitted, the standard output is used.

-F p|c|t | --format=plain|custom|tar

Selects the format of the output:

p | plain — Output a plain-text SQL script file. This is the default.

c | custom — Output a custom archive suitable for input into `pg_restore`. This is the most flexible format in that it allows reordering of loading data as well as object definitions. This format is also compressed by default.

t | tar — Output a tar archive suitable for input into `pg_restore`. Using this archive format allows reordering and/or exclusion of database objects at the time the database is restored. It is also possible to limit which data is reloaded at restore time.

-i | --ignore-version

Ignore version mismatch between `pg_dump` and the database server. `pg_dump` can dump from servers running previous releases of HAWQ (or PostgreSQL), but very old versions may not be supported anymore. Use this option if you need to override the version check. **(This does not make sense. Ask question)**

-n *schema* | --schema=*schema*

Dump only schemas matching the schema pattern. This selects both the schema itself, and all its contained objects. If this option is not specified, all non-system schemas in the target database will be dumped. Multiple schemas can be selected by writing multiple `-n` switches. Since the schema parameter is interpreted as a pattern similar to `psql`'s `\d` commands, you can select multiple schemas using wildcard characters in the pattern. Add wildcards within quotes to prevent the shell from expanding the wildcards.

Note: When -n is specified, `pg_dump` does not dump database objects that the selected schema(s) may depend upon. Therefore, there is no guarantee that the results of a specific-schema dump can be successfully restored into a clean database.

Note: Non-schema objects such as blobs are not dumped when `-n` is specified. You can add blobs back to the dump with the `--blobs` switch.

-N *schema* | --exclude-schema=*schema*

Do not dump any schemas matching the schema pattern. The schema pattern is interpreted according to the rules or `-n`. You can use `-N` more than once to exclude schemas matching several patterns. When both `-n` and `-N` are given, the utility dumps the schemas that match at least one `-n` switch but not the `-N` switches. If `-N` appears without `-n`, then schemas matching `-N` are excluded.

-o | --oids

Dump object identifiers (OIDs) as part of the data for every table. Use of this option is not recommended for files that are intended to be restored into HAWQ.

-O | --no-owner

Do not output commands to set ownership of objects to match the original database. By default, `pg_dump` issues `ALTER OWNER` or `SET SESSION AUTHORIZATION` statements to set ownership of created database objects. To successfully run this script, you must be a superuser or own the objects in the script. Specify `-O` to make a script that can be restored by any user, and grant them ownership of all the objects. This option is only meaningful for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`. **(Little convoluted, ask Lili what she means)**

-s | --schema-only

Dump only the object definitions (schema), not data.

-S *username* | --superuser=*username*

Specify the superuser name for disabling triggers. This is only relevant if `--disable-triggers` is used. It is better to leave this out, and instead start the resulting script as a superuser.

-t *table* | --table=*table*

Dump only tables (or views or sequences) matching the table pattern. Specify the table in the format `schema.table`.

To select multiple tables, write multiple `-t` switches. The table pattern is interpreted according to the rules used by `psql`'s `\d` commands, you can select multiple tables using wildcard characters in the pattern. Add wildcards within quotes to prevent the shell from expanding the wildcards. The `-n` and `-N` switches have no effect when you use `-t`. Tables selected by `-t` will be dumped regardless of those switches, and non-table objects will not be dumped.

Note: When `-t` is specified, `pg_dump` does not dump any other database objects that the selected table(s) may depend upon. Therefore, there is no guarantee that the results of a specific-table dump can be successfully restored into a clean database.

Note: You cannot used `-t` to specify a child table partition. To dump a partitioned table, you must specify the parent table name.

-T *table* | --exclude-table=*table*

Do not dump any tables matching the table pattern. The pattern is interpreted according to the same rules as `-t`. You can use `-T` more than once to exclude tables matching several patterns. When both `-t` and `-T` are given, the behavior is to dump just the tables that match at least one `-t` switch but no `-T` switches. If `-T` appears without `-t`, then tables matching `-T` are excluded from what is otherwise a normal dump.

-v | --verbose

Specifies verbose mode. This will cause `pg_dump` to output detailed object comments and start/stop times to the dump file, and progress messages to standard error.

-x | --no-privileges | --no-acl

Prevent dumping of access privileges (`GRANT`/`REVOKE` commands).

--disable-dollar-quoting

This option disables the use of dollar quoting for function bodies, and forces them to be quoted using SQL standard string syntax.

--disable-triggers

This option is relevant when creating a data-only dump. It instructs `pg_dump` to include commands to temporarily disable triggers on the target tables while the data is reloaded. Use this if you have triggers on the tables that you do not want to invoke during data reload. The commands emitted for `--disable-triggers` must be done as superuser. Specify a superuser name with `-S`, and be careful when starting the script as a superuser. This option only works for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`.

--use-set-session-authorization

Output SQL-standard `SET SESSION AUTHORIZATION` commands instead of `ALTER OWNER` commands to determine object ownership. This makes the dump more standards compatible, but depending on the history of the objects in the dump, may not restore properly. A dump using `SET SESSION AUTHORIZATION` will require superuser privileges to restore correctly, whereas `ALTER OWNER` requires lesser privileges.

--gp-syntax | --no-gp-syntax

Use `--gp-syntax` to dump HAWQ syntax in the `CREATE TABLE` statements. This preserves the distribution policy (`DISTRIBUTED BY` or `DISTRIBUTED RANDOMLY` clauses) to dump a HAWQ table and to restore into other HAWQ systems. The default is to include HAWQ syntax when connected to a HAWQ system, and to exclude it when connected to a regular PostgreSQL system.

-Z 0..9 | --compress=0..9

Specify the compression level to use in archive formats that support compression. Currently only the *custom* archive format supports compression.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT,` or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-W | --password

Force a password prompt.

Notes

When a data-only dump is chosen and the option `--disable-triggers` is used, `pg_dump` disables triggers on user tables before inserting the data and re-enables them after the data has been inserted. Stopping restore before it is complete, may leave the system catalogs in the wrong state.

Members of `tar` archives are limited to less than 8 GB. This is an inherent limitation of the `tar` file format. Therefore this format cannot be used if the textual representation of any one table exceeds that size. The total size of a `tar` archive or any other output format is not limited, except possibly by the operating system.

The dump file produced by `pg_dump` does not contain the statistics used by the optimizer to make query planning decisions. Therefore, it is wise to run `ANALYZE` after restoring from a dump file to ensure good performance.

Examples

To dump a database called *mydb* into a SQL-script file:

```
pg_dump mydb > db.sql
```

To reload a SQL-script into a new database, *newdb*:

```
psql -d newdb -f db.sql
```

To dump a HAWQ database in `tar` file format and include distribution policy information:

```
pg_dump -Ft --gp-syntax mydb > db.tar
```

To dump a database into a custom-format archive file:

```
pg_dump -Fc mydb > db.dump
```

To reload an archive file into a new database named *newdb*:

```
pg_restore -d newdb db.dump
```

To dump a single table named *mytab*:

```
pg_dump -t mytab mydb > db.sql
```

To specify an upper-case or mixed-case name in `-t` and related switches, use double-quotes around the name. Otherwise it will be folded to lower case. Since double quotes are special to the shell, use the following syntax:

```
pg_dump -t '"MixedCaseName"' mydb > mytab.sql
```

See Also

`pg_dumpall`, `pg_restore`, `psql`

pg_dumpall

Extracts all databases in a HAWQ system to a single script file or other archive file.

Synopsis

pg_dumpall [*connection_option* ...] [*dump_option* ...]

Description

`pg_dumpall` is a standard PostgreSQL utility for backing up all databases in PostgreSQL or HAWQ instance. It creates a single (non-parallel) dump file.

`pg_dumpall` creates a single script file that contains SQL commands. These commands are used as input to `psql` to restore the databases. `pg_dumpall` calls `pg_dump` for each database. It also dumps all the common global database objects. This script also includes information about database users and groups, and access permissions that apply to databases as a whole.

You must connect as superuser to run `pg_dumpall` because the script reads tables from all databases to produce a complete dump. Also you need superuser privileges to to add users and groups, and to create databases.

The SQL script is written to the standard output. Shell operators can be used to redirect it into a file.

`pg_dumpall` needs to connect several times to the HAWQ master server once for each database. If you use password authentication you can store the password in a `~/.pgpass` file.

Options

Dump Options

-a | --data-only

Only dumps the data, not the schema (data definitions). This option only works for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`.

-c | --clean

Output commands to drop database objects before creating them. This option only works for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`.

-d | --inserts

Dump data as `INSERT` commands (rather than `COPY`). This restores the data slowly, but is useful for making dumps to load into non-PostgreSQL-based databases. Also, since this option generates a separate command for each row, an error in reloading a row is limited to a single row. Note that the restore may fail altogether if you have rearranged column order. The `-D` option is safe against column order changes, though even slower.

-D | --column-inserts | --attribute-inserts

Dumps data as `INSERT` commands with explicit column names (`INSERT INTO` *`table`* (*`column`*, ...) `VALUES ...`). This will make restoration very slow; it is used to load dumps into non-PostgreSQL-based databases. Also, since this option generates a separate command for each row,an error in reloading a row is limited to a single row.

-F | --filespaces

Dump filespace definitions.

-g | --globals-only

Dump only global objects (roles and tablespaces), no databases.

-i | --ignore-version

Ignore version mismatch between `pg_dump` and the database server. `pg_dump` can dump from servers running previous releases of HAWQ (or PostgreSQL), but very old versions may not be supported anymore. Use this option if you need to override the version check. **(Need to ask for less ambiguity)**

-o | --oids

Dump object identifiers (OIDs) as part of the data for every table. Pivotal recommends you use this to restore files into HAWQ.

-O | --no-owner

Do not output commands to set ownership of objects to match the original database. By default, `pg_dump` issues `ALTER OWNER` or `SET SESSION AUTHORIZATION` statements to set ownership of created database objects. To successfully run this script, you must be a superuser or own the objects in the script. Specify `-O` to make a script that can be restored by any user, and grant them ownership of all the objects. This option is only meaningful for the plain-text format. For the archive formats, you may specify the option when you call `pg_restore`. **(Little convoluted, ask Lili what she means)**

-r | --resource-queues

Dump resource queue definitions.

-s | --schema-only

Dump only the object definitions (schema), not data.

-S *username* | --superuser=*username*

Specify the superuser name for disabling triggers. This is only relevant if `--disable-triggers` is used. It is better to leave this out, and instead start the resulting script as a superuser.

-v | --verbose

Specifies verbose mode. This will cause `pg_dump` to output detailed object comments and start/stop times to the dump file, and progress messages to standard error.

-x | --no-privileges | --no-acl

Prevent dumping of access privileges (`GRANT/REVOKE` commands).

--disable-dollar-quoting

This option disables the use of dollar quoting for function bodies, and forces them to be quoted using SQL standard string syntax.

--disable-triggers

This option is only relevant when creating a data-only dump. It instructs `pg_dumpall` to include commands to temporarily disable triggers on the target tables while the data is reloaded. Use this if you have triggers on the tables that you do not want to invoke during data reload. The commands emitted for `--disable-triggers` must be done as superuser. Specify a superuser name with `-S`, and be careful when starting the script as a superuser.

--use-set-session-authorization

Output SQL-standard `SET SESSION AUTHORIZATION` commands instead of `ALTER OWNER` commands to determine object ownership. This makes the dump more standards compatible, but depending on the history of the objects in the dump, may not restore properly. A dump using `SET SESSION AUTHORIZATION` will require superuser privileges to restore correctly, whereas `ALTER OWNER` requires lesser privileges.

--gp-syntax

Output HAWQ syntax in the `CREATE TABLE` statements. This preserves the distribution policy (`DISTRIBUTED BY` or `DISTRIBUTED RANDOMLY` clauses) to dump a HAWQ table and to restore into other HAWQ systems.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT,` or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-W | --password

Force a password prompt.

Notes

Since `pg_dumpall` calls `pg_dump` internally, some diagnostic messages refer to `pg_dump`.

Once restored, it is wise to run `ANALYZE` on each database so the query planner has useful statistics. You can also run `vacuumdb -a -z` to analyze all databases.

To restore or create databases in non-default locations while using `pg_dumpall`, check that you have all the necessary tablespace, filespace, and directories.

Examples

To dump all databases:

```
pg_dumpall > db.out
```

To reload this file:

```
psql template1 -f db.out
```

To dump only global objects (including filespaces and resource queues):

```
pg_dumpall -g -f -r
```

See Also

`pg_dump`

pg_restore

Restores a database from an archive file created by `pg_dump`.

Synopsis

pg_restore [*connection_option* ...] [*restore_option* ...] *filename*

Description

`pg_restore` is a utility for restoring a database from an archive created by `pg_dump` in a non-plain-text formats. `pg_restore` reconstructs the database to the state it was in at the time it was saved. The archive files also allow `pg_restore` to be selective about what is restored, or even to reorder the items prior to being restored.

`pg_restore` can operate in two modes. If a database name is specified, the archive is restored directly into the database. Otherwise, a script containing the SQL commands necessary to rebuild the database is created and written to a file or standard output. The script output is equivalent to the plain text output format of `pg_dump`. Some of the options controlling the output are therefore analogous to `pg_dump` options.

`pg_restore` cannot restore information that is not present in the archive file. For instance, if the archive was made using the "dump data as `INSERT` commands" option, `pg_restore` will not be able to load the data using `COPY` statements.

Options

filename

Specifies the location of the archive file to be restored. If not specified, the standard input is used.

-a | --data-only

Restore only the data, not the schema (data definitions).

-c | --clean

Clean (drop) database objects before recreating them.

-C | --create

Creates the database before restoring it. When this option is used, the database named with `-d` is used only to issue the initial `CREATE DATABASE` command. All data is restored into the database name that appears in the archive.

-d *dbname* | --dbname=*dbname*

Connects to this database and restore directly into this database. The default is to use the `PGDATABASE` environment variable setting, or the same name as the current system user.

-e | --exit-on-error

Exits if an error is encountered while sending SQL commands to the database. The default is to continue and to display a count of errors at the end of the restoration.

-f *outfilename* | --file=*outfilename*

Specifies output file for generated script, or for the listing when used with `-l`. Default is the standard output.

-F t|c | --format=tar|custom

The format of the archive produced by `pg_dump`. It is not necessary to specify the format, since `pg_restore` will determine the format automatically. Format can be either `tar` or `custom`.

-i | --ignore-version

Ignore database version checks.

-l | --list

List the contents of the archive. The output of this operation can be used with the `-L` option to restrict and reorder the items that are restored.

-L *list-file* | --use-list=*list-file*

Restore elements in the order they appear in the *`list-file`* only. Lines can be moved and may also be commented out by placing a `;` at the start of the line.

-n *schema* | --schema=*schema*

Restore only objects that are in the named schema. This can be combined with the `-t` option to restore just a specific table.

-O | --no-owner

Do not output commands to set ownership of objects to match the original database. By default, `pg_restore` issues `ALTER OWNER` or `SET SESSION AUTHORIZATION` statements to set ownership of created schema elements. These statements will fail unless you must connect to the database as a superuser, or own the objects in the script. With `-O`, any user name can be used for the initial connection, and this user will own all the created objects.

-P '*function-name*(*argtype* [, ...])' |
--function='*function-name*(*argtype* [, ...])'

Restore the named function only. The function name must be enclosed in quotes. Be careful to spell the function name and arguments exactly as they appear in the dump file's table of contents (as shown by the `--list` option).

-s | --schema-only

Restore only the schema (data definitions), not the data (table contents). Sequence current values will not be restored, either. (Do not confuse this with the `--schema` option, which uses the word schema in a different meaning.)

-S *username* | --superuser=*username*

Specify the superuser user name to use when disabling triggers. This is only relevant if `--disable-triggers` is used.

-t *table* | --table=*table*

Restore definition and/or data of named table only.

-T *trigger* | --trigger=*trigger*

Restore named trigger only.

-v | --verbose

Specifies verbose mode.

-x | --no-privileges | --no-acl

Prevent restoration of access privileges (`GRANT`/`REVOKE` commands).

--disable-triggers

This option is only relevant when performing a data-only restore. It instructs `pg_restore` to execute commands to temporarily disable triggers on the target tables while the data is reloaded. Use this if you have triggers on the tables that you do not want to invoke during data reload. You must be superuser to issue the `--disable-triggers` command. So, you should also specify a superuser name with `-S`, or preferably run `pg_restore` as a superuser.

--no-data-for-failed-tables

If the table already exists, the table data is restored even if the creation command for the table fails. This is the default. With this option, data for such a table is skipped. This behavior is useful when the target database may already contain the desired table contents. Specifying this option prevents duplicate or obsolete data from being loaded. This option is effective only when restoring directly into a database, not when producing SQL script output.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-W | --password

Force a password prompt.

-1 | --single-transaction

Execute the restore as a single transaction. This ensures that either all the commands complete successfully, or no changes are applied.

Notes

If your installation has any local additions to the `template1` database, load the output of `pg_restore` into an empty database; otherwise you will see errors for duplicate definitions of the added objects. To make an empty database without any local additions, copy from `template0` not `template1`, for example:

```
CREATE DATABASE foo WITH TEMPLATE template0;
```

When restoring data to a pre-existing table and the option `--disable-triggers` is used, `pg_restore` disables triggers on user tables before inserting the data and then re-enables them after the data is inserted. If the restore is stopped in the middle, the system catalogs may be left in the wrong state.

`pg_restore` will not restore large objects for a single table. If an archive contains large objects, then all large objects will be restored.

See also the `pg_dump` documentation for details on limitations of `pg_dump`.

Once restored, it is wise to run `ANALYZE` on each restored table so the query planner has useful statistics.

Examples

Assume we have dumped a database called `mydb` into a custom-format dump file:

```
pg_dump -Fc mydb > db.dump
```

To drop the database and recreate it from the dump:

```
dropdb mydb
pg_restore -C -d template1 db.dump
```

To reload the dump into a new database called *newdb*.

```
createdb -T template0 newdb
pg_restore -d newdb db.dump
```

Note: there is no `-C`, we instead connect directly to the database to be restored into. Also the new database uses `template0` not `template1`, to ensure it is initially empty:

To reorder database items, it is first necessary to dump the table of contents of the archive:

```
pg_restore -l db.dump > db.list
```

The listing file consists of a header and one line for each item, for example,

```
; Archive created at Fri Jul 28 22:28:36 2006
;     dbname: mydb
;     TOC Entries: 74
;     Compression: 0
```

```
;     Dump Version: 1.4-0
;     Format: CUSTOM
;
; Selected TOC Entries:
;
2; 145344 TABLE species postgres
3; 145344 ACL species
4; 145359 TABLE nt_header postgres
5; 145359 ACL nt_header
6; 145402 TABLE species_records postgres
7; 145402 ACL species_records
8; 145416 TABLE ss_old postgres
9; 145416 ACL ss_old
10; 145433 TABLE map_resolutions postgres
11; 145433 ACL map_resolutions
12; 145443 TABLE hs_old postgres
13; 145443 ACL hs_old
```

Semicolons start a comment, and the numbers at the start of lines refer to the internal archive ID assigned to each item. Lines in the file can be commented out, deleted, and reordered. For example,

```
10; 145433 TABLE map_resolutions postgres
;2; 145344 TABLE species postgres
;4; 145359 TABLE nt_header postgres
6; 145402 TABLE species_records postgres
;8; 145416 TABLE ss_old postgres
```

Could be used as input to `pg_restore` and would only restore items 10 and 6, in that order:

```
pg_restore -L db.list db.dump
```

See Also

pg_dump

psql

Interactive command-line interface for HAWQ

Synopsis

psql [*option*...] [*dbname* [*username*]]

Description

`psql` is a terminal-based front-end to HAWQ. It enables you to type in queries interactively, issue them to HAWQ, and see the query results. Alternatively, input can be from a file. In addition, it provides a number of meta-commands and various shell-like features to facilitate writing scripts and automating a wide variety of tasks.

Options

-a | --echo-all

Prints all input lines to standard output as they are read. This is more useful for script processing rather than interactive mode.

-A | --no-align

Switches to unaligned output mode. (The default output mode is aligned.)

-c '*command*' | --command '*command*'

Specifies that `psql` is to execute the specified command string, and then exit. This is useful in shell scripts. *command* must be either a command string that is completely parseable by the server, or a single backslash command. Thus you cannot mix SQL and `psql` meta-commands with this option. To achieve that, you could pipe the string into `psql`, like this: `echo '\x \\ SELECT * FROM foo;' | psql`. (`\\` is the separator meta-command.)

If the command string contains multiple SQL commands, they are processed in a single transaction, unless there are explicit `BEGIN/COMMIT` commands included in the string to divide it into multiple transactions. This is different from the behavior when the same string is fed to `psql`'s standard input.

-d dbname* | --dbname *dbname

Specifies the name of the database to connect to. This is equivalent to specifying dbname as the first non-option argument on the command line.

If this parameter contains an equals sign, it is treated as a `conninfo` string; for example you can pass `'dbname=postgres user=username password=mypass'` as dbname.

-e | --echo-queries

Copies all SQL commands sent to the server to standard output as well.

-E | --echo-hidden

Echoes the actual queries generated by `\d` and other backslash commands. You can use this to study `psql`'s internal operations.

-f *filename* | --file *filename*

Uses a file as the source of commands instead of reading commands interactively. After the file is processed, `psql` terminates. If *`filename`* is - (hyphen), then standard input is read. Using this option is subtly different from writing `psql < filename`. In general, both will do what you expect, but using `-f` enables some nice features such as error messages with line numbers.

-F *separator* | --field-separator *separator*

Uses the specified separator as the field separator for unaligned output.

-H | --html

Turns on HTML tabular output.

-l | --list

Lists all available databases, then exit. Other non-connection options are ignored.

-L *filename* | --log-file *filename*

Writes all query output into the specified log file, in addition to the normal output destination.

-o *filename* | --output *filename*

Puts all query output into the specified file.

-P *assignment* | --pset *assignment*

Allows you to specify printing options in the style of `\pset` on the command line. Note that here you have to separate name and value with an equal sign instead of a space. Thus to set the output format to LaTeX, you could write `-P format=latex`.

-q | --quiet

Specifies that `psql` should do its work quietly. By default, it prints welcome messages and various informational output. If this option is used, none of this happens. This is useful with the `-c` option.

-R *separator* | --record-separator *separator*

Uses *`separator`* as the record separator for unaligned output.

-s | --single-step

Runs in single-step mode. That means the user is prompted before each command is sent to the server, with the option to cancel execution as well. Use this to debug scripts.

-S | --single-line

Runs in single-line mode where a new line terminates an SQL command, as a semicolon does.

-t | --tuples-only

Turns off printing of column names and result row count footers, etc. This command is equivalent to `\pset tuples_only` and is provided for convenience.

-T *table_options* | --table-attr *table_options*

Allows you to specify options to be placed within the HTML table tag. See `\pset` for details.

-v *assignment* | --set *assignment* | --variable *assignment*

Performs a variable assignment, like the `\set` internal command. Note that you must separate name and value, if any, by an equal sign on the command line. To unset a variable, leave off the equal sign. To just set a variable without a value, use the equal sign but leave off the value. These assignments are done during a very early stage of start-up, so variables reserved for internal purposes might get overwritten later.

-V | --version

Prints the `psql` version and exit.

-x | --expanded

Turns on the expanded table formatting mode.

-X | --no-psqlrc

Does not read the start-up file (neither the system-wide `psqlrc` file nor the user's `~/.psqlrc` file).

-1 | --single-transaction

When `psql` executes a script with the `-f` option, adding this option wraps `BEGIN/COMMIT` around the script to execute it as a single transaction. This ensures that either all the commands complete successfully, or no changes are applied.

If the script itself uses `BEGIN`, `COMMIT`, or `ROLLBACK`, this option will not have the desired effects. Also, if the script contains any command that cannot be executed inside a transaction block, specifying this option will cause that command (and hence the whole transaction) to fail.

-? | --help

Shows help about `psql` command line arguments, and exits.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-W | --password

Pivotal recommends using this option to force a password prompt. If no password prompt is issued and the server requires password authentication, the connection attempt will fail.

-w
--no-password

Does not issue a password prompt. If the server requires password authentication, storing the password a .pgpass file ensures a successful connection when running batch jobs and scripts.

Note: This option remains set for the entire session, and so it affects uses of the meta-command `\connect` as well as the initial connection attempt.

Exit Status

`psql` returns the following values:

0 to the shell if it finished normally.

1 if a fatal error of its own (out of memory, file not found) occurs.

2 if the connection to the server went bad and the session was not interactive.

3 if an error occurred in a script and the variable `ON_ERROR_STOP` was set.

Usage

Connecting To A Database

`psql` is a client application for HAWQ. To connect to a database you need to know the following information:

- Name of your target database
- Host name and port number of the HAWQ master server
- Database user name

`psql` can be told about those parameters via command line options, namely `-d`, `-h`, `-p`, and `-U` respectively. If an argument is found that does not belong to any option it is interpreted as the database name (or the user name, if the database name is already given). Not all these options are required; there are useful defaults. If you omit the host name, `psql` will connect via a UNIX-domain socket to a master server on the local host, or via TCP/IP to `localhost` on machines that do not have UNIX-domain sockets. The default master port number is 5432. If you use a different port for the master, you must specify the port. The default database user name is your UNIX user name, as is the default database name. Note that you cannot just connect to any database under any user name. Your database administrator should have informed you about your access rights.

When the defaults are not right, you can save yourself some typing by setting any or all of the environment variables `PGAPPNAME`, `PGDATABASE`, `PGHOST`, `PGPORT`, and `PGUSER` to appropriate values.

It is also convenient to have a `~/.pgpass` file to avoid regularly having to type in passwords. This file should reside in your home directory and contain lines of the following format:

```
hostname:port:database:username:password
```

The permissions on `.pgpass` must disallow any access to world or group (for example: `chmod 0600 ~/.pgpass`). If the permissions are less strict than this, the file will be ignored. The file permissions are not currently checked on Microsoft Windows clients.

If the connection could not be made due to insufficient privileges, or if the server is not running, `psql` will return an error and terminate.

Entering SQL Commands

In normal operation, `psql` provides a prompt with the name of the database to which `psql` is currently connected, followed by the string **=>** for a regular user or **=#** for a superuser. For example:

```
testdb=>
testdb=#
```

At the prompt, the user may type in SQL commands. Ordinarily, input lines are sent to the server when a command-terminating semicolon is reached. An end of line does not terminate a command. Thus commands can be spread over several lines for clarity. If the command was sent and executed without error, the results of the command are displayed on the screen.

Meta-Commands

Anything you enter in `psql` that begins with an unquoted backslash is a `psql` meta-command that is processed by `psql` itself. These commands help make `psql` more useful for administration or scripting. Meta-commands are more commonly called slash or backslash commands.

The format of a `psql` command is the backslash, followed immediately by a command verb, then any arguments. The arguments are separated from the command verb and each other by any number of whitespace characters.

To include whitespace into an argument you may quote it with a single quote. To include a single quote into such an argument, use two single quotes. Anything contained in single quotes is furthermore subject to C-like substitutions for `\n` (new line), `\t` (tab), `\digits` (octal), and `\xdigits` (hexadecimal).

If an unquoted argument begins with a colon (`:`), it is taken as a `psql` variable and the value of the variable is used as the argument instead.

Arguments that are enclosed in backquotes (`) are taken as a command line that is passed to the shell. The output of the command (with any trailing newline removed) is taken as the argument value. The above escape sequences also apply in backquotes.

Some commands take an SQL identifier (such as a table name) as argument. These arguments follow the syntax rules of SQL: Unquoted letters are forced to lowercase, while double quotes (") protect letters from case conversion and allow incorporation of whitespace into the identifier. Within double quotes, paired double quotes reduce to a single double quote in the resulting name. For example, `FOO"BAR"BAZ` is interpreted as `fooBARbaz`, and `"A weird"" name"` becomes `A weird" name`.

Parsing for arguments stops when another unquoted backslash occurs. This is taken as the beginning of a new meta-command. The special sequence `\\` (two backslashes) marks the end of arguments and continues parsing SQL commands, if any. That way SQL and `psql` commands can be freely mixed on a line. But in any case, the arguments of a meta-command cannot continue beyond the end of the line.

The following meta-commands are defined:

\a

If the current table output format is unaligned, it is switched to aligned. If it is not unaligned, it is set to unaligned. This command is kept for backwards compatibility. See `\pset` for a more general solution.

\cd [*directory*]

Changes the current working directory. Without argument, changes to the current user's home directory. To print your current working directory, use `\!pwd`.

\C [*title*]

Sets the title of any tables being printed as the result of a query or unset any such title. This command is equivalent to `\pset title`.

\c | \connect [*dbname* [*username*] [*host*] [*port*]]

Establishes a new connection. If the new connection is successfully made, the previous connection is closed. If any of dbname, username, host or port are omitted, the value of that parameter from the previous connection is used. If the connection attempt failed, the previous connection will only be kept if `psql` is in interactive mode. When executing a non-interactive script, processing will immediately stop with an error. This distinction was chosen as a user convenience against typos, and a safety mechanism that scripts are not accidentally acting on the wrong database.

\conninfo

Displays information about the current connection including the database name, the user name, the type of connection (UNIX domain socket, `TCP/IP`, etc.), the host, and the port.

\copy {*table* [(*column_list*)] | (*query*)}
{from | to} {*filename* | stdin | stdout | pstdin | pstdout}
[with] [binary] [oids] [delimiter [as] '*character*']
[null [as] '*string*'] [csv [header]

[quote [as] '*character*'] [escape [as] '*character*']
[force quote *column_list*] [force not null *column_list*]]

Performs a frontend (client) copy. This is an operation that runs an SQL `COPY` command, but instead of the server reading or writing the specified file, `psql` reads or writes the file and routes the data between the server and the local file system. This means that file accessibility and privileges are those of the local user, not the server, and no SQL superuser privileges are required.

The syntax of the command is similar to that of the SQL `COPY` command. Note that, because of this, special parsing rules apply to the `\copy` command. In particular, the variable substitution rules and backslash escapes do not apply.

`\copy ... from stdin | to stdout` reads/writes based on the command input and output respectively. All rows are read from the same source that issued the command, continuing until `\.` is read or the stream reaches `EOF`. Output is sent to the same place as command output. To read/write from `psql`'s standard input or output, use `pstdin` or `pstdout`. This option is useful for populating tables in-line within a SQL script file.

This operation is not as efficient as the SQL `COPY` command because all data must pass through the client/server connection.

\copyright

Shows the copyright and distribution terms of PostgreSQL on which HAWQ is based.

\d [*relation_pattern*] |
\d+ [*relation_pattern*] |
\dS [*relation_pattern*]

For each relation (table, external table, view, or sequence) matching the relation pattern, show all columns, their types, the tablespace (if not the default) and any special attributes such as `NOT NULL` or defaults, if any. Associated constraints, rules, and triggers are also shown, as is the view definition if the relation is a view.

- The command form `\d+` is identical, except that more information is displayed: any comments associated with the columns of the table are shown, as is the presence of OIDs in the table.
- The command form `\dS` is identical, except that system information is displayed as well as user information.

For example, `\dt` displays user tables, but not system tables; `\dtS` displays both user and system tables.Both these commands can take the `+` parameter to display additional information, as in `\dt+` and `\dtS+`.

If `\d` is used without a pattern argument, it is equivalent to `\dtvs` which will show a list of all tables, views, and sequences.

\da [*aggregate_pattern*]

Lists all available aggregate functions, together with the data types they operate on. If a pattern is specified, only aggregates whose names match the pattern are shown.

\db [*tablespace_pattern*] | \db+ [*tablespace_pattern*]

Lists all available tablespaces and their corresponding filespace locations. If pattern is specified, only tablespaces whose names match the pattern are shown. If + is appended to the command name, each object is listed with its associated permissions.

\dc [*conversion_pattern*]

Lists all available conversions between character-set encodings. If pattern is specified, only conversions whose names match the pattern are listed.

\dC

Lists all available type casts.

\dd [*object_pattern*]

Lists all available objects. If pattern is specified, only matching objects are shown.

\dD [*domain_pattern*]

Lists all available domains. If pattern is specified, only matching domains are shown.

\df [*function_pattern*] | \df+ [*function_pattern*]

Lists available functions, together with their argument and return types. If pattern is specified, only functions whose names match the pattern are shown. If the form `\df+` is used, additional information about each function, including language and description, is shown. To reduce clutter, `\df` does not show data type I/O functions. This is implemented by ignoring functions that accept or return type `cstring`.

\dg [*role_pattern*]

Lists all database roles. If pattern is specified, only those roles whose names match the pattern are listed.

\distPvxS [*sequence* | *table* | *parent table* | *view* | *external_table* | *system_object*]

This is not the actual command name: the letters `s`, `t`, `P`, `v`, `x`, `S` stand for sequence, table, parent table, view, external table, and system table, respectively. You can specify any or all of these letters, in any order, to obtain a listing of all the matching objects. The letter `S` restricts the listing to system objects; without `S`, only non-system objects are shown. If + is appended to the command name, each object is listed with its associated description, if any. If a pattern is specified, only objects whose names match the pattern are listed.

\dl

This is an alias for `\lo_list`, which shows a list of large objects.

\dn [*schema_pattern*] | \dn+ [*schema_pattern*]

Lists all available schemas (namespaces). If pattern is specified, only schemas whose names match the pattern are listed. Non-local temporary schemas are suppressed. If + is appended to the command name, each object is listed with its associated permissions and description, if any.

\do [*operator_pattern*]

Lists available operators with their operand and return types. If pattern is specified, only operators whose names match the pattern are listed.

\dp [*relation_pattern_to_show_privileges*]

Produces a list of all available tables, views and sequences with their associated access privileges. If pattern is specified, only tables, views and sequences whose names match the pattern are listed. The `GRANT` and `REVOKE` commands are used to set access privileges.

\dT [*datatype_pattern*] | \dT+ [*datatype_pattern*]

Lists all data types or only those that match pattern. The command form `\dT+` shows extra information.

\du [*role_pattern*]

Lists all database roles, or only those that match pattern.

\e | \edit [*filename*]

If a file name is specified, the file is edited; after the editor exits, its content is copied back to the query buffer. If no argument is given, the current query buffer is copied to a temporary file which is then edited in the same fashion. The new query buffer is then re-parsed according to the normal rules of `psql`, where the whole buffer is treated as a single line. (Thus you cannot make scripts this way. Use `\i` for that.) This means also that if the query ends with (or rather contains) a semicolon, it is immediately executed. In other cases it will merely wait in the query buffer.

`psql` searches the environment variables `PSQL_EDITOR`, `EDITOR`, and `VISUAL` (in that order) for an editor to use. If all of them are unset, `vi` is used on UNIX systems, `notepad.exe` on Windows systems.

\echo *text* [...]

Prints the arguments to the standard output, separated by one space and followed by a newline. This can be useful to intersperse information in the output of scripts.

If you use the `\o` command to redirect your query output you may wish to use `\qecho` instead of this command.

\encoding [*encoding*]

Sets the client character set encoding. Without an argument, this command shows the current encoding.

\f [*field_separator_string*]

Sets the field separator for unaligned query output. The default is the vertical bar (`|`). See also `\pset` for a generic way of setting output options.

\g [{*filename* | |*command* }]

Sends the current query input buffer to the server and optionally stores the query's output in a file or pipes the output into a separate UNIX shell executing command. A bare `\g` is virtually equivalent to a semicolon. A `\g` with argument is a one-shot alternative to the `\o` command.

\h | \help [*sql_command*]

Gives syntax help on the specified SQL command. If a command is not specified, then `psql` will list all the commands for which syntax help is available. Use an asterisk (*) to show syntax help on all SQL commands. To simplify typing, commands that consists of several words do not have to be quoted.

\H

Turns on HTML query output format. If the HTML format is already on, it is switched back to the default aligned text format. This command is for compatibility and convenience, but see `\pset` about setting other output options.

\i *input_filename*

Reads input from a file and executes it as though it had been typed on the keyboard. If you want to see the lines on the screen as they are read you must set the variable `ECHO` to all.

\l | \list | \l+ | \list+

Lists the names, owners, and character set encodings of all the databases in the server. If + is appended to the command name, database descriptions are also displayed.

\lo_export *loid filename*

Reads the large object with OID *`loid`* from the database and writes it to *`filename`*. Note that this is subtly different from the server function `lo_export`, which acts with the permissions of the user that the database server runs as and on the server's file system. Use `\lo_list` to find out the large object's OID.

\lo_import *large_object_filename* [*comment*]

Stores the file into a large object. Optionally, it associates the given comment with the object. Example:

```
mydb=> \lo_import '/home/gpadmin/pictures/photo.xcf' 'a
picture of me'
lo_import 152801
```

The response indicates that the large object received object ID 152801 which one ought to remember if one wants to access the object ever again. For that reason it is recommended to always associate a human-readable comment with every object.

Those can then be seen with the `\lo_list` command. Note that this command is subtly different from the server-side `lo_import` because it acts as the local user on the local file system, rather than the server's user and file system.

`\lo_list`

Shows a list of all large objects currently stored in the database, along with any comments provided for them.

`\lo_unlink` ***`largeobject_oid`***

Deletes the large object of the specified OID from the database. Use `\lo_list` to find out the large object's OID.

`\o [ {`*`query_result_filename`*` | |`*`command`*`} ]`

Saves future query results to a file or pipes them into a UNIX shell command. If no arguments are specified, the query output will be reset to the standard output. Query results include all tables, command responses, and notices obtained from the database server, as well as output of various backslash commands that query the database (such as `\d`), but not error messages. To intersperse text output in between query results, use `\qecho`.

`\p`

Prints the current query buffer to the standard output.

`\password [`*`username`*`]`

Changes the password of the specified user (by default, the current user). This command prompts for the new password, encrypts it, and sends it to the server as an `ALTER ROLE` command. This makes sure that the new password does not appear in cleartext in the command history, the server log, or elsewhere.

`\prompt [ text ] name`

Prompts the user to set a variable *name*. Optionally, you can specify a prompt. Enclose prompts longer than one word in single quotes.

By default, \prompt uses the terminal for input and output. However, use the -f command line switch to specify standard input and standard output.

`\pset` ***`print_option`*** **`[`*`value`*`]`**

This command sets options affecting the output of query result tables. *`print_option`* describes which option is to be set. Adjustable printing options are:

- **`format`** – Sets the output format to one of `unaligned`, `aligned`, `html`, `latex`, `troff-ms`, or `wrapped`. First letter abbreviations are allowed. Unaligned writes all columns of a row on a line, separated by the currently active field separator. This is intended to create output that might be intended to be read in by other programs. Aligned mode is the standard, human-readable, nicely formatted text output that is default. The HTML and LaTeX modes put out tables that are intended to be included in documents using the respective mark-up language. They are not complete documents! (This might not be so dramatic in HTML, but in LaTeX you must have a complete document wrapper.)

The wrapped option sets the output format like the `aligned` parameter , but wraps wide data values across lines to make the output fit in the target column width. The target width is set with the `columns` option. To specify the column width and select the wrapped format, use two \pset commands; for example, to set the with to 72 columns and specify wrapped format, use the commands `\pset columns 72` and then `\pset format wrapped`.

Note: Since psql does not attempt to wrap column header titles, the wrapped format behaves the same as aligned if the total width needed for column headers exceeds the target.

- **`border`** – The second argument must be a number. In general, the higher the number the more borders and lines the tables will have, but this depends on the particular format. In HTML mode, this will translate directly into the `border=...` attribute, in the others only values `0` (no border), `1` (internal dividing lines), and `2` (table frame) make sense.
- **`columns`** – Sets the target width for the `wrapped` format, and also the width limit for determining whether output is wide enough to require the pager. The default is *zero*. Zero causes the target width to be controlled by the environment variable `COLUMNS`, or the detected screen width if `COLUMNS` is not set. In addition, if `columns` is zero then the wrapped format affects screen output only. If columns is nonzero then file and pipe output is wrapped to that width as well.

  After setting the target width, use the command `\pset format wrapped` to enable the wrapped format.
- **`expanded | x`**) – Toggles between regular and expanded format. When expanded format is enabled, query results are displayed in two columns, with the column name on the left and the data on the right. This mode is useful if the data would not fit on the screen in the normal horizontal mode. Expanded mode is supported by all four output formats.
- **`linestyle [unicode | ascii | old-ascii]`** – Sets the border line drawing style to one of unicode, ascii, or old-ascii. Unique abbreviations, including one letter, are allowed for the three styles. The default setting is `ascii`. This option only affects the `aligned` and `wrapped` output formats.

  `ascii` – uses plain ASCII characters. Newlines in data are shown using a + symbol in the right-hand margin. When the wrapped format wraps data from one line to the next without a newline character, a dot (.) is shown in the right-hand margin of the first line, and again in the left-hand margin of the following line.

  `old-ascii` – style uses plain ASCII characters, using the formatting style used in PostgreSQL 8.4 and earlier. Newlines in data are shown using a : symbol in place of the left-hand column separator. When the data is wrapped from one line to the next without a newline character, a ; symbol is used in place of the left-hand column separator.

  `unicode` – style uses Unicode box-drawing characters. Newlines in data are shown using a carriage return symbol in the right-hand margin. When the data is wrapped from one line to the next without a newline character, an ellipsis symbol is shown in the right-hand margin of the first line, and again in the left-hand margin of the following line.

When the `border` setting is greater than zero, this option also determines the characters with which the border lines are drawn. Plain ASCII characters work everywhere, but Unicode characters look nicer on displays that recognize them.

- **`null 'string'`** – The second argument is a string to print whenever a column is null. The default is not to print anything, which can easily be mistaken for an empty string. For example, the command `\pset null '(empty)'` displays *(empty)* in null columns.
- **`fieldsep`** – Specifies the field separator to be used in unaligned output mode. That way one can create, for example, tab- or comma-separated output, which other programs might prefer. To set a tab as field separator, type `\pset fieldsep '\t'`. The default field separator is `'|'` (a vertical bar).
- **`footer`** – Toggles the display of the default footer (*x* rows).
- **`numericlocale`** – Toggles the display of a locale-aware character to separate groups of digits to the left of the decimal marker. It also enables a locale-aware decimal marker.
- **`recordsep`** – Specifies the record (line) separator to use in unaligned output mode. The default is a newline character.
- **`title [text]`** – Sets the table title for any subsequently printed tables. This can be used to give your output descriptive tags. If no argument is given, the title is unset.
- **`tableattr | T [text]`** – Allows you to specify any attributes to be placed inside the HTML table tag. This could for example be `cellpadding` or `bgcolor`. Note that you probably don't want to specify border here, as that is already taken care of by `\pset border`.
- **`tuples_only | t [no value | on | off]`** – The `\pset tuples_only` command by itselt toggles between tuples only and full display. The values *on* and *off* set the tuples display, regardless of the current setting. Full display may show extra information such as column headers, titles, and various footers. In tuples only mode, only actual table data is shown The `\t` command is equivalent to `\pset tuples_only` and is provided for convenience.
- **`pager`** – Controls the use of a pager for query and `psql` help output. When `on`, if the environment variable `PAGER` is set, the output is piped to the specified program. Otherwise a platform-dependent default (such as `more`) is used. When `off`, the pager is not used. When `on`, the pager is used only when appropriate. Pager can also be set to `always`, which causes the pager to be always used.

\q

Quits the `psql` program.

\qecho *text* [...]

This command is identical to `\echo` except that the output will be written to the query output channel, as set by `\o`.

\r

Resets (clears) the query buffer.

\s [*history_filename*]

Print or save the command line history to `filename`. If `filename` is omitted, the history is written to the standard output.

\set [*name* [*value* [...]]]

Sets the internal variable `name` to `value` or, if more than one value is given, to the concatenation of all of them. If no second argument is given, the variable is just set with no value. To unset a variable, use the `\unset` command.

Valid variable names can contain characters, digits, and underscores. See “Variables” on page 356. Variable names are case-sensitive.

Although you are welcome to set any variable to anything you want, `psql` treats several variables as special. They are documented in the section about variables.

This command is totally separate from the SQL command `SET`.

\t [no value | on | off]

The `\t` command by itself toggles a display of output column name headings and row count footer. The values *on* and *off* set the tuples display, regardless of the current setting.This command is equivalent to `\pset tuples_only` and is provided for convenience.

\T *table_options*

Allows you to specify attributes to be placed within the table tag in HTML tabular output mode.

\timing [no value | on | off]

The `\timing` command by itself toggles a display of how long each SQL statement takes, in milliseconds. The values *on* and *off* set the time display, regardless of the current setting.

\w {*filename* | |*command*}

Outputs the current query buffer to a file or pipes it to a UNIX command.

\x

Toggles expanded table formatting mode.

\z [*relation_to_show_privileges*]

Produces a list of all available tables, views and sequences with their associated access privileges. If a pattern is specified, only tables, views and sequences whose names match the pattern are listed. This is an alias for `\dp`.

\! [*command*]

Escapes to a separate UNIX shell or executes the UNIX command. The arguments are not further interpreted, the shell will see them as is.

\?

Shows help information about the `psql` backslash commands.

Patterns

The various `\d` commands accept a pattern parameter to specify the object name(s) to be displayed. In the simplest case, a pattern is just the exact name of the object. The characters within a pattern are normally folded to lower case, just as in SQL names; for example, `\dt FOO` will display the table named `foo`. As in SQL names, placing double quotes around a pattern stops folding to lower case. Should you need to include an actual double quote character in a pattern, write it as a pair of double quotes within a double-quote sequence; again this is in accord with the rules for SQL quoted identifiers. For example, `\dt "FOO""BAR"` will display the table named `FOO"BAR` (not `foo"bar`). Unlike the normal rules for SQL names, you can put double quotes around just part of a pattern, for instance `\dt FOO"FOO"BAR` will display the table named `fooFOObar`.

Within a pattern, `*` matches any sequence of characters (including no characters) and `?` matches any single character. (This notation is comparable to UNIX shell file name patterns.) For example, `\dt int*` displays all tables whose names begin with `int`. But within double quotes, `*` and `?` lose these special meanings and are just matched literally.

A pattern that contains a dot (`.`) is interpreted as a schema name pattern followed by an object name pattern. For example, `\dt foo*.bar*` displays all tables whose table name starts with `bar` that are in schemas whose schema name starts with `foo`. When no dot appears, then the pattern matches only objects that are visible in the current schema search path. Again, a dot within double quotes loses its special meaning and is matched literally.

Advanced users can use regular-expression notations. All regular expression special characters work as specified in the PostgreSQL documentation on regular expressions, except for `.` which is taken as a separator as mentioned above, `*` which is translated to the regular-expression notation `.*`, and `?` which is translated to `..` You can emulate these pattern characters at need by writing `?` for `.`, `(R+|)` for `R*`, or `(R|)` for `R?`. Remember that the pattern must match the whole name, unlike the usual interpretation of regular expressions; write `*` at the beginning and/or end if you don't wish the pattern to be anchored. Note that within double quotes, all regular expression special characters lose their special meanings and are matched literally. Also, the regular expression special characters are matched literally in operator name patterns (such as the argument of `\do`).

Whenever the pattern parameter is omitted completely, the `\d` commands display all objects that are visible in the current schema search path – this is equivalent to using the pattern `*`. To see all objects in the database, use the pattern `*.*`.

Advanced Features

Variables

`psql` provides variable substitution features similar to common UNIX command shells. Variables are simply name/value pairs, where the value can be any string of any length. To set variables, use the `psql` meta-command `\set`:

```
testdb=> \set foo bar
```

sets the variable `foo` to the value `bar`. To retrieve the content of the variable, precede the name with a colon and use it as the argument of any slash command:

```
testdb=> \echo :foo
bar
```

Note: The arguments of `\set` are subject to the same substitution rules as with other commands. Thus you can construct interesting references such as `\set :foo 'something'` and get 'soft links' or 'variable variables' of Perl or PHP fame, respectively. Unfortunately, there is no way to do anything useful with these constructs. On the other hand, `\set bar :foo` is a perfectly valid way to copy a variable.

If you call `\set` without a second argument, the variable is set, with an empty string as *`value`*. To unset (or delete) a variable, use the command `\unset`.

`psql`'s internal variable names can consist of letters, numbers, and underscores in any order and any number of them. A number of these variables are treated specially by `psql`. They indicate certain option settings that can be changed at run time by altering the value of the variable or represent some state of the application. Although you can use these variables for any other purpose, this is not recommended, as the program behavior might behave unexpectedly. By convention, all specially treated variables consist of all upper-case letters (and possibly numbers and underscores). To ensure maximum compatibility in the future, avoid using such variable names for your own purposes. A list of all specially treated variables are as follows:

AUTOCOMMIT

When on (the default), each SQL command is automatically committed upon successful completion. To postpone commit in this mode, you must enter a `BEGIN` or `START TRANSACTION` SQL command. When off or unset, SQL commands are not committed until you explicitly issue `COMMIT` or `END`. The autocommit-on mode works by issuing an implicit `BEGIN` for you, just before any command that is not already in a transaction block and is not itself a `BEGIN` or other transaction-control command, nor a command that cannot be executed inside a transaction block (such as `VACUUM`).

In autocommit-off mode, you must explicitly abandon any failed transaction by entering `ABORT` or `ROLLBACK`. Also keep in mind that if you exit the session without committing, your work will be lost.

The autocommit-on mode is PostgreSQL's traditional behavior, but autocommit-off is closer to the SQL spec. If you prefer autocommit-off, you may wish to set it in your `~/.psqlrc` file.

DBNAME

The name of the database you are currently connected to. This is set every time you connect to a database (including program start-up), but can be unset.

ECHO

If set to all, all lines entered from the keyboard or from a script are written to the standard output before they are parsed or executed. To select this behavior on program start-up, use the switch `-a`. If set to queries, `psql` merely prints all queries as they are sent to the server. The switch for this is `-e`.

ECHO_HIDDEN

When this variable is set and a backslash command queries the database, the query is first shown. This way you can study the HAWQ internals and provide similar functionality in your own programs. (To select this behavior on program start-up, use the switch `-E`.) If you set the variable to the value `noexec`, the queries are just shown but are not actually sent to the server and executed.

ENCODING

The current client character set encoding.

FETCH_COUNT

If this variable is set to an integer value > 0, the results of `SELECT` queries are fetched and displayed in groups of that many rows, rather than the default behavior of collecting the entire result set before display. Therefore only a limited amount of memory is used, regardless of the size of the result set. Settings of 100 to 1000 are commonly used when enabling this feature. Keep in mind that when using this feature, a query may fail after having already displayed some rows.

Although you can use any output format with this feature, the default aligned format tends to look bad because each group of `FETCH_COUNT` rows will be formatted separately, leading to varying column widths across the row groups. The other output formats work better.

HISTCONTROL

If this variable is set to `ignorespace`, lines which begin with a space are not entered into the history list. If set to a value of `ignoredups`, lines matching the previous history line are not entered. A value of `ignoreboth` combines the two options. If unset, or if set to any other value than those above, all lines read in interactive mode are saved on the history list.

HISTFILE

The file name that will be used to store the history list. The default value is `~/.psql_history`. For example, putting

```
\set HISTFILE ~/.psql_history- :DBNAME
```

in `~/.psqlrc` will cause `psql` to maintain a separate history for each database.

HISTSIZE

The number of commands to store in the command history. The default value is 500.

HOST

The database server host you are currently connected to. This is set every time you connect to a database (including program start-up), but can be unset.

IGNOREEOF

If unset, sending an `EOF` character (usually `CTRL+D`) to an interactive session of `psql` will terminate the application. If set to a numeric value, that many `EOF` characters are ignored before the application terminates. If the variable is set but has no numeric value, the default is `10`.

LASTOID

The value of the last affected OID, as returned from an `INSERT` or `lo_insert` command. This variable is only guaranteed to be valid until after the result of the next SQL command has been displayed.

ON_ERROR_ROLLBACK

When on, if a statement in a transaction block generates an error, the error is ignored and the transaction continues. When interactive, such errors are only ignored in interactive sessions, and not when reading script files. When off (the default), a statement in a transaction block that generates an error aborts the entire transaction. The on_error_rollback-on mode works by issuing an implicit `SAVEPOINT` for you, just before each command that is in a transaction block, and rolls back to the savepoint on error.

ON_ERROR_STOP

By default, if non-interactive scripts encounter an error, such as a malformed SQL command or internal meta-command, processing continues. This has been the traditional behavior of `psql` but it is sometimes not desirable. If this variable is set, script processing will immediately terminate. If the script was called from another script it will terminate in the same fashion. If the outermost script was not called from an interactive `psql` session but rather using the `-f` option, `psql` will return error code 3, to distinguish this case from fatal error conditions (error code 1).

PORT

The database server port to which you are currently connected. This is set every time you connect to a database (including program start-up), but can be unset.

PROMPT1
PROMPT2
PROMPT3

These specify what the prompts `psql` issues should look like. See "Prompting" on page 361.

QUIET

This variable is equivalent to the command line option `-q`. It is not very useful in interactive mode.

SINGLELINE

This variable is equivalent to the command line option `-S`.

SINGLESTEP

This variable is equivalent to the command line option `-s`.

USER

The database user you are currently connected as. This is set every time you connect to a database (including program start-up), but can be unset.

VERBOSITY

This variable can be set to the values `default`, `verbose`, or `terse` to control the verbosity of error reports.

SQL Interpolation

An additional useful feature of `psql` variables is that you can substitute (interpolate) them into regular SQL statements. The syntax for this is again to prepend the variable name with a colon (`:`).

```
testdb=> \set foo 'my_table'
testdb=> SELECT * FROM :foo;
```

would then query the table *my_table*. The value of the variable is copied literally, so it can even contain unbalanced quotes or backslash commands. You must make sure that it makes sense where you put it. Variable interpolation will not be performed into quoted SQL entities.

A popular application of this facility is to refer to the last inserted OID in subsequent statements to build a foreign key scenario. Another possible use of this mechanism is to copy the contents of a file into a table column. First load the file into a variable and then proceed as above.

```
testdb=> \set content '''' `cat my_file.txt` ''''
testdb=> INSERT INTO my_table VALUES (:content);
```

One problem with this approach is that *my_file.txt* might contain single quotes. These need to be escaped so that they don't cause a syntax error when the second line is processed. This could be done with the program `sed`:

```
testdb=> \set content '''' `sed -e "s/'/''/g" < my_file.txt`
''''
```

If you are using non-standard-conforming strings then you'll also need to double backslashes. This is a bit tricky:

```
testdb=> \set content '''' `sed -e "s/'/''/g" -e
's/\\/\\\\/g' < my_file.txt` ''''
```

Note the use of different shell quoting conventions so that neither the single quote marks nor the backslashes are special to the shell. Backslashes are still special to `sed`, however, so we need to double them.

Since colons may legally appear in SQL commands, the following rule applies: the character sequence "`:name`" is not changed unless "`name`" is the name of a variable that is currently set. In any case you can escape a colon with a backslash to protect it from substitution. (The colon syntax for variables is standard SQL for embedded query languages, such as ECPG. The colon syntax for array slices and type casts are HAWQ extensions, hence the conflict.)

Prompting

The prompts `psql` issues can be customized to your preference. The three variables `PROMPT1`, `PROMPT2`, and `PROMPT3` contain strings and special escape sequences that describe the appearance of the prompt. Prompt 1 is the normal prompt that is issued when `psql` requests a new command. Prompt 2 is issued when more input is expected during command input because the command was not terminated with a semicolon or a quote was not closed. Prompt 3 is issued when you run an SQL `COPY` command and you are expected to type in the row values on the terminal.

The value of the selected prompt variable is printed literally, except where a percent sign (`%`) is encountered. Depending on the next character, certain other text is substituted instead. Defined substitutions are:

%M

The full host name (with domain name) of the database server, or `[local]` if the connection is over a UNIX domain socket, or `[local:/dir/name]`, if the UNIX domain socket is not at the compiled in default location.

%m

The host name of the database server, truncated at the first dot, or `[local]` if the connection is over a UNIX domain socket.

%>

The port number at which the database server is listening.

%n

The database session user name. (The expansion of this value might change during a database session as the result of the command `SET SESSION AUTHORIZATION`.)

%/

The name of the current database.

%~

Like `%/`, but the output is `~` (tilde) if the database is your default database.

%#

If the session user is a database superuser, then a **#**, otherwise a **>**. (The expansion of this value might change during a database session as the result of the command `SET SESSION AUTHORIZATION`.)

%R

In prompt 1 normally **=**, but **^** if in single-line mode, and **!** if the session is disconnected from the database (which can happen if `\connect` fails). In prompt 2 the sequence is replaced by **-**, *****, a single quote, a double quote, or a dollar sign, depending on whether `psql` expects more input because the command wasn't terminated yet, because you are inside a `/* ... */` comment, or because you are inside a quoted or dollar-escaped string. In prompt 3 the sequence doesn't produce anything.

%x

Transaction status: an empty string when not in a transaction block, or `*` when in a transaction block, or `!` when in a failed transaction block, or `?` when the transaction state is indeterminate (for example, because there is no connection).

%digits

The character with the indicated octal code is substituted.

%:*name*:

The value of the `psql` variable name. See “Variables” on page 356 for details.

%`*command*`

The output of command, similar to ordinary back-tick substitution.

%[... %]

Prompts may contain terminal control characters which, for example, change the color, background, or style of the prompt text, or change the title of the terminal window. In order for line editing to work properly, these non-printing control characters must be designated as invisible by surrounding them with `%[` and `%]`. Multiple pairs of these may occur within the prompt. For example,

```
testdb=> \set PROMPT1 '%[%033[1;33;40m%]%n@%/%R%[%033[0m%]%#
'
```

results in a boldfaced (`1;`) yellow-on-black (`33;40`) prompt on VT100-compatible, color-capable terminals. To insert a percent sign into your prompt, write `%%`. The default prompts are `'%/%R%# '` for prompts 1 and 2, and `'>> '` for prompt 3.

Command-Line Editing

`psql` supports the NetBSD *libedit* library for convenient line editing and retrieval. The command history is automatically saved when `psql` exits and is reloaded when `psql` starts up. Tab-completion is also supported, although the completion logic makes no claim to be an SQL parser. If for some reason you do not like the tab completion, you can turn it off by putting this in a file named `.inputrc` in your home directory:

```
$if psql
set disable-completion on
$endif
```

Environment

PAGER

If the query results do not fit on the screen, they are piped through this command. Typical values are `more` or `less`. The default is platform-dependent. The use of the pager can be disabled by using the `\pset` command.

PGDATABASE
PGHOST

PGPORT
PGUSER

Default connection parameters.

PSQL_EDITOR
EDITOR
VISUAL

Editor used by the `\e` command. The variables are examined in the order listed; the first that is set is used.

SHELL

Command executed by the `\!` command.

TMPDIR

Directory for storing temporary files. The default is `/tmp`.

Files

Before starting up, `psql` attempts to read and execute commands from the user's `~/.psqlrc` file.

The command-line history is stored in the file `~/.psql_history`.

Notes

`psql` only works smoothly with servers of the same version. That does not mean other combinations will fail outright, but subtle and not-so-subtle problems might come up. Backslash commands are particularly likely to fail if the server is of a different version.

Notes for Windows users

`psql` is built as a console application. Since the Windows console windows use a different encoding than the rest of the system, you must take special care when using 8-bit characters within `psql`. If `psql` detects a problematic console code page, it will warn you at startup. To change the console code page, two things are necessary:

Set the code page by entering `cmd.exe /c chcp 1252`. (`1252` is a character encoding of the Latin alphabet, used by Microsoft Windows for English and some other Western languages.) If you are using Cygwin, you can put this command in `/etc/profile`.

Set the console font to Lucida Console, because the raster font does not work with the ANSI code page.

Examples

Start `psql` in interactive mode:

```
psql -p 54321 -U sally mydatabase
```

In `psql` interactive mode, spread a command over several lines of input. Notice the changing prompt:

```
testdb=> CREATE TABLE my_table (
testdb(>  first integer not null default 0,
testdb(>  second text)
testdb-> ;
CREATE TABLE
```

Look at the table definition:

```
testdb=> \d my_table
             Table "my_table"
 Attribute |  Type   |      Modifier
-----------+---------+--------------------
 first     | integer | not null default 0
 second    | text    |
```

Run `psql` in non-interactive mode by passing in a file containing SQL commands:

```
psql -f /home/gpadmin/test/myscript.sql
```

vacuumdb

Garbage-collects and analyzes a database.

Synopsis

vacuumdb [*connection-option*...] [--full | -f] [**-F**] [**--verbose** | **-v**] [**--analyze** | **-z**] [**--table** | **-t** *table* [(*column* [,...])]] [*dbname*]

vacuumdb [*connection-options*...] [**--all** | **-a**] [--full | -f] [**-F**] [**--verbose** | **-v**] [**--analyze** | **-z**]

vacuumdb --help | --version

Description

`vacuumdb` is a utility for cleaning a PostgreSQL database. vacuumdb will also generate internal statistics used by the PostgreSQL query optimizer.

`vacuumdb` is a wrapper around the SQL command `VACUUM`. There is no effective difference between vacuuming databases via this utility and via other methods for accessing the server.

Options

-a | --all

Vacuums all databases.

[-d] *dbname* | [--dbname] *dbname*

The name of the database to vacuum. If this is not specified and `--all` is not used, the database name is read from the environment variable `PGDATABASE`. If that is not set, the user name specified for the connection is used.

-f | --full

Selects a full vacuum, which may reclaim more space, but takes much longer and exclusively locks the table.
Warning: A `VACUUM FULL` is not recommended in HAWQ.

-F | --freeze

Freeze row transaction information.

-q | --quiet

Do not display a response.

-t *table* [(*column*)] | --table *table* [(*column*)]

Clean or analyze this table only. Column names may be specified only in conjunction with the `--analyze` option. If you specify columns, you probably have to escape the parentheses from the shell.

-v | --verbose

Print detailed information during processing.

-z | --analyze

Collect statistics for use by the query planner.

Connection Options

-h *host* | --host *host*

The host name of the HAWQ master database server. If not specified, reads the name from the environment variable `PGHOST` or defaults to localhost.

-p *port* | --port *port*

The TCP port where the HAWQ master database server listens for connections. If not specified, reads the environment variable `PGPORT`, or defaults to 5432.

-U *username* | --username *username*

The database role name to connect as. If not specified, reads from the environment variable `PGUSER` or defaults to the current system role name.

-w | --no-password

Use this to run automated batch jobs and scripts. In general, if the server requires password authentication ensure that it can be accessed through a `.pgpass` file. Otherwise the connection attempt will fail.

-W | --password

Force a password prompt.

Notes

`vacuumdb` might need to connect several times to the master server, asking for a password each time. It is convenient to have a `~/.pgpass` file in such cases.

Examples

To clean the database *test*:

```
vacuumdb test
```

To clean and analyze a database named *bigdb*:

```
vacuumdb --analyze bigdb
```

To clean a single table *foo* in a database named *mydb*, and analyze a single column *bar* of the table. Note the quotes around the table and column names to escape the parentheses from the shell:

```
vacuumdb --analyze --verbose --table 'foo(bar)' mydb
```

See Also

VACUUM, ANALYZE

•

D. Server Configuration Parameters

There are many configuration parameters that affect the behavior of the HAWQ system. Many of these configuration parameters have the same names, settings, and behaviors as in a regular PostgreSQL database system.

Parameter Types and Values

All parameter names are case-insensitive. Every parameter takes a value of one of four types: `Boolean`, `integer`, `floating point`, or `string`. Boolean values may be written as `ON`, `OFF`, `TRUE`, `FALSE`, `YES`, `NO`, `1`, `0` (all case-insensitive).

Some settings specify a memory size or time value. Each of these has an implicit unit, which is either kilobytes, blocks (typically eight kilobytes), milliseconds, seconds, or minutes. Valid memory size units are **`kB`** (kilobytes), **`MB`** (megabytes), and **`GB`** (gigabytes). Valid time units are **`ms`** (milliseconds), **`s`** (seconds), **`min`** (minutes), **`h`** (hours), and **`d`** (days). Note that the multiplier for memory units is 1024, not 1000. A valid time expression contains a number and a unit. When specifying a memory or time unit using the `SET` command, enclose the value in quotes. For example:

```
SET work_mem TO '200MB';
```

Note: There is no space between the value and the unit names.

Setting Parameters

Many of the configuration parameters have limitations on who can change them and where or when they can be set. For example, to change certain parameters, you must be a HAWQ superuser. Other parameters require a restart of the system for the changes to take effect. A parameter that is classified as *session* can be set at the system level (in the `postgresql.conf` file), at the database-level (using `CREATE DATABASE`), at the role-level (using `ALTER ROLE`), or at the session-level (using `SET`). System parameters can only be set in the `postgresql.conf` file.

In HAWQ, the master and each segment instance has its own `postgresql.conf` file (located in their respective data directories). Some parameters are considered *local* parameters, meaning that each segment instance looks to its own `postgresql.conf` file to get the value of that parameter. You must set local parameters on every instance in the system (master and segments). Others parameters are considered *master* parameters. Master parameters need only be set at the master instance.

Table D.1 Settable Classifications

Set Classification	Description
master or local	A *master* parameter only needs to be set in the `postgresql.conf` file of the HAWQ master instance. The value for this parameter is then either passed to (or ignored by) the segments at run time. A local parameter must be set in the `postgresql.conf` file of the master AND each segment instance. Each segment instance looks to its own configuration to get the value for the parameter. Local parameters always requires a system restart for changes to take effect.
session or system	*Session* parameters can be changed on the fly within a database session, and can have a hierarchy of settings: at the system level (`postgresql.conf`), at the database level (`ALTER DATABASE...SET`), at the role level (`ALTER ROLE...SET`), or at the session level (`SET`). If the parameter is set at multiple levels, then the most granular setting takes precedence (for example, session overrides role, role overrides database, and database overrides system). A *system* parameter can only be changed via the `postgresql.conf` file(s).

Table D.1 Settable Classifications

Set Classification	Description
restart or reload	When changing parameter values in the postgrsql.conf file(s), some require a *restart* of HAWQ for the change to take effect. Other parameter values can be refreshed by just reloading the server configuration file (using `gpstop -u`), and do not require stopping the system.
superuser	These session parameters can only be set by a database superuser. Regular database users cannot set this parameter.
read only	These parameters are not settable by database users or superusers. The current value of the parameter can be shown but not altered.

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
add_missing_from	Boolean	off	Automatically adds missing table references to FROM clauses. Present for compatibility with releases of PostgreSQL prior to 8.1, where this behavior was allowed by default.	master session reload
application_name	string		Sets the application name for a client session. For example, if connecting via `psql`, this will be set to `psql`. Setting an application name allows it to be reported in log messages and statistics views.	master session reload
array_nulls	Boolean	on	This controls whether the array input parser recognizes unquoted NULL as specifying a null array element. By default, this is on, allowing array values containing null values to be entered. HAWQ versions before 3.0 did not support null values in arrays, and therefore would treat NULL as specifying a normal array element with the string value 'NULL'.	master session reload
authentication_timeout	Any valid time expression (number and unit)	1min	Maximum time to complete client authentication. This prevents hung clients from occupying a connection indefinitely.	local system restart
backslash_quote	on (allow \' always) off (reject always) safe_encoding (allow only if client encoding does not allow ASCII \ within a multibyte character)	safe_encoding	This controls whether a quote mark can be represented by \' in a string literal. The preferred, SQL-standard way to represent a quote mark is by doubling it ('') but PostgreSQL has historically also accepted \'. However, use of \' creates security risks because in some client character set encodings, there are multibyte characters in which the last byte is numerically equivalent to ASCII \.	master session reload
block_size	number of bytes	32768	Reports the size of a disk block.	read only
bonjour_name	string	unset	Specifies the Bonjour broadcast name. By default, the computer name is used, specified as an empty string. This option is ignored if the server was not compiled with Bonjour support.	master system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
check_function_bodies	Boolean	on	When set to off, disables validation of the function body string during `CREATE FUNCTION`. Disabling validation is occasionally useful to avoid problems such as forward references when restoring function definitions from a dump.	master session reload
client_encoding	character set	UTF8	Sets the client-side encoding (character set). The default is to use the same as the database encoding. See Supported Character Sets in the PostgreSQL documentation.	master session reload
client_min_messages	DEBUG5 DEBUG4 DEBUG3 DEBUG2 DEBUG1 LOG NOTICE WARNING ERROR FATAL PANIC	NOTICE	Controls which message levels are sent to the client. Each level includes all the levels that follow it. The later the level, the fewer messages are sent.	master session reload
cpu_operator_cost	floating point	0.0025	Sets the planner's estimate of the cost of processing each operator in a WHERE clause. This is measured as a fraction of the cost of a sequential page fetch.	master session reload
cpu_tuple_cost	floating point	0.01	Sets the planner's estimate of the cost of processing each row during a query. This is measured as a fraction of the cost of a sequential page fetch.	master session reload
cursor_tuple_fraction	integer	1	Tells the query planner how many rows are expected to be fetched in a cursor query, thereby allowing the planner to use this information to optimize the query plan. The default of 1 means all rows will be fetched.	master session reload
custom_variable_classes	comma-separated list of class names	unset	Specifies one or several class names to be used for custom variables. A custom variable is a variable not normally known to the server but used by some add-on module. Such variables must have names consisting of a class name, a dot, and a variable name.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
DateStyle	<format>, <date style> where <format> is ISO, Postgres, SQL, or German and <date style> is DMY, MDY, or YMD.	ISO, MDY	Sets the display format for date and time values, as well as the rules for interpreting ambiguous date input values. This variable contains two independent components: the output format specification and the input/output specification for year/month/day ordering.	master session reload
db_user_namespace	Boolean	off	This enables per-database user names. If on, you should create users as *username@dbname*. To create ordinary global users, simply append @ when specifying the user name in the client.	local system restart
deadlock_timeout	Any valid time expression (number and unit)	1s	The time to wait on a lock before checking to see if there is a deadlock condition. On a heavily loaded server you might want to raise this value. Ideally the setting should exceed your typical transaction time, so as to improve the odds that a lock will be released before the waiter decides to check for deadlock.	local system restart
debug_assertions	Boolean	off	Turns on various assertion checks.	local system restart
debug_pretty_print	Boolean	off	Indents debug output to produce a more readable but much longer output format. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload
debug_print_parse	Boolean	off	For each executed query, prints the resulting parse tree. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload
debug_print_plan	Boolean	off	For each executed query, prints the HAWQ parallel query execution plan. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload
debug_print_prelim_plan	Boolean	off	For each executed query, prints the preliminary query plan. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
debug_print_rewritten	Boolean	off	For each executed query, prints the query rewriter output. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload
debug_print_slice_table	Boolean	off	For each executed query, prints the HAWQ query slice plan. *client_min_messages* or *log_min_messages* must be DEBUG1 or lower.	master session reload
default_statistics_target	integer > 0	25	Sets the default statistics target for table columns that have not had a column-specific target set via ALTER TABLE SET STATISTICS. Larger values increase the time needed to do ANALYZE, but may improve the quality of the planner's estimates.	master session reload
default_tablespace	name of a tablespace	unset	The default tablespace in which to create tables when a CREATE command does not explicitly specify a tablespace.	master session reload
default_transaction_isolation	read committed read uncommitted repeatable read serializable	read committed	Controls the default isolation level of each new transaction.	master session reload
default_transaction_read_only	Boolean	off	Controls the default read-only status of each new transaction. A read-only SQL transaction cannot alter non-temporary tables.	master session reload
dynamic_library_path	a list of absolute directory paths separated by colons	$libdir	If a dynamically loadable module needs to be opened and the file name specified in the CREATE FUNCTION or LOAD command does not have a directory component (i.e. the name does not contain a slash), the system will search this path for the required file. The compiled-in PostgreSQL package library directory is substituted for $libdir. This is where the modules provided by the standard PostgreSQL distribution are installed.	local system restart
effective_cache_size	floating point	512MB	Sets the planner's assumption about the effective size of the disk cache that is available to a single query. This parameter has no effect on the size of shared memory allocated by a HAWQ server instance, nor does it reserve kernel disk cache; it is used only for estimation purposes.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
enable_bitmapscan	Boolean	on	Enables or disables the query planner's use of bitmap-scan plan types. Note that this is different than a Bitmap Scan. Each bitmap per column can be compared to create a final list of selected tuples.	master session reload
enable_groupagg	Boolean	on	Enables or disables the query planner's use of group aggregation plan types.	master session reload
enable_hashagg	Boolean	on	Enables or disables the query planner's use of hash aggregation plan types.	master session reload
enable_hashjoin	Boolean	on	Enables or disables the query planner's use of hash-join plan types.	master session reload
enable_mergejoin	Boolean	off	Enables or disables the query planner's use of merge-join plan types. Merge join is based on the idea of sorting the left- and right-hand tables into order and then scanning them in parallel. So, both data types must be capable of being fully ordered, and the join operator must be one that can only succeed for pairs of values that fall at the 'same place' in the sort order. In practice this means that the join operator must behave like equality.	master session reload
enable_nestloop	Boolean	off	Enables or disables the query planner's use of nested-loop join plans. It's not possible to suppress nested-loop joins entirely, but turning this variable off discourages the planner from using one if there are other methods available.	master session reload
enable_secure_filesystem	Boolean	off	Set if HAWQ support secure enabled file system	master system restart
enable_seqscan	Boolean	on	Enables or disables the query planner's use of sequential scan plan types. It's not possible to suppress sequential scans entirely, but turning this variable off discourages the planner from using one if there are other methods available.	master session reload
enable_sort	Boolean	on	Enables or disables the query planner's use of explicit sort steps. It's not possible to suppress explicit sorts entirely, but turning this variable off discourages the planner from using one if there are other methods available.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
enable_tidscan	Boolean	on	Enables or disables the query planner's use of tuple identifier (TID) scan plan types.	master session reload
escape_string_warning	Boolean	on	When on, a warning is issued if a backslash (\) appears in an ordinary string literal ('...' syntax). Escape string syntax (E'...') should be used for escapes, because in future versions, ordinary strings will have the SQL standard-conforming behavior of treating backslashes literally.	master session reload
explain_pretty_print	Boolean	on	Determines whether EXPLAIN VERBOSE uses the indented or non-indented format for displaying detailed query-tree dumps.	master session reload
extra_float_digits	integer	0	Adjusts the number of digits displayed for floating-point values, including float4, float8, and geometric data types. The parameter value is added to the standard number of digits. The value can be set as high as 2, to include partially-significant digits; this is especially useful for dumping float data that needs to be restored exactly. Or it can be set negative to suppress unwanted digits.	master session reload
from_collapse_limit	1-*n*	20	The planner will merge sub-queries into upper queries if the resulting FROM list would have no more than this many items. Smaller values reduce planning time but may yield inferior query plans.	master session reload
gp_adjust_selectivity_for_outerjoins	Boolean	on	Enables the selectivity of NULL tests over outer joins.	master session reload
gp_analyze_relative_error	floating point < 1.0	0.25	Sets the estimated acceptable error in the cardinality of the table — a value of 0.5 is supposed to be equivalent to an acceptable error of 50% (this is the default value used in PostgreSQL). If the statistics collected during ANALYZE are not producing good estimates of cardinality for a particular table attribute, decreasing the relative error fraction (accepting less error) tells the system to sample more rows.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications

gp_autostats_mode	none
	on_change
	on_no_stats
		on_no_
		stats
			Specifies the mode for triggering automatic statistics collection with `ANALYZE`. The `on_no_stats` option triggers statistics collection for `CREATE TABLE AS SELECT`, `INSERT`, or `COPY` operations on any table that has no existing statistics.
			The `on_change` option triggers statistics collection only when the number of rows affected meets or exceeds the threshold defined by `gp_autostats_on_change_threshold`. Operations that can trigger automatic statistics collection with `on_change` are:
			`CREATE TABLE AS SELECT`
			`UPDATE`
			`DELETE`
			`INSERT`
			`COPY`
			Default is `on_no_stats`.
				master
				session
				reload

gp_autostats_on_change_thresh old	integer	21474836 47	Specifies the threshold for automatic statistics collection when `gp_autostats_mode` is set to `on_change`. When a triggering table operation affects a number of rows exceeding this threshold, `ANALYZE` is added and statistics are collected for the table.	master session reload
gp_cached_segworkers_threshold	integer > 0	5	When a user starts a session with HAWQ and issues a query, the system creates groups or 'gangs' of worker processes on each segment to do the work. After the work is done, the segment worker processes are destroyed except for a cached number which is set by this parameter. A lower setting conserves system resources on the segment hosts, but a higher setting may improve performance for power-users that want to issue many complex queries in a row.	master session reload
gp_command_count	integer > 0	1	Shows how many commands the master has received from the client. Note that a single SQLcommand might actually involve more than one command internally, so the counter may increment by more than one for a single query. This counter also is shared by all of the segment processes working on the command.	read only

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_connectemc_mode	on, off, local, remote	on	Controls the ConnectEMC event logging and dial-home capabilities of HAWQ Performance Monitor on the EMC Greenplum Data Computing Appliance (DCA). ConnectEMC must be installed in order to generate events. Allowed values are: • `on` (the default) - log events to the `gpperfmon` database and send dial-home notifications to EMC Support • `off` - turns off ConnectEMC event logging and dial-home capabilities • `local` - log events to the `gpperfmon` database only • `remote` - sends dial-home notifications to EMC Support (does not log events to the `gpperfmon` database)	master system restart superuser
gp_connections_per_thread	integer	64	A value larger than or equal to the number of primary segments means that each slice in a query plan will get its own thread when dispatching to the segments. A value of 0 indicates that the dispatcher should use a single thread when dispatching all query plan slices to a segment. Lower values will use more threads, which utilizes more resources on the master. Typically, the default does not need to be changed unless there is a known throughput performance problem.	master session reload
gp_content	integer		The local content id if a segment.	read only
gp_dbid	integer		The local content dbid if a segment.	read only
gp_debug_linger	Any valid time expression (number and unit)	0	Number of seconds for a HAWQ process to linger after a fatal internal error.	master session reload
gp_dynamic_partition_pruning	on/off	on	Enables plans that can dynamically eliminate the scanning of partitions.	master session reload

gp_email_from	string		The email address used to send email alerts, in the format of:
			`'username@domain.com'`
			or
			`'Name <username@domain.com>'`
				master
				system
				restart

gp_email_smtp_password	string		The password/passphrase used to authenticate with the SMTP server.	master system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_email_smtp_server	string		The fully qualified domain name or IP address and port of the SMTP server to use to send the email alerts. Must be in the format of: *smtp_servername.domain.com:port*	master system restart
gp_email_smtp_userid	string		The user id used to authenticate with the SMTP server.	master system restart
gp_email_to	string		A semi-colon (`;`) separated list of email addresses to receive email alert messages to in the format of: '*username@domain.com*' or '*Name <username@domain.com>*' If this parameter is not set, then email alerts are disabled.	master system restart
gp_enable_adaptive_nestloop	Boolean	on	Enables the query planner to use a new type of join node called "Adaptive Nestloop" at query execution time. This causes the planner to favor a hash-join over a nested-loop join if the number of rows on the outer side of the join exceeds a precalculated threshold.	master session reload
gp_enable_agg_distinct	Boolean	on	Enables or disables two-phase aggregation to compute a single distinct-qualified aggregate. This applies only to subqueries that include a single distinct-qualified aggregate function.	master session reload
gp_enable_agg_distinct_pruning	Boolean	on	Enables or disables three-phase aggregation and join to compute distinct-qualified aggregates. This applies only to subqueries that include one or more distinct-qualified aggregate functions.	master session reload
gp_enable_direct_dispatch	Boolean	on	Enables or disables the dispatching of targeted query plans for queries that access data on a single segment. When on, queries that target rows on a single segment will only have their query plan dispatched to that segment (rather than to all segments). This significantly reduces the response time of qualifying queries as there is no interconnect setup involved. Direct dispatch does require more CPU utilization on the master.	master system restart
gp_enable_fallback_plan	Boolean	on	Allows use of disabled plan types when a query would not be feasible without them.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_enable_fast_sri	Boolean	on	When set to `on`, the query planner plans single row inserts so that they are sent directly to the correct segment instance (no motion operation required). This significantly improves performance of single-row-insert statements.	master session reload
gp_enable_gpperfmon	Boolean	off	Enables or disables the data collection agents of HAWQ Performance Monitor.	local system restart
gp_enable_groupext_distinct_gather	Boolean	on	Enables or disables gathering data to a single node to compute distinct-qualified aggregates on grouping extension queries. When this parameter and `gp_enable_groupext_distinct_pruning` are both enabled, the planner uses the cheaper plan.	master session reload
gp_enable_groupext_distinct_pruning	Boolean	on	Enables or disables three-phase aggregation and join to compute distinct-qualified aggregates on grouping extension queries. Usually, enabling this parameter generates a cheaper query plan that the planner will use in preference to existing plan.	master session reload
gp_enable_multiphase_agg	Boolean	on	Enables or disables the query planner's use of two or three-stage parallel aggregation plans. This approach applies to any subquery with aggregation. If `gp_enable_multiphase_agg` is off, then `gp_enable_agg_distinct` and `gp_enable_agg_distinct_pruning` are disabled.	master session reload
gp_enable_predicate_propagation	Boolean	on	When enabled, the query planner applies query predicates to both table expressions in cases where the tables are joined on their distribution key column(s). Filtering both tables prior to doing the join (when possible) is more efficient.	master session reload
gp_enable_preunique	Boolean	on	Enables two-phase duplicate removal for SELECT DISTINCT queries (not SELECT COUNT(DISTINCT)). When enabled, it adds an extra SORT DISTINCT set of plan nodes before motioning. In cases where the distinct operation greatly reduces the number of rows, this extra SORT DISTINCT is much cheaper than the cost of sending the rows across the Interconnect.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_enable_sequential_window_plans	Boolean	on	If on, enables non-parallel (sequential) query plans for queries containing window function calls. If off, evaluates compatible window functions in parallel and rejoins the results. This is an experimental parameter.	master session reload
gp_enable_sort_distinct	Boolean	on	Enable duplicates to be removed while sorting.	master session reload
gp_enable_sort_limit	Boolean	on	Enable LIMIT operation to be performed while sorting. Sorts more efficiently when the plan requires the first *limit_number* of rows at most.	master session reload
gp_external_enable_exec	Boolean	on	Enables or disables the use of external tables that execute OS commands or scripts on the segment hosts (`CREATE EXTERNAL TABLE EXECUTE` syntax). Must be enabled if using the Performance Monitor or MapReduce features.	master system restart
gp_external_grant_privileges	Boolean	off	In releases prior to 4.0, enables or disables non-superusers to issue a `CREATE EXTERNAL [WEB] TABLE` command in cases where the `LOCATION` clause specifies `http` or `gpfdist`. In releases after 4.0, the ability to create an external table can be granted to a role using `CREATE ROLE` or `ALTER ROLE`.	master system restart
gp_external_max_segs	integer	64	Sets the number of segments that will scan external table data during an external table operation, the purpose being not to overload the system with scanning data and take away resources from other concurrent operations. This only applies to external tables that use the `gpfdist://` protocol to access external table data.	master system restart
gp_filerep_tcp_keepalives_count	number of lost keepalives	2	How many keepalives may be lost before the connection is considered dead. A value of 0 uses the system default. If TCP_KEEPCNT is not supported, this parameter must be 0. Use this parameter for all connections that are between a primary and mirror segment. Use tcp_keepalives_count for settings that are not between a primary and mirror segment.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_filerep_tcp_keepalives_idle	number of seconds	1 min	Number of seconds between sending keepalives on an otherwise idle connection. A value of 0 uses the system default. If TCP_KEEPIDLE is not supported, this parameter must be 0. Use this parameter for all connections that are between a primary and mirror segment. Use tcp_keepalives_idle for settings that are not between a primary and mirror segment.	local system restart
gp_filerep_tcp_keepalives_interval	number of seconds	30 sec	How many seconds to wait for a response to a keepalive before retransmitting. A value of 0 uses the system default. If TCP_KEEPINTVL is not supported, this parameter must be 0. Use this parameter for all connections that are between a primary and mirror segment. Use tcp_keepalives_interval for settings that are not between a primary and mirror segment.	local system restart
gp_fts_probe_interval	10 seconds or greater	1min	Specifies the polling interval for the fault detection process (`ftsprobe`). The `ftsprobe` process will take approximately this amount of time to detect a segment failure.	master system restart
gp_fts_probe_threadcount	1 - 128	5	Specifies the number of `ftsprobe` threads to create. This parameter should be set to a value equal to or greater than the number of segments per host.	master system restart
gp_fts_probe_timeout	10 seconds or greater	10 secs	Specifies the allowed timeout for the fault detection process (`ftsprobe`) to establish a connection to a segment before declaring it down.	master system restart
gp_gpperfmon_send_interval	Any valid time expression (number and unit)	1sec	Sets the frequency that the HAWQ server processes send query execution updates to the Performance Monitor agent processes. Query operations (iterators) executed during this interval are sent through UDP to the segment monitor agents. If you find that an excessive number of UDP packets are dropped during long-running, complex queries, you may consider increasing this value.	master system restart
gp_hashjoin_tuples_per_bucket	integer	5	Sets the target density of the hash table used by HashJoin operations. A smaller value will tend to produce larger hash tables, which can increase join performance.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_interconnect_default_rtt	1-1000ms	20ms	Sets the default rtt (in ms) for UDP interconnect.	master session reload
gp_interconnect_fc_method	“capacity” or “loss”	“loss”	Sets the flow control method used for UDP interconnect. Valid values are "capacity" and "loss". For “capacity” based flow control, senders do not send packets when receivers do not have capacity. “Loss” based flow control is based on “capacity” based flow control, and it also tunes sending speed according to packet losses.	master session reload
gp_interconnect_hash_multiplier	2-25	2	Sets the size of the hash table used by the UDP interconnect to track connections. This number is multiplied by the number of segments to determine the number of buckets in the hash table. Increasing the value may increase interconnect performance for complex multi-slice queries (while consuming slightly more memory on the segment hosts).	master session reload
gp_interconnect_min_rto	1-1000ms	20ms	Sets the min rto (in ms) for UDP interconnect.	master session reload
gp_interconnect_min_retries_before_timeout	1-4096	100	Sets the min retries before reporting a transmit timeout in the interconnect.	master session reload
gp_interconnect_queue_depth	1-2048	4	Sets the amount of data per-peer to be queued by the UDP interconnect on receivers (when data is received but no space is available to receive it the data will be dropped, and the transmitter will need to resend it). Increasing the depth from its default value will cause the system to use more memory; but may increase performance. It is reasonable for this to be set between 1 and 10. Queries with data skew potentially perform better when this is increased. Increasing this may radically increase the amount of memory used by the system.	master session reload
gp_interconnect_setup_timeout	Any valid time expression (number and unit)	5min	Time to wait for the Interconnect to complete setup before it times out.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_interconnect_snd_queue_depth	1-4096	2	used to specify the average size of a send queue. The buffer pool size for each send process can be calculated by using gp_interconnect_snd_queue_depth * number of processes in the downstream gang.	master session reload
gp_interconnect_timer_period	1-100ms	5ms	Sets the timer period (in ms) for UDP interconnect. Default value is 5ms	master session reload
gp_interconnect_timer_checking_period	1-100ms	20ms	Sets the timer checking period (in ms) for UDP interconnect	master session reload
gp_interconnect_transmit_timeout	1-7200s	3600s	Timeout (in seconds) on interconnect to transmit a packet.	master session reload
gp_interconnect_type	TCP UDP	UDP	Sets the networking protocol used for Interconnect traffic. With the TCP protocol, HAWQ has an upper limit of 1000 segment instances - less than that if the query workload involves complex, multi-slice queries. UDP allows for greater interconnect scalability. Note that the Greenplum software does the additional packet verification and checking not performed by UDP, so reliability and performance is equivalent to TCP.	master session reload
gp_log_format	csv text	csv	Specifies the format of the server log files. If using *gp_toolkit* administrative schema, the log files must be in csv format.	local system restart
gp_max_csv_line_length	number of bytes	1048576	The maximum length of a line in a CSV formatted file that will be imported into the system. The default is 1MB (1048576 bytes). Maximum allowed is 4MB (4194184 bytes). The default may need to be increased if using the *gp_toolkit* administrative schema to read HAWQ log files.	local system restart
gp_max_databases	1-64	16	The maximum number of databases allowed in a HAWQ system.	master system restart
gp_max_filespaces	1-32	8	The maximum number of filespaces allowed in a HAWQ system.	master system restart
gp_max_local_distributed_cache	integer	1024	Sets the number of local to distributed transactions to cache. Higher settings may improve performance.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_max_packet_size	512-65536	8192	Sets the size (in bytes) of messages sent by the UDP interconnect, and sets the tuple-serialization chunk size for both the UDP and TCP interconnect.	master system restart
gp_max_tablespaces	1-64	16	The maximum number of tablespaces allowed in a HAWQ system.	master system restart
gp_motion_cost_per_row	floating point	0	Sets the query planner cost estimate for a Motion operator to transfer a row from one segment to another, measured as a fraction of the cost of a sequential page fetch. If 0, then the value used is two times the value of *cpu_tuple_cost*.	master session reload
gp_num_contents_in_cluster	-	-	The number of primary segments in the HAWQ system.	read only
gp_reject_percent_threshold	1-*n*	300	For single row error handling on COPY and external table SELECTs, sets the number of rows processed before SEGMENT REJECT LIMIT *n* PERCENT starts calculating.	master session reload
gp_reraise_signal	Boolean	on	If enabled, will attempt to dump core if a fatal server error occurs.	master session reload
gp_resqueue_memory_policy	none, auto, eager_free	eager_free	Enables HAWQ memory management features. When set to `none`, memory management is the same as in HAWQ releases prior to 4.1. When set to `auto`, query memory usage is controlled by statement_mem and resource queue memory limits.	local system restart/reload
gp_resqueue_priority	Boolean	on	Enables or disables query prioritization. When this parameter is disabled, existing priority settings are not evaluated at query run time.	local system restart
gp_resqueue_priority_cpucores_per_segment	0.1 - 25.0	segments = 4 master = 24	Specifies the number of CPU units per segment. In a configuration where one segment is configured per CPU core on a host, this unit is 1.0 (default). If an 8-core host is configured with four segments, the value would be 2.0. A master host typically only has one segment running on it (the master instance), so the value for the master should reflect the usage of all available CPU cores. Incorrect settings can result in CPU under-utilization. The default values are appropriate for the Greenplum Data Computing Appliance.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_resqueue_priority_sweeper_interval	500 - 15000 ms	1000	Specifies the interval at which the sweeper process evaluates current CPU usage. When a new statement becomes active, its priority is evaluated and its CPU share determined when the next interval is reached.	local system restart
gp_role	dispatch execute utility		The role of this server process — set to *dispatch* for the master and *execute* for a segment.	read only
gp_safefswritesize	integer	0	Specifies a minimum size for safe write operations to append-only tables in a non-mature file system. When a number of bytes greater than zero is specified, the append-only writer adds padding data up to that number in order to prevent data corruption due to file system errors. Each non-mature file system has a known safe write size that must be specified here when using HAWQ with that type of file system. This is commonly set to a multiple of the extent size of the file system; for example, Linux ext3 is 4096 bytes, so a value of 32768 is commonly used.	local system restart
gp_segment_connect_timeout	Any valid time expression (number and unit)	10min	Time that the HAWQ interconnect will try to connect to a segment instance over the network before timing out. Controls the network connection timeout between master and primary segments, and primary to mirror segment replication processes.	local system reload
gp_segments_for_planner	0-*n*	0	Sets the number of primary segment instances for the planner to assume in its cost and size estimates. If 0, then the value used is the actual number of primary segments. This variable affects the planner's estimates of the number of rows handled by each sending and receiving process in Motion operators.	master session reload
gp_session_id	1-*n*	14	A system assigned ID number for a client session. Starts counting from 1 when the master instance is first started.	read only
gp_set_proc_affinity	Boolean	off	If enabled, when a HAWQ server process (postmaster) is started it will bind to a CPU.	master system restart
gp_set_read_only	Boolean	off	Set to on to disable writes to the database. Any in progress transactions must finish before read-only mode takes affect.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
gp_snmp_community	SNMP community name	public	Set to the community name you specified for your environment.	master system reload
gp_snmp_monitor_address	hostname:port		The *hostname:port* of your network monitor application. Typically, the port number is 162. If there are multiple monitor addresses, separate them with a comma.	master system reload
gp_snmp_use_inform_or_trap	inform trap	trap	Trap notifications are SNMP messages sent from one application to another (for example, between HAWQ and a network monitoring application). These messages are unacknowledged by the monitoring application, but generate less network overhead. Inform notifications are the same as trap messages, except that the application sends an acknowledgement to the application that generated the alert.	master system reload
gp_statistics_pullup_from_child_partition	Boolean	on	Enables the query planner to utilize statistics from child tables when planning queries on the parent table.	master session reload
gp_statistics_use_fkeys	Boolean	off	When enabled, allows the optimizer to use foreign key information stored in the system catalog to optimize joins between foreign keys and primary keys.	master session reload
gp_vmem_idle_resource_timeout	Any valid time expression (number and unit)	18s	If a database session is idle for longer than the time specified, the session will free system resources (such as shared memory), but remain connected to the database. This allows more concurrent connections to the database at one time.	master system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications

gp_vmem_protect_limit	integer	8192	Sets the amount of memory (in number of MBs) that all postgres processes of an active segment instance can consume. To prevent over allocation of memory, set to:
			`( X * physical_memory ) / primary_segments`
			Where *X* is a value between 1.0 and 1.5. X=1 offers the best system performance. X=1.5 may cause more swapping on the system, but less queries will be cancelled.
			For example, on a segment host with 16GB physical memory and 4 primary segment instances the calculation would be:
			`(1 * 16) / 4 = 4GB`
			`4 * 1024 = 4096MB`
			If a query causes this limit to be exceeded, memory will not be allocated and the query will fail. Note that this is a local parameter and must be set for every segment in the system.
				local
				system
				restart

gp_vmem_protect_segworker_cache_limit	number of megabytes	500	If a query executor process consumes more than this configured amount, then the process will not be cached for use in subsequent queries after the process completes. Systems with lots of connections or idle processes may want to reduce this number to free more memory on the segments. Note that this is a local parameter and must be set for every segment.	local system restart
gp_workfile_checksumming	Boolean	on	Adds a checksum value to each block of a work file (or spill file) used by `HashAgg` and `HashJoin` query operators. This adds an additional safeguard from faulty OS disk drivers writing corrupted blocks to disk. When a checksum operation fails, the query will cancel and rollback rather than potentially writing bad data to disk.	master session reload
gp_workfile_compress_algorithm	none zlib	none	When a hash aggregation or hash join operation spills to disk during query processing, specifies the compression algorithm to use on the spill files. If using zlib, it must be in your $PATH on all segments.	master session reload
gpperfmon_port	integer	8888	Sets the port on which all performance monitor agents communicate with the master.	master system restart
pxf_enable_stat_collection	boolean	on	Collects statistical information about PXF.	

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
integer_datetimes	Boolean	on	Reports whether PostgreSQL was built with support for 64-bit-integer dates and times.	read only
IntervalStyle	postgres postgres_verbose sql_standard iso_8601	postgres	Sets the display format for interval values. The value *sql_standard* produces output matching SQL standard interval literals. The value *postgres* produces output matching PostgreSQL releases prior to 8.4 when the DateStyle parameter was set to ISO. The value *postgres_verbose* produces output matching HAWQ releases prior to 3.3 when the DateStyle parameter was set to non-ISO output. The value *iso_8601* will produce output matching the time interval *format with designators* defined in section 4.4.3.2 of ISO 8601. See the PostgreSQL 8.4 documentation for more information.	master session reload
join_collapse_limit	1-*n*	20	The planner will rewrite explicit inner `JOIN` constructs into lists of `FROM` items whenever a list of no more than this many items in total would result. By default, this variable is set the same as *from_collapse_limit*, which is appropriate for most uses. Setting it to 1 prevents any reordering of inner JOINs. Setting this variable to a value between 1 and *from_collapse_limit* might be useful to trade off planning time against the quality of the chosen plan (higher values produce better plans).	master session reload
krb_caseins_users	Boolean	off	Sets whether Kerberos user names should be treated case-insensitively. The default is case sensitive (off).	master system restart
krb_server_keyfile	path and file name	unset	Sets the location of the Kerberos server key file.	master system restart
krb_srvname	service name	postgres	Sets the Kerberos service name.	master system restart
krb5_ccname	path and file name	/tmp/postgrres.ccname	set the location of the Kerberos ticket cache.	master system restart
lc_collate	<system dependent>		Reports the locale in which sorting of textual data is done. The value is determined when the HAWQ array is initialized.	read only

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
lc_ctype	<system dependent>		Reports the locale that determines character classifications. The value is determined when the HAWQ array is initialized.	read only
lc_messages	<system dependent>		Sets the language in which messages are displayed. The locales available depends on what was installed with your operating system - use *locale -a* to list available locales. The default value is inherited from the execution environment of the server. On some systems, this locale category does not exist. Setting this variable will still work, but there will be no effect. Also, there is a chance that no translated messages for the desired language exist. In that case you will continue to see the English messages.	local system restart
lc_monetary	<system dependent>		Sets the locale to use for formatting monetary amounts, for example with the *to_char* family of functions. The locales available depends on what was installed with your operating system - use *locale -a* to list available locales. The default value is inherited from the execution environment of the server.	local system restart
lc_numeric	<system dependent>		Sets the locale to use for formatting numbers, for example with the *to_char* family of functions. The locales available depends on what was installed with your operating system - use *locale -a* to list available locales. The default value is inherited from the execution environment of the server.	local system restart
lc_time	<system dependent>		This parameter currently does nothing, but may in the future.	local system restart
listen_addresses	localhost, host names, IP addresses, * (all available IP interfaces)	*	Specifies the TCP/IP address(es) on which the server is to listen for connections from client applications - a comma-separated list of host names and/or numeric IP addresses. The special entry * corresponds to all available IP interfaces. If the list is empty, only UNIX-domain sockets can connect.	master system restart
local_preload_libraries			Comma separated list of shared library files to preload at the start of a client session.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
log_autostats	Boolean	on	Logs information about automatic `ANALYZE` operations related to gp_autostats_mode and gp_autostats_on_change_threshold.	master session reload superuser
log_connections	Boolean	off	This outputs a line to the server log detailing each successful connection. Some client programs, like psql, attempt to connect twice while determining if a password is required, so duplicate “connection received” messages do not always indicate a problem.	local system restart
log_disconnections	Boolean	off	This outputs a line in the server log at termination of a client session, and includes the duration of the session.	local system restart
log_dispatch_stats	Boolean	off	When set to “on,” this parameter adds a log message with verbose information about the dispatch of the statement.	local system restart
log_duration	Boolean	off	Causes the duration of every completed statement which satisfies *log_statement* to be logged.	master session reload superuser
log_error_verbosity	TERSE DEFAULT VERBOSE	DEFAULT	Controls the amount of detail written in the server log for each message that is logged.	master session reload superuser
log_executor_stats	Boolean	off	For each query, write performance statistics of the query executor to the server log. This is a crude profiling instrument. Cannot be enabled together with *log_statement_stats*.	local system restart
log_hostname	Boolean	off	By default, connection log messages only show the IP address of the connecting host. Turning on this option causes logging of the host name as well. Note that depending on your host name resolution setup this might impose a non-negligible performance penalty.	local system restart
log_min_duration_statement	number of milliseconds, 0, -1	-1	Logs the statement and its duration on a single log line if its duration is greater than or equal to the specified number of milliseconds. Setting this to 0 will print all statements and their durations. -1 disables the feature. For example, if you set it to 250 then all SQL statements that run 250ms or longer will be logged. Enabling this option can be useful in tracking down unoptimized queries in your applications.	master session reload superuser

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
log_min_error_statement	DEBUG5 DEBUG4 DEBUG3 DEBUG2, DEBUG1 INFO NOTICE WARNING ERROR FATAL PANIC	ERROR	Controls whether or not the SQL statement that causes an error condition will also be recorded in the server log. All SQL statements that cause an error of the specified level or higher are logged. The default is PANIC (effectively turning this feature off for normal use). Enabling this option can be helpful in tracking down the source of any errors that appear in the server log.	master session reload superuser
log_min_messages	DEBUG5 DEBUG4 DEBUG3 DEBUG2 DEBUG1 INFO NOTICE WARNING ERROR LOG FATAL PANIC	NOTICE	Controls which message levels are written to the server log. Each level includes all the levels that follow it. The later the level, the fewer messages are sent to the log.	master session reload superuser
log_parser_stats	Boolean	off	For each query, write performance statistics of the query parser to the server log. This is a crude profiling instrument. Cannot be enabled together with *log_statement_stats*.	master session reload superuser
log_planner_stats	Boolean	off	For each query, write performance statistics of the query planner to the server log. This is a crude profiling instrument. Cannot be enabled together with *log_statement_stats*.	master session reload superuser
log_rotation_age	Any valid time expression (number and unit)	1d	Determines the maximum lifetime of an individual log file. After this time has elapsed, a new log file will be created. Set to zero to disable time-based creation of new log files.	local system restart
log_rotation_size	number of kilobytes	0	Determines the maximum size of an individual log file. After this many kilobytes have been emitted into a log file, a new log file will be created. Set to zero to disable size-based creation of new log files.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
log_statement	NONE DDL MOD ALL	ALL	Controls which SQL statements are logged. DDL logs all data definition commands like CREATE, ALTER, and DROP commands. MOD logs all DDL statements, plus INSERT, UPDATE, DELETE, TRUNCATE, and COPY FROM. PREPARE and EXPLAIN ANALYZE statements are also logged if their contained command is of an appropriate type.	master session reload superuser
log_statement_stats	Boolean	off	For each query, write total performance statistics of the query parser, planner, and executor to the server log. This is a crude profiling instrument.	master session reload superuser
log_timezone	string	unknown	Sets the time zone used for timestamps written in the log. Unlike TimeZone, this value is system-wide, so that all sessions will report timestamps consistently. The default is `unknown`, which means to use whatever the system environment specifies as the time zone.	local system restart
log_truncate_on_rotation	Boolean	off	Truncates (overwrites), rather than appends to, any existing log file of the same name. Truncation will occur only when a new file is being opened due to time-based rotation. For example, using this setting in combination with a log_filename such as `gpseg#-%H.log` would result in generating twenty-four hourly log files and then cyclically overwriting them. When off, pre-existing files will be appended to in all cases.	local system restart
max_appendonly_tables	2048	10000	Sets the maximum number of append-only relations that can be written to or loaded concurrently. Append-only table partitions and subpartitions are considered as unique tables against this limit. Increasing the limit will allocate more shared memory at server start.	master system restart
max_connections	10-*n*	250 on master 750 on segments	The maximum number of concurrent connections to the database server. In a HAWQ system, user client connections go through the HAWQ master instance only. Segment instances should allow 5-10 times the amount as the master. When you increase this parameter, max_prepared_transactions must be increased as well. Increasing this parameter may cause HAWQ to request more shared memory.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
max_files_per_process	integer	150	Sets the maximum number of simultaneously open files allowed to each server subprocess. If the kernel is enforcing a safe per-process limit, you don't need to worry about this setting. Some platforms such as BSD, the kernel will allow individual processes to open many more files than the system can really support. Note. Increasing this value can improve performance of HAWQ, but bring heavier workload to HDFS.	local system restart
max_fsm_pages	integer > 16 * *max_fsm_relations*	200000	Sets the maximum number of disk pages for which free space will be tracked in the shared free-space map. Six bytes of shared memory are consumed for each page slot.	local system restart
max_fsm_relations	integer	1000	Sets the maximum number of relations for which free space will be tracked in the shared memory free-space map. Should be set to a value larger than the total number of: tables +system tables. It costs about 60 bytes of memory for each relation per segment instance. It is better to allow some room for overhead and set too high rather than too low.	local system restart
max_function_args	integer	100	Reports the maximum number of function arguments.	read only
max_identifier_length	integer	63	Reports the maximum identifier length.	read only
max_locks_per_transaction	integer	64	The shared lock table is created with room to describe locks on *max_locks_per_transaction* * (*max_connections* + *max_prepared_transactions*) objects, so no more than this many distinct objects can be locked at any one time. This is not a hard limit on the number of locks taken by any one transaction, but rather a maximum average value. You might need to raise this value if you have clients that touch many different tables in a single transaction.	local system restart
max_prepared_transactions	integer	250 on master 250 on segments	Sets the maximum number of transactions that can be in the prepared state simultaneously. HAWQ uses prepared transactions internally to ensure data integrity across the segments. This value must be at least as large as the value of max_connections on the master. Segment instances should be set to the same value as the master.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
max_resource_portals_per_transaction	integer	64	Sets the maximum number of simultaneously open user-declared cursors allowed per transaction. Note that an open cursor will hold an active query slot in a resource queue. Used for workload management.	master system restart
max_resource_queues	integer	8	Sets the maximum number of resource queues that can be created in a HAWQ system. Note that resource queues are system-wide (as are roles) so they apply to all databases in the system.	master system restart
max_stack_depth	number of kilobytes	2MB	Specifies the maximum safe depth of the server's execution stack. The ideal setting for this parameter is the actual stack size limit enforced by the kernel (as set by *ulimit -s* or local equivalent), less a safety margin of a megabyte or so. Setting the parameter higher than the actual kernel limit will mean that a runaway recursive function can crash an individual backend process.	local system restart
max_statement_mem	number of kilobytes	2000MB	Sets the maximum memory limit for a query. Helps avoid out-of-memory errors on a segment host during query processing as a result of setting statement_mem too high. When gp_resqueue_memory_policy=auto, statement_mem and resource queue memory limits control query memory usage. Taking into account the configuration of a single segment host, calculate this setting as follows: `(seghost_physical_memory) / (average_number_concurrent_queries)`	master session reload superuser
optimizer_log	Boolean	True	Indicates whether the new optimizer, ORCA or the existing planner produced the query execution plan. It also records the reason for using a plan generated by the existing planner. For more information about Orca and the existing planner, see Chapter 2, "About Query Processing".	

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
optimizer_minidump	`ONERROR/ALWAYS`	`ONERROR`	The new optimizer Orca generates minidumps to describe the optimization context for a given query. You can use the information in these files to reproduce failures or performance regressions during optimization in any environment. The minidump file is located under the master data directory and uses the following naming format: `Minidump_<date>_<time>.mpd` Setting this GUC to `ALWAYS`, generates a minidump for all queries. Pivotal recommends that you set this GUC to `ONERROR` in production environments to minimize costs.	
password_encryption	Boolean	`on`	When a password is specified in CREATE USER or ALTER USER without writing either ENCRYPTED or UNENCRYPTED, this option determines whether the password is to be encrypted.	master session reload
pljava_classpath	string		A colon (:) separated list of the jar files containing the Java classes used in any PL/Java functions. The jar files listed here must also be installed on all HAWQ hosts in the following location: `$GPHOME/lib/postgresql/java/`	master session reload
pljava_statement_cache_size	number of kilobytes	`10`	Sets the size in KB of the JRE MRU (Most Recently Used) cache for prepared statements.	master system restart superuser
pljava_release_lingering_savepoints	Boolean	`true`	If true, lingering savepoints used in PL/Java functions will be released on function exit. If false, savepoints will be rolled back.	master system restart superuser
pljava_vmoptions	string	`-Xmx64M`	Defines the startup options for the Java VM.	master system restart superuser
port	any valid port number	`5432`	The database listener port for a HAWQ instance. The master and each segment has its own port. You must shut down your HAWQ system before changing port numbers.	local system restart
random_page_cost	floating point	`100`	Sets the planner's estimate of the cost of a nonsequentially fetched disk page. This is measured as a multiple of the cost of a sequential page fetch.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
regex_flavor	advanced extended basic	advanced	The 'extended' setting may be useful for exact backwards compatibility with pre-7.4 releases of PostgreSQL.	master session reload
resource_cleanup_gangs_on_wait	Boolean	on	If a statement is submitted through a resource queue, clean up any idle query executor worker processes before taking a lock on the resource queue.	master system restart
resource_select_only	Boolean	off	Sets the types of queries managed by resource queues. If set to on, then SELECT, SELECT INTO, CREATE TABLE AS SELECT, and DECLARE CURSOR commands are evaluated. If set to off INSERT, UPDATE, and DELETE commands will be evaluated as well.	master system restart
search_path	a comma-separated list of schema names	$user,public	Specifies the order in which schemas are searched when an object is referenced by a simple name with no schema component. When there are objects of identical names in different schemas, the one found first in the search path is used. The system catalog schema, *pg_catalog*, is always searched, whether it is mentioned in the path or not. When objects are created without specifying a particular target schema, they will be placed in the first schema listed in the search path. The current effective value of the search path can be examined via the SQL function *current_schemas()*. *current_schemas()* shows how the requests appearing in *search_path* were resolved.	master session reload
seq_page_cost	floating point	1	Sets the planner's estimate of the cost of a disk page fetch that is part of a series of sequential fetches.	master session reload
server_encoding	<system dependent>	UTF8	Reports the database encoding (character set). It is determined when the HAWQ array is initialized. Ordinarily, clients need only be concerned with the value of *client_encoding*.	read only
server_ticket_renew_interval	Integer	43200000	Set the kerberos ticket renew interval in milliseconds	master system restart
server_version	string	8.2.15	Reports the version of PostgreSQL that this release of HAWQ is based on.	read only
server_version_num	integer	80215	Reports the version of PostgreSQL that this release of HAWQ is based on as an integer.	read only

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
shared_buffers	integer > 16K * *max_connections*	125MB	Sets the amount of memory a HAWQ server instance uses for shared memory buffers. This setting must be at least 128 kilobytes and at least 16 kilobytes times max_connections.	local system restart
shared_preload_libraries			A comma-separated list of shared libraries that are to be preloaded at server start. PostgreSQL procedural language libraries can be preloaded in this way, typically by using the syntax '$libdir/plXXX' where XXX is pgsql, perl, tcl, or python. By preloading a shared library, the library startup time is avoided when the library is first used. If a specified library is not found, the server will fail to start.	local system restart
ssl	Boolean	off	Enables SSL connections.	master system restart
ssl_ciphers	string	ALL	Specifies a list of SSL ciphers that are allowed to be used on secure connections. See the openssl manual page for a list of supported ciphers.	master system restart
standard_conforming_strings	Boolean	of	Reports whether ordinary string literals ('...') treat backslashes literally, as specified in the SQL standard. The value is currently always off, indicating that backslashes are treated as escapes. It is planned that this will change to on in a future release when string literal syntax changes to meet the standard. Applications may check this parameter to determine how string literals will be processed. The presence of this parameter can also be taken as an indication that the escape string syntax (E'...') is supported.	read only
statement_mem	number of kilobytes	128MB	Allocates segment host memory per query. The amount of memory allocated with this parameter cannot exceed max_statement_mem or the memory limit on the resource queue through which the query was submitted.When gp_resqueue_memory_policy=auto, statement_mem and resource queue memory limits control query memory usage.	master session reload
statement_timeout	number of milliseconds	0	Abort any statement that takes over the specified number of milliseconds. 0 turns off the limitation.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
stats_queue_level	Boolean	off	Collects resource queue statistics on database activity.	master session reload
superuser_reserved_connections	integer < *max_connections*	3	Determines the number of connection slots that are reserved for HAWQ superusers.	local system restart
tcp_keepalives_count	number of lost keepalives	0	How many keepalives may be lost before the connection is considered dead. A value of 0 uses the system default. If TCP_KEEPCNT is not supported, this parameter must be 0. Use this parameter for all connections that are not between a primary and mirror segment. Use gp_filerep_tcp_keepalives_count for settings that are between a primary and mirror segment.	local system restart
tcp_keepalives_idle	number of seconds	0	Number of seconds between sending keepalives on an otherwise idle connection. A value of 0 uses the system default. If TCP_KEEPIDLE is not supported, this parameter must be 0. Use this parameter for all connections that are not between a primary and mirror segment. Use gp_filerep_tcp_keepalives_idle for settings that are between a primary and mirror segment.	local system restart
tcp_keepalives_interval	number of seconds	0	How many seconds to wait for a response to a keepalive before retransmitting. A value of 0 uses the system default. If TCP_KEEPINTVL is not supported, this parameter must be 0. Use this parameter for all connections that are not between a primary and mirror segment. Use gp_filerep_tcp_keepalives_interval for settings that are between a primary and mirror segment.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
temp_buffers	integer	1024	Sets the maximum number of temporary buffers used by each database session. These are session-local buffers used only for access to temporary tables. The setting can be changed within individual sessions, but only up until the first use of temporary tables within a session. The cost of setting a large value in sessions that do not actually need a lot of temporary buffers is only a buffer descriptor, or about 64 bytes, per increment. However if a buffer is actually used, an additional 8192 bytes will be consumed.	master session reload
TimeZone	time zone abbreviation		Sets the time zone for displaying and interpreting time stamps. The default is to use whatever the system environment specifies as the time zone. See Date/Time Keywords in the PostgreSQL documentation.	local restart
timezone_abbreviations	string	Default	Sets the collection of time zone abbreviations that will be accepted by the server for date time input. The default is `Default`, which is a collection that works in most of the world. `Australia` and `India`, and other collections can be defined for a particular installation. Possible values are names of configuration files stored in `/share/postgresql/timezonesets/` in the installation directory.	master session reload
track_activities	Boolean	on	Enables the collection of statistics on the currently executing command of each session, along with the time at which that command began execution. When enabled, this information is not visible to all users, only to superusers and the user owning the session. This data can be accessed via the *pg_stat_activity* system view.	master session reload
track_counts	Boolean	off	Enables the collection of row and block level statistics on database activity. If enabled, the data that is produced can be accessed via the *pg_stat* and *pg_statio* family of system views.	local system restart
transaction_isolation	read committed serializable	read committed	Sets the current transaction's isolation level.	master session reload

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
transaction_read_only	Boolean	off	Sets the current transaction's read-only status.	master session reload
transform_null_equals	Boolean	off	When on, expressions of the form expr = NULL (or NULL = expr) are treated as expr IS NULL, that is, they return true if expr evaluates to the null value, and false otherwise. The correct SQL-spec-compliant behavior of expr = NULL is to always return null (unknown).	master session reload
unix_socket_directory	directory path	unset	Specifies the directory of the UNIX-domain socket on which the server is to listen for connections from client applications.	local system restart
unix_socket_group	UNIX group name	unset	Sets the owning group of the UNIX-domain socket. By default this is an empty string, which uses the default group for the current user.	local system restart
unix_socket_permissions	numeric UNIX file permission mode (as accepted by the *chmod* or *umask* commands)	511	Sets the access permissions of the UNIX-domain socket. UNIX-domain sockets use the usual UNIX file system permission set. Note that for a UNIX-domain socket, only write permission matters.	local system restart
update_process_title	Boolean	on	Enables updating of the process title every time a new SQL command is received by the server. The process title is typically viewed by the `ps` command.	local system restart
vacuum_cost_delay	milliseconds < 0 (in multiples of 10)	0	The length of time that the process will sleep when the cost limit has been exceeded. 0 disables the cost-based vacuum delay feature.	local system restart
vacuum_cost_limit	integer > 0	200	The accumulated cost that will cause the vacuuming process to sleep.	local system restart
vacuum_cost_page_dirty	integer > 0	20	The estimated cost charged when vacuum modifies a block that was previously clean. It represents the extra I/O required to flush the dirty block out to disk again.	local system restart
vacuum_cost_page_hit	integer > 0	1	The estimated cost for vacuuming a buffer found in the shared buffer cache. It represents the cost to lock the buffer pool, lookup the shared hash table and scan the content of the page.	local system restart

Table D.2 Server Configuration Parameters

Parameter	Value Range	Default	Description	Set Classifications
vacuum_cost_page_miss	integer > 0	10	The estimated cost for vacuuming a buffer that has to be read from disk. This represents the effort to lock the buffer pool, lookup the shared hash table, read the desired block in from the disk and scan its content.	local system restart
vacuum_freeze_min_age	integer 0-100000000000	100000000	Specifies the cutoff age (in transactions) that VACUUM should use to decide whether to replace transaction IDs with *FrozenXID* while scanning a table. VACUUM will limit the effective value to half the value of autovacuum_freeze_max_age, so that there is not an unreasonably short time between forced autovacuums.	local system restart

E. HAWQ Environment Variables

This is a reference of the environment variables to set for HAWQ. Set these in your user's startup shell profile (such as `~/.bashrc` or `~/.bash_profile`), or in `/etc/profile` if you want to set them for all users.

Required Environment Variables

Note: `GPHOME`, `PATH` and `LD_LIBRARY_PATH` can be set by sourcing the `greenplum_path.sh` file from your HAWQ installation directory.

GPHOME

This is the installed location of your HAWQ software. For example:

```
GPHOME=/usr/local/greenplum-db-4.1.x.x
export GPHOME
```

PATH

Your `PATH` environment variable should point to the location of the HAWQ `bin` directory. Solaris users must also add `/usr/sfw/bin` and `/opt/sfw/bin` to their `PATH`. For example:

```
PATH=$GPHOME/bin:$PATH
PATH=$GPHOME/bin:/usr/local/bin:/usr/sbin:/usr/sfw/bin:/opt/sfw/b
in:$PATH
export PATH
```

LD_LIBRARY_PATH

The `LD_LIBRARY_PATH` environment variable should point to the location of the HAWQ/PostgreSQL library files. For Solaris, this also points to the GNU compiler and readline library files as well (readline libraries may be required for Python support on Solaris). For example:

```
LD_LIBRARY_PATH=$GPHOME/lib
LD_LIBRARY_PATH=$GPHOME/lib:/usr/sfw/lib
export LD_LIBRARY_PATH
```

MASTER_DATA_DIRECTORY

This should point to the directory created by the `gpinitsystem` utility in the master data directory location. For example:

```
MASTER_DATA_DIRECTORY=/data/master/gpseg-1
export MASTER_DATA_DIRECTORY
```

Optional Environment Variables

The following are standard PostgreSQL environment variables, which are also recognized in HAWQ. You may want to add the connection-related environment variables to your profile for convenience, so you do not have to type so many options on the command line for client connections. Note that these environment variables should be set on the HAWQ master host only.

PGAPPNAME

The name of the application that is usually set by an application when it connects to the server. This name is displayed in the activity view and in log entries. The `PGAPPNAME` environmental variable behaves the same as the `application_name` connection parameter. The default value for `application_name` is *psql*. The name cannot be longer than 63 characters.

PGDATABASE

The name of the default database to use when connecting.

PGHOST

The HAWQ master host name.

PGHOSTADDR

The numeric IP address of the master host. This can be set instead of or in addition to `PGHOST` to avoid DNS lookup overhead.

PGPASSWORD

The password used if the server demands password authentication. Use of this environment variable is not recommended for security reasons (some operating systems allow non-root users to see process environment variables via `ps`). Instead consider using the `~/.pgpass` file.

PGPASSFILE

The name of the password file to use for lookups. If not set, it defaults to `~/.pgpass`. See the section about The Password File in the PostgreSQL documentation for more information.

PGOPTIONS

Sets additional configuration parameters for the HAWQ master server.

PGPORT

The port number of the HAWQ server on the master host. The default port is 5432.

PGUSER

The HAWQ user name used to connect.

PGDATESTYLE

Sets the default style of date/time representation for a session. (Equivalent to `SET datestyle TO` ....)

PGTZ

Sets the default time zone for a session. (Equivalent to `SET timezone TO` ....)

PGCLIENTENCODING

Sets the default client character set encoding for a session. (Equivalent to `SET client_encoding TO` ....)

F. HAWQ Data Types

HAWQ has a rich set of native data types available to users. Users may also define new data types using the `CREATE TYPE` command. This reference shows all of the built-in data types. In addition to the types listed here, there are also some internally used data types, such as *oid* (object identifier), but those are not documented in this guide.

The following data types are specified by SQL: *bit*, *bit varying*, *boolean*, *character varying, varchar*, *character, char*, *date*, *double precision*, *integer*, *interval*, *numeric*, *decimal*, *real*, *smallint*, *time* (with or without time zone), and *timestamp* (with or without time zone).

Each data type has an external representation determined by its input and output functions. Many of the built-in types have obvious external formats. However, several types are either unique to PostgreSQL (and HAWQ), such as geometric paths, or have several possibilities for formats, such as the date and time types. Some of the input and output functions are not invertible. That is, the result of an output function may lose accuracy when compared to the original input.

Table F.1 HAWQ Built-in Data Types

Name[1]	Alias	Size	Range	Description
bigint	int8	8 bytes	-9223372036854775808 to 9223372036854775807	large range integer
bigserial	serial8	8 bytes	1 to 9223372036854775807	large autoincrementing integer
bit [(n)]		*n* bits	bit string constant	fixed-length bit string
bit varying [(n)]	varbit	actual number of bits	bit string constant	variable-length bit string
boolean	bool	1 byte	true/false, t/f, yes/no, y/n, 1/0	logical boolean (true/false)
box		32 bytes	((x1,y1),(x2,y2))	rectangular box in the plane - not allowed in distribution key columns.
bytea		1 byte + *binary string*	sequence of octets	variable-length binary string
character [(n)]	char [(n)]	1 byte + *n*	strings up to *n* characters in length	fixed-length, blank padded
character varying [(n)]	varchar [(n)]	1 byte + *string size*	strings up to *n* characters in length	variable-length with limit
cidr		12 or 24 bytes		IPv4 networks

Table F.1 HAWQ Built-in Data Types

Name[1]	Alias	Size	Range	Description
circle		24 bytes	<(x,y),r> (center and radius)	circle in the plane - not allowed in distribution key columns.
date		4 bytes	4713 BC - 294,277 AD	calendar date (year, month, day)
decimal [(p, s)]	numeric [(p, s)]	variable	no limit	user-specified precision, exact
double precision	float8 float	8 bytes	15 decimal digits precision	variable-precision, inexact
inet		12 or 24 bytes		IPv4 hosts and networks
integer	int, int4	4 bytes	-2147483648 to +2147483647	usual choice for integer
interval [(p)]		12 bytes	-178000000 years - 178000000 years	time span
lseg		32 bytes	((x1,y1),(x2,y2))	line segment in the plane - not allowed in distribution key columns.
macaddr		6 bytes		MAC addresses
money		4 bytes	-21474836.48 to +21474836.47	currency amount
path		16+16n bytes	[(x1,y1),...]	geometric path in the plane - not allowed in distribution key columns.
point		16 bytes	(x,y)	geometric point in the plane - not allowed in distribution key columns.
polygon		40+16n bytes	((x1,y1),...)	closed geometric path in the plane - not allowed in distribution key columns.
real	float4	4 bytes	6 decimal digits precision	variable-precision, inexact
serial	serial4	4 bytes	1 to 2147483647	autoincrementing integer
smallint	int2	2 bytes	-32768 to +32767	small range integer
text		1 byte + *string size*	strings of any length	variable unlimited length
time [(p)] [without time zone]		8 bytes	00:00:00[.000000] - 24:00:00[.000000]	time of day only
time [(p)] with time zone	timetz	12 bytes	00:00:00+1359 - 24:00:00-1359	time of day only, with time zone
timestamp [(p)] [without time zone]		8 bytes	4713 BC - 294,277 AD	both date and time

Table F.1 HAWQ Built-in Data Types

Name[1]	Alias	Size	Range	Description
timestamp [(p)] with time zone	timestamptz	8 bytes	4713 BC - 294,277 AD	both date and time, with time zone
xml		1 byte + *xml size*	xml of any length	variable unlimited length

1. For variable length data types (such as char, varchar, text, xml, etc.) if the data is greater than or equal to 127 bytes, the storage overhead is 4 bytes instead of 1.

G. MADlib References

MADlib is an open-source library for scalable in-database analytics. It provides data-parallel implementations of mathematical, statistical and machine learning methods for structured and unstructured data. MADlib combines the efforts used in commercial practice, academic research, and open-source development.

Useful links are as follows:

- MADlib project site `http://doc.madlib.net`
- MADlib bug reporting site: `http://jira.madlib.net` and quick guide: `https://github.com/madlib/madlib/wiki/Bug-reporting`

Please refer to the readme file for information about incorporated third-party material. License information regarding MADlib and included third-party libraries can be found inside the license directory.

Some MADlib algorithms have been integrated into HAWQ, to enable these analytic functions to run directly in the database. The schema for MADlib functions in HAWQ is MADLIB. These are as follows:

- Linear regression: `http://doc.madlib.net/v0.5/group_grp_linreg.html`
- Logistic regression: `http://doc.madlib.net/v0.5/group_grp_logreg.html`
- Multinomial Logistic regression: `http://doc.madlib.net/v0.5/group_grp_mlogreg.html`
- Association rules: `http://doc.madlib.net/v0.5/group_grp_assoc_rules.html`
- K-means: `http://doc.madlib.net/v0.5/group_grp_kmeans.html`