

# Pivotal HAWQ

Version 1.1

## Administrator Guide

Rev: Ao8

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# 1 About the HAWQ Architecture

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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.

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 Interconnect
- About Redundancy and Failover in HAWQ

## 1.1 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.

### 1.1.1 HAWQ Segment

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

Segments 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 Greenplum database.

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.

## 1.1.2 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.

## 1.1.3 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.

## 1.2 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

### 1.2.1 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.

## 1.2.2 Segment Failover

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

When a segment is down, the existing sessions are automatically 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 again, the Fault Tolerance Service verifies their state, returning the segment number to normal. All the sessions are automatically reconfigured to use the full computing power.

## 1.2.3 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 Pivotal HAWQ Query Processing

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### 2.1 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 Greenplum Query Plans
- Understanding Parallel Query Execution

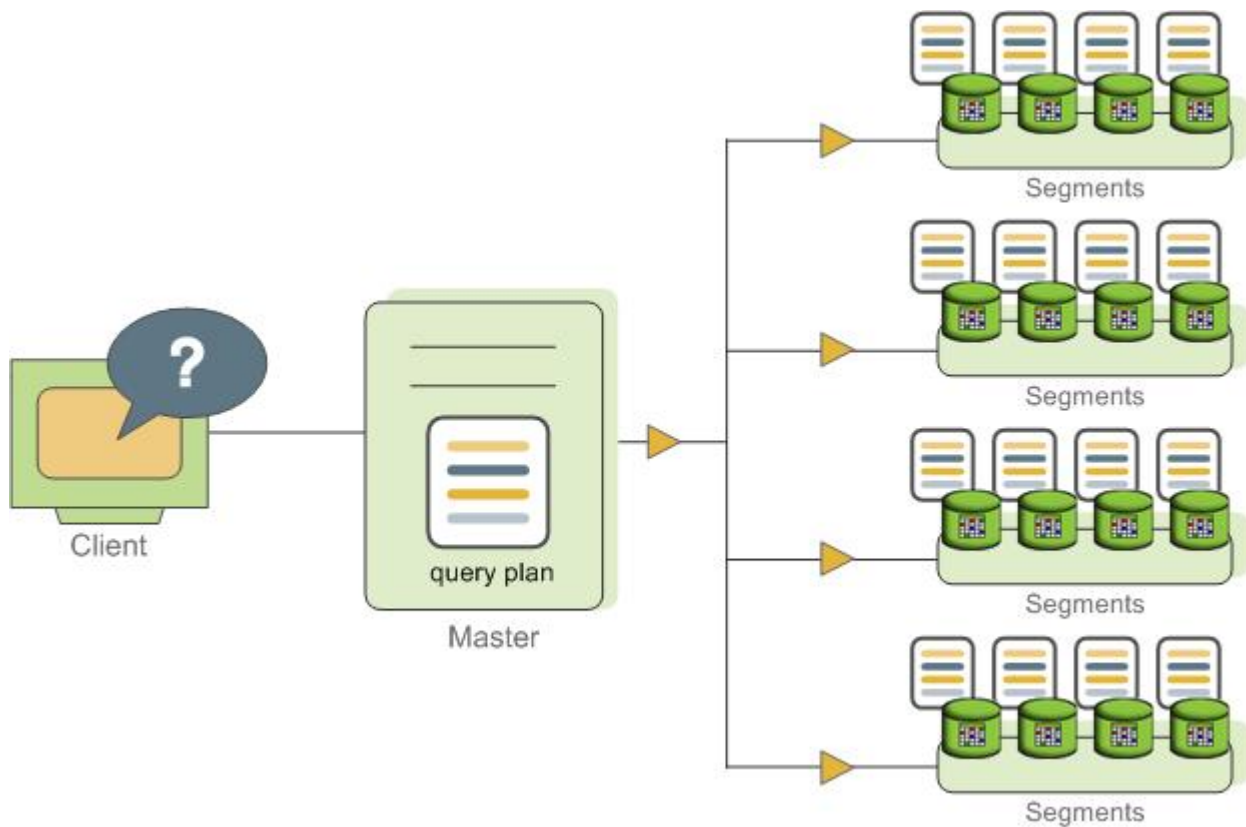
#### 2.1.1 Query Planning and Dispatch

This section describes the following:

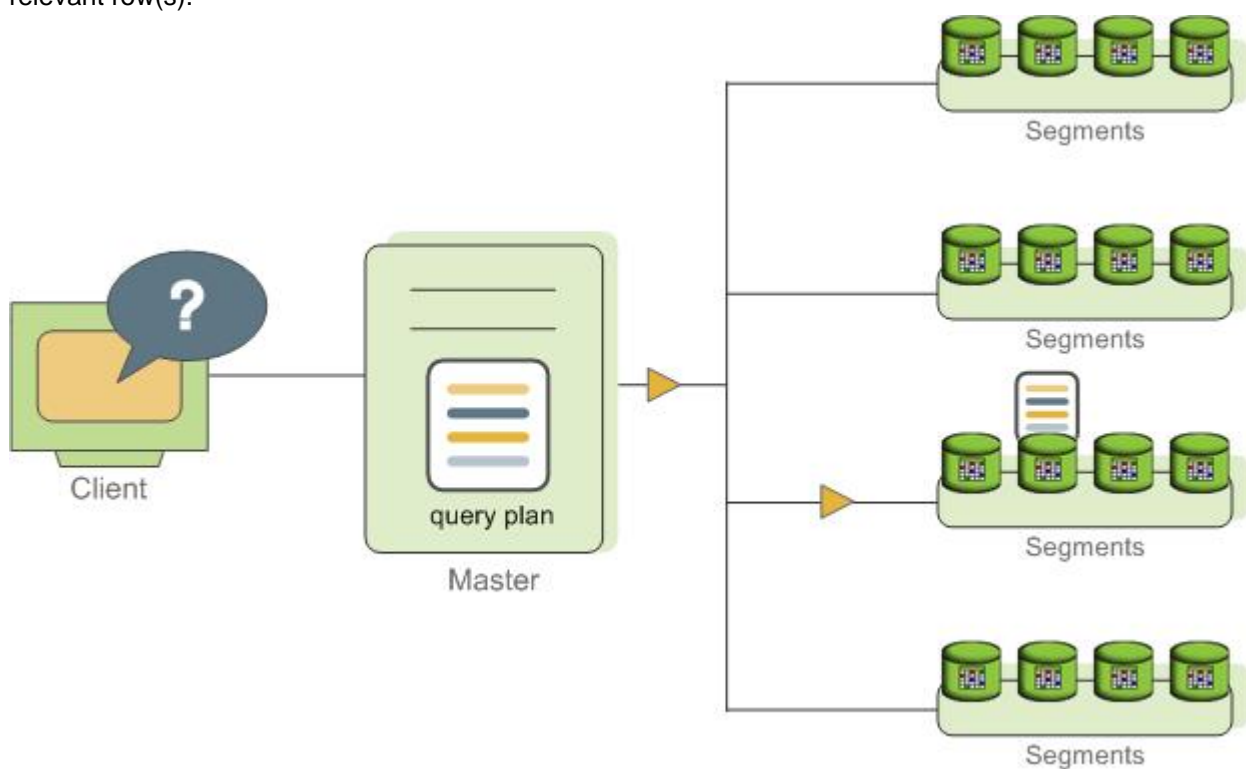
- Planning and Dispatch
- ORCA

#### 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.



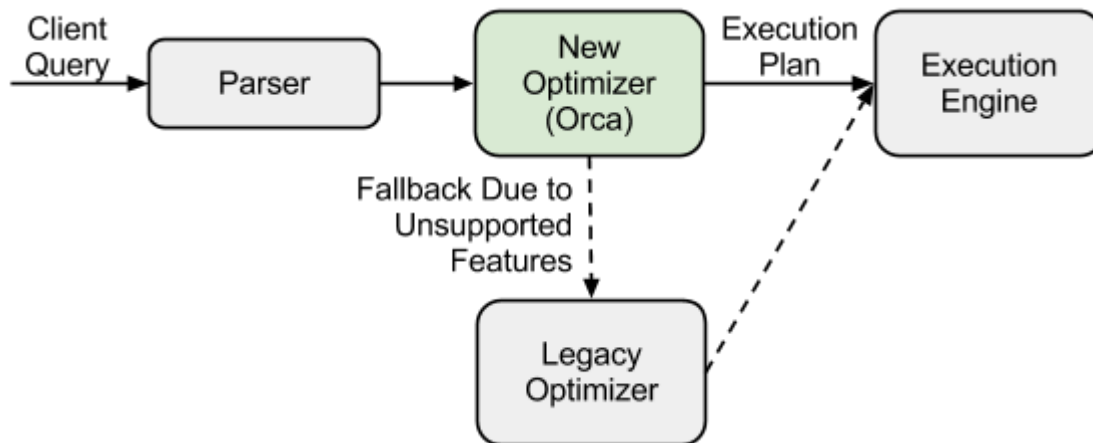
Certain queries may access only data on a single segment, such as single-row INSERT, UPDATE, DELETE, or SELECT operations or queries that filter on the table distribution key column(s). In queries such as these, the query plan is not dispatched to all segments, but is targeted at the segment that contains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



## 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 better 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 existing planner generated the plan, the log message reads "Planner produced plan". To turn off logging, see `optimizer_log`.

## 2.2 Greenplum Query Plans

A *query plan* is the set of operations Greenplum 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.

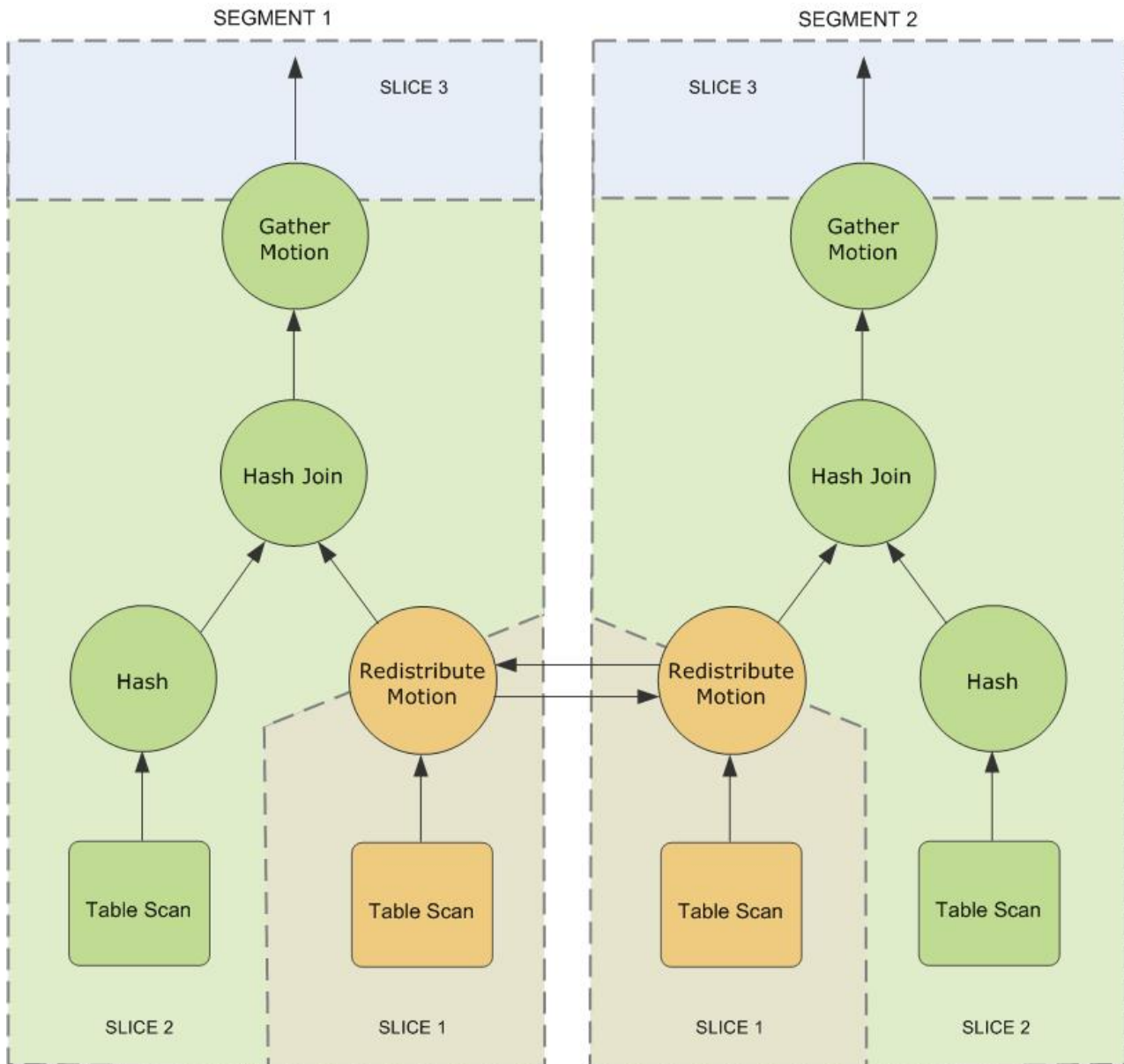
To achieve maximum parallelism during query execution, Greenplum divides the work of the query plan into *slices*. A slice is a portion of the plan that segments can work on independently. A query plan is sliced wherever a motion operation occurs in the plan, with one slice on each side of the motion.

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';
```

The following figure shows the query plan. Each segment receives a copy of the query plan and works on it in parallel.





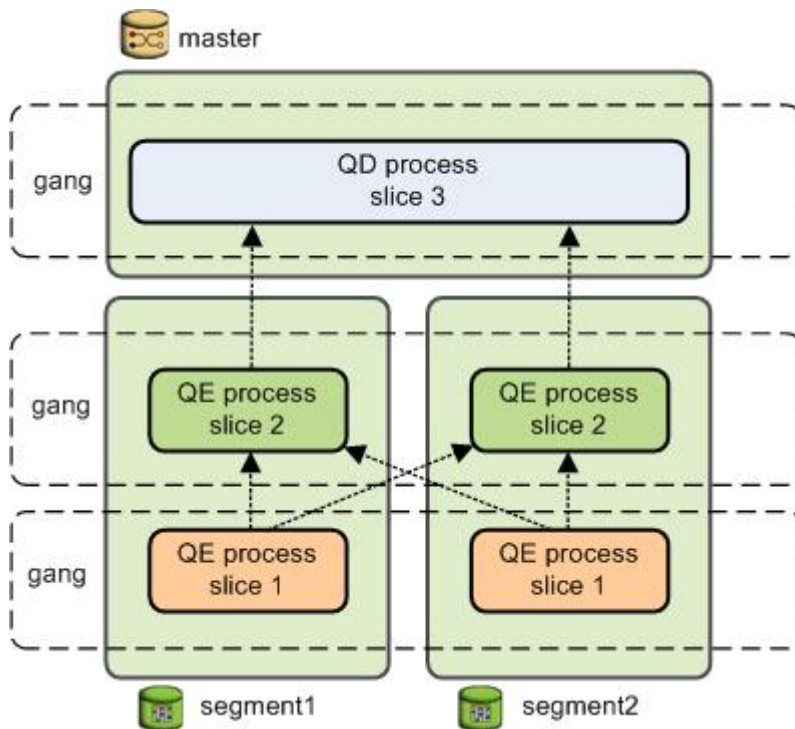
The query plan for this example has a redistribute motion that moves tuples between the segments to complete the join. The redistribute motion is necessary because the customer table is distributed across the segments by *cust\_id*, but the sales table is distributed across the segments by *sale\_id*. 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.

## 2.3 Parallel Query Execution

Greenplum 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. The following figure shows the query worker processes on the master and two segment instances for the query plan in `slice_plan.jpg`



## 3 Querying Data

---

This chapter describes the use of the SQL language in Pivotal HAWQ Database. SQL commands are typically entered using the standard PostgreSQL interactive terminal `psql`, but other programs that have similar functionality can be used as well.

- Defining Queries
- Using Functions and Operators

### 3.1 Defining Queries

---

A query is a SQL command that views, changes or analyzes the data in a database. This section describes how to construct SQL queries in HAWQ Database.

- SQL Lexicon
- SQL Value Expressions

#### 3.1.1 SQL Lexicon

SQL (structured query language) is the language used to access the database. The SQL language has a specific lexicon (words, special characters, etc.) used to construct queries or commands that the database engine can understand.

SQL input consists of a sequence of commands. A command is composed of a sequence of tokens, terminated by a semicolon (;). Which tokens are valid depends on the syntax of the particular command. The syntax rules for each command are described in the chapter, SQL Command Reference.

HAWQ Database is based on PostgreSQL and adheres to the same SQL structure and syntax (with some minor exceptions). In most cases, the syntax is identical to PostgreSQL, however some commands may have additional or restricted syntax in HAWQ Database. For a complete explanation of the SQL rules and concepts as implemented in PostgreSQL, see SQL Syntax in the PostgreSQL documentation.

#### 3.1.2 SQL Value Expressions

Value expressions are used in a variety of contexts, such as in the target list of the `SELECT` command, as new column values in `INSERT` or `UPDATE`, or in search conditions in a number of commands. The result of a value expression is sometimes called a *scalar*, to distinguish it from the result of a table expression (which is a table). Value expressions are therefore also called scalar expressions (or even simply expressions). The expression syntax allows the calculation of values from primitive parts using arithmetic, logical, set, and other operations.

Pivotal HAWQ supports the following value expressions:

- A function call

- An aggregate expression
- A window expression
- A scalar subquery

Another value expression in parentheses, useful to group subexpressions and override precedence.

In addition to this list, there are a number of constructs that can be classified as an expression but do not follow any general syntax rules. These generally have the semantics of a function or operator and are explained in [Using Functions and Operators](#).

## Function Calls

The syntax for a function call is the name of a function (possibly qualified with a schema name), followed by its argument list enclosed in parentheses:

```
function  
([expression [, expression ... ]])
```

For example, the following function call computes the square root of 2:

```
sqrt(2)
```

The list of built-in functions is listed in [Built-in Functions and Operators](#). Other functions may be added by the user.

## Aggregate Expressions

An aggregate expression represents the application of an aggregate function across the rows selected by a query. An aggregate function reduces multiple inputs to a single output value, such as the sum or average of the inputs. The syntax of an aggregate expression is one of the following:

```
aggregate_name (expression [ , ... ] ) [FILTER (WHERE condition)]  
aggregate_name (ALL expression [ , ... ] ) [FILTER (WHERE condition)]  
aggregate_name (DISTINCT expression [ , ... ] ) [FILTER (WHERE condition)]  
aggregate_name ( * ) [FILTER (WHERE condition)]
```

Where *aggregate\_name* is a previously defined aggregate (possibly qualified with a schema name), and *expression* is any value expression that does not itself contain an aggregate expression.

The first form of aggregate expression invokes the aggregate across all input rows for which the given expression(s) yield non-null values. The second form is the same as the first, since ALL is the default. The third form invokes the aggregate for all distinct non-null values of the expressions found in the input rows. The last form invokes the aggregate once for each input row regardless of null or non-null values; since no particular input value is specified, it is generally only useful for the count(\*) aggregate function.

For example, count(\*) yields the total number of input rows; count(f1) yields the number of input rows in which f1 is non-null; count(distinct f1) yields the number of distinct non-null values of f1.

The FILTER clause allows you to specify a condition to limit the input rows to the aggregate function. For example:

```
SELECT count(*) FILTER (WHERE gender='F') FROM employee;
```

The WHERE *condition* of the FILTER clause cannot contain a set returning function, subquery, a window function, or an outer reference. If using a user-defined aggregate function, the state transition function must be declared as STRICT (see CREATE AGGREGATE).

The predefined aggregate functions are described in Aggregate Functions. Other aggregate functions may be added by the user.

An aggregate expression may only appear in the result list or HAVING clause of a SELECT command. It is forbidden in other clauses, such as WHERE, because those clauses are logically evaluated before the results of aggregates are formed.

When an aggregate expression appears in a subquery (see "Scalar Subqueries" on page 119 and "Subquery Expressions" on page 126), the aggregate is normally evaluated over the rows of the subquery. But an exception occurs if the aggregate's arguments contain only outer-level variables: the aggregate then belongs to the nearest such outer level, and is evaluated over the rows of that query. The aggregate expression as a whole is then an outer reference for the subquery it appears in, and acts as a constant over any one evaluation of that subquery. The restriction about appearing only in the result list or HAVING clause applies with respect to the query level that the aggregate belongs to.

Pivotal HAWQ Database currently does not support DISTINCT with more than one input expression.

## Window Expressions

Window expressions allow application developers to more easily compose complex online analytical processing (OLAP) queries using standard SQL commands. For example, moving averages or sums can be calculated over various intervals; aggregations and ranks can be reset as selected column values change; and complex ratios can be expressed in simple terms.

A window expression represents the application of a *window function* applied to a *window frame*, which is defined in a special OVER() clause. A window partition is a set of rows that are grouped together for the purpose of applying an window function. Unlike aggregate functions, which return a result value for each group of rows, window functions return a result value for every row, but that value is calculated with respect to the rows in a particular window partition. If no partition is specified, the window function is computed over the complete intermediate result set.

The syntax of a window expression is:

```
window_function ( [expression [, ...]] ) OVER ( window_specification )
```

Where *window\_function* is one of the functions listed in "Window Functions" on page 126, *expression* is any value expression that does not itself contain a window expression, and *window\_specification* is:

```
[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 }]]
and where window_frame_bound can be one of:
UNBOUNDED PRECEDING
expression PRECEDING
CURRENT ROW
expression FOLLOWING
UNBOUNDED FOLLOWING
```

A window expression may only appear in the select list of a SELECT command. For example:

```
SELECT count(*) OVER(PARTITION BY customer_id), * FROM sales;
```

The OVER clause is what differentiates window functions from other aggregate or reporting functions. The OVER clause defines the *window\_specification* to which the window function is applied. A window specification has the following characteristics:

- The PARTITION BY clause, which defines the window partitions to which the window function is applied. If omitted, the entire result set is treated as one partition.
- The ORDER BY clause defines the expression(s) for sorting rows within a window partition. Note that the ORDER BY of a window specification is separate and distinct from the ORDER BY clause of a regular query expression (see The ORDER BY Clause, under SELECT). The ORDER BY clause is required for the window functions that calculate rankings, as it identifies the measure(s) for the ranking values. For OLAP aggregations, the ORDER BY clause is required in order to use window frames (the ROWS | RANGE clause). **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`
- The ROWS/RANGE clause is used to define a window frame for aggregate (non-ranking) window functions. A window frame defines a set of rows within a window partition. When a window frame is defined, the window function is computed with respect to the contents of this moving frame rather than the fixed contents of the entire window partition. Window frames can be row-based (ROWS) or value-based (RANGE).

## Scalar Subqueries

A scalar subquery is an ordinary SELECT query in parentheses that returns exactly one row with one column. The SELECT query is executed and the single returned value is used in the surrounding value expression. It is an error to use a query that returns more than one row or more than one column as a scalar subquery. A scalar subquery is correlated if it contains references to the outer query block.

## 3.2 Using Functions and Operators

- Functions in HAWQ
- User-Defined Functions
- Built-in Functions and Operators

### 3.2.1 Functions in HAWQ

Function Type	Pivotal 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. <code>current_timestamp</code> 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: <code>random()</code> , <code>currval()</code> , <code>timeofday()</code> .	Any function with side effects is volatile, even if its result is predictable. For example: <code>setval()</code>

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();
```



## 3.2.2 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”. 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).

Additionally, HAWQ supports the following properties for user defined functions. These properties can be appended to CREATE FUNCTION statement.

- If a UDF does not contain any SQL at all, use: **NO SQL** (this is the default)
- If a UDF contains SQL which does not access any data (e.g. SELECT 1+2;), use: **CONTAINS SQL**
- If a UDF only executes select queries on data, or calls other UDFs that query data (I think this is what you are asking about), use: **READS SQL DATA**
- If a UDF modifies the data (contains DML or DDL, or calls other UDFs that contain DDL or DML), use: **MODIFIES SQL DATA**

In order to maintain consistency, specifying MODIFIES SQL DATA and READS SQL DATA force the UDF to execute on the master.

**Important:** HAWQ does not support the following:

- SECURITY DEFINER when creating functions
- Set returning functions
- TABLE functions
- Nested functions error out during execution
- User-Defined base type
- SORTOP
- Window functions
- ALTER set encoding, set schema, rename

## 3.2.3 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 [User-Defined Functions](#). See the Functions and Operators section of the PostgreSQL documentation for more information about these built-in functions and operators.



Operator/Function	Volatile	Stable
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
Date/Time Functions and Operators	timeofday	age current_date current_time current_timestamp overtime 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	

Operator/Function	Volatile	Stable
System Information Functions		All session information functions All access privilege inquiry functions All schema visibility inquiry functions All comment information functions
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)

## Advanced Analytic Functions

HAWQ has the following built-in advanced analytic functions that are not available in PostgreSQL. All of these analytic functions are *immutable* functions

**Table: Advanced Analytic Functions**

Function	Return Type	Full Syntax	Description
matrix_add (array[], array[])		matrix_add( array[[1,1],[2,2]], array[[3,4],[5,6]])	Adds two two-dimensional matrices. The matrices must be conformable.

Function	Return Type	Full Syntax	Description
	smallint[] int[], bigint[], float[]		
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[], <i>expr</i> )	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: Advanced Aggregate Functions

Function	Return Type	Full Syntax	Description
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;	Performs matrix summation. Can take as input a two-dimensional array that is treated as a matrix.

Function	Return Type	Full Syntax	Description
		sum ----- {{1,3},{4,4}}	
pivot_sum( label[], label, <i>expr</i> )	int[], bigint[], float[]	pivot_sum(array['A1','A2'], attr, value)	A pivot aggregation using sum to resolve duplicate entries.
mregr_coef( <i>expr</i> , 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( <i>expr</i> , 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( <i>expr</i> , 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( <i>expr</i> , 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.

Function	Return Type	Full Syntax	Description
<code>nb_probabilities(text[], bigint, bigint[], bigint[])</code>	text	<code>nb_probabilities(classes, attr_count, class_count, class_total)</code>	<p>Determine probability for each class using a Naive Bayes Classifier.</p> <p>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.</p>

## 4 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

### 4.1 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 allow only 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 `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	

Field	Description
	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 <code>listen_addresses</code> 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 <code>ssl</code> configuration parameter
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 <code>@</code> .
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 <code>+</code> . 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 <code>@</code> .
CIDR-address	<p>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 <code>/</code>, and the CIDR mask length.</p> <p>Typical examples of a CIDR-address are <code>172.20.143.89/32</code> for a single host, or <code>172.20.143.0/24</code> for a small network, or <code>10.6.0.0/16</code> 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.</p>
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, <code>255.0.0.0</code> represents an IPv4 CIDR mask length of 8, and <code>255.255.255.255</code> 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.

### 4.1.1 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.

**To edit the `pg_hba.conf` file:**

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 md5encrypted
# passwords to authenticate the user
# Note that to use SHA-256 encryption, replace md5 with
# password in the line below host all dba192.168.0.0/32 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:** You can also control database access by setting object privileges as described in “Managing Object Privileges”. The `pg_hba.conf` file just controls who can initiate a database session and how those connections are authenticated.

## 4.2 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 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`.

## 4.2.1 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.

### To create a Self-signed Certificate without a Passphrase for Testing Only

1. Use the following OpenSSL command:

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

2. 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 the Self-signed Certificate with HAWQ:

1. Remove the passphrase with the following commands:

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

2. Enter the old passphrase when prompted to unlock the existing key.
3. 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
```

4. 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](#).

## 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.

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

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

### 5.1 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.
  1. 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.
  2. 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

### 5.2 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.

## 5.3 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 `gadmin` as an administrative user to the KDC database, run the following command:

```
kadmin.local -q "addprinc gadmin/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 `gadmin`.

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

## 5.3.1 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 gadmin/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 `gadmin/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 `gadmin/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.

## 5.3.2 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
```

6. 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.

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 gpadmin/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.

Adding this line to the postgresql.conf specifies the folder /home/gpadmin as the location of the keytab file gpdb-kerberos.keytab.

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:

### 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.

## 5.4 Sample Kerberos Configuration File

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

```
[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_etypes = aes128-cts des3-hmac-sha1 des-cbc-crc
des-cbc-md5
default_tkt_etypes = aes128-cts des3-hmac-sha1 des-cbc-crc
des-cbc-md5
permitted_etypes = 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  
}
```

## 6 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 connect 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.

### 6.1 Supported Data Types

HAWQ InputFormat supports the following 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.sql.Array	setArray	getArray
BIT/VARBIT	com.pivotal.hawq.mapreduce.datatype.	setVarbit	getVarbit
BYTEA	byte[]	setByte	getByte
INTERVAL	com.pivotal.hawq.mapreduce.datatype. HAWQInterval	setInterval	getInterval

SQL/HAWQ	JDBC/JAVA	setXXX	getXXX
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	setVircle	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.

## 6.2 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:

1. 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
```

## 6.3 Accessing 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.

### 6.3.1 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;
```

## 6.3.2 Metadata Export Tool

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

```
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;
```

## 7 SQL Command Reference

---

This topic contains a description and the syntax of the following SQL commands supported by HAWQ:

### 7.1 ABORT

---

Aborts the current transaction.

#### 7.1.1 Synopsis

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

#### 7.1.2 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.

#### 7.1.3 Parameters

WORK

TRANSACTION

Optional key words that have no effect.

#### 7.1.4 Notes

Use COMMIT to successfully terminate a transaction.

Issuing ABORT when not inside a transaction does no harm, but provokes a warning message.

#### 7.1.5 Compatibility

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

#### 7.1.6 See Also

**BEGIN**, COMMIT, ROLLBACK

## 7.2 ALTER ROLE

Changes a database role (user or group).

### 7.2.1 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 ]
```

### 7.2.2 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 325 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.

## 7.2.3 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" for more information about 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' | '' }
```

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.

## 7.2.4 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.

## 7.2.5 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';
```

## 7.2.6 Compatibility

The ALTER ROLE statement is a HAWQ extension.

## 7.2.7 See Also

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

## 7.3 ALTER TABLE

---

Changes the definition of a table.

### 7.3.1 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
    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 [, ... ] )

```

## 7.3.2 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 × 100) × (2 × 3) MB or 24 GB.

## 7.3.3 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. 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 ?AWQ 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 ?AWQ 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 ?AWQ. Also a table is only allowed one unique constraint and the uniqueness must be within the ?AWQ 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 92 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');
```

## 7.3.4 Notes

Take special care when altering or dropping columns that are part of the ?AWQ 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.

## 7.3.5 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) < 10);
```

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);
```

## 7.3.6 Compatibility

The ADD, DROP, and SET DEFAULT forms conform with the SQL standard. The other forms are ?AWQ 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

## 7.4 ALTER USER

Changes the definition of a database role (user).

### 7.4.1 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'
```

### 7.4.2 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.

## 7.4.3 Compatibility

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

## 7.4.4 See Also

ALTER ROLE

## 7.5 ANALYZE

---

Collects statistics about a database.

### 7.5.1 Synopsis

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

### 7.5.2 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.

### 7.5.3 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.

## 7.5.4 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.

## 7.5.5 Examples

Collect statistics for the table *mytable*:

```
ANALYZE mytable;
```

## 7.5.6 Compatibility

There is no ANALYZE statement in the SQL standard.

## 7.5.7 See Also

ALTER TABLE , EXPLAIN, VACUUM

## 7.6 BEGIN

Starts a transaction block.

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

### 7.6.1 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), ?AWQ 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.

### 7.6.2 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 ?AWQ 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.

## 7.6.3 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).

## 7.6.4 Examples

To begin a transaction block:

```
BEGIN;
```

## 7.6.5 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.

## 7.6.6 See Also

COMMIT, ROLLBACK, SAVEPOINT

## 7.7 CHECKPOINT

---

Forces a transaction log checkpoint.

### 7.7.1 Synopsis

```
CHECKPOINT
```

### 7.7.2 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.

### 7.7.3 Compatibility

The CHECKPOINT command is a HAWQ language extension.

## 7.8 CLOSE

---

Closes a cursor.

### 7.8.1 Synopsis

```
CLOSE cursor_name
```

### 7.8.2 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.

## 7.8.3 Parameters

`cursor_name`

The name of an open cursor to close.

## 7.8.4 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.

## 7.8.5 Examples

Close the cursor `portala`:

```
CLOSE portala;
```

## 7.8.6 Compatibility

CLOSE is fully conforming with the SQL standard.

## 7.8.7 See Also

DECLARE, FETCH

## 7.9 COMMIT

Commits the current transaction.

### 7.9.1 Synopsis

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

## 7.9.2 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.

## 7.9.3 Parameters

WORK  
TRANSACTION

Optional key words. They have no effect.

## 7.9.4 Notes

Use ROLLBACK to abort a transaction.

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

## 7.9.5 Examples

To commit the current transaction and make all changes permanent:

```
COMMIT;
```

## 7.9.6 Compatibility

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

## 7.9.7 See Also

BEGIN, END, ROLLBACK

# 7.10 COPY

---

Copies data between a file and a table.

## 7.10.1 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 [, ...]] ]

```

## 7.10.2 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.

## 7.10.3 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.
```

## 7.10.4 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 an 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 ?AWQ 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 mode 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.

## 7.10.5 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 ?AWQ 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.

## 7.10.6 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 ?AWQ.

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\n377\r\n0` — 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.

## 7.10.7 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.
```

## 7.10.8 Compatibility

There is no COPY statement in the SQL standard.

## 7.10.9 See Also

CREATE EXTERNAL TABLE

## 7.11 CREATE AGGREGATE

---

Defines a new aggregate function.

## 7.11.1 Synopsis

```
CREATE [ORDERED] AGGREGATE name (input_data_type [ , ... ])
( SFUNC = sfunc,
  STYPE = state_data_type
  [, PREFUNC = prefunc]
  [, FINALFUNC = ffunc]
  [, INITCOND = initial_condition]
  [, SORTOP = sort_operator] )
```

## 7.11.2 Description

CREATE AGGREGATE defines a new aggregate function. Some basic and commonly-used aggregate functions such as count, min, max, sum, avg and so on are already provided in Greenplum Database. If one defines new types or needs an aggregate function not already provided, then CREATE AGGREGATE can be used to provide the desired features.

An aggregate function is identified by its name and input data type(s). Two aggregates in the same schema can have the same name if they operate on different input types. The name and input data type(s) of an aggregate must also be distinct from the name and input data type(s) of every ordinary function in the same schema.

An aggregate function is made from one, two or three ordinary functions (all of which must be IMMUTABLE functions):

- a state transition function *sfunc*
- an optional preliminary segment-level calculation function *prefunc*
- an optional final calculation function *ffunc*

These are used as follows:

```
sfunc( internal-state, next-data-values ) ---> next-internal-state
prefunc( internal-state, internal-state ) ---> next-internal-state
ffunc( internal-state ) ---> aggregate-value
```

You can specify PREFUNC as method for optimizing aggregate execution. By specifying PREFUNC, the aggregate can be executed in parallel on segments first and then on the master. When a two-level execution is performed, SFUNC is executed on the segments to generate partial aggregate results, and PREFUNC is executed on the master to aggregate the partial results from segments. If single-level aggregation is performed, all the rows are sent to the master and sfunc is applied to the rows.

Single-level aggregation and two-level aggregation are equivalent execution strategies. Either type of aggregation can be implemented in a query plan. When you implement the functions prefunc and sfunc, you must ensure that the invocation of sfunc on the segment instances followed by prefunc on the master produce the same result as single-level aggregation that sends all the rows to the master and then applies only the sfunc to the rows.

HAWQ creates a temporary variable of data type *stype* to hold the current internal state of the aggregate function. At each input row, the aggregate argument values are calculated and the state transition function is invoked with the current state value and the new argument values to calculate a new internal state value. After all the rows have been processed, the final function is invoked once to calculate the aggregate return value. If there is no final function then the ending state value is returned as-is.

An aggregate function can provide an optional initial condition, an initial value for the internal state value. This is specified and stored in the database as a value of type text, but it must be a valid external representation of a constant of the state value data type. If it is not supplied then the state value starts out NULL.

If the state transition function is declared STRICT, then it cannot be called with NULL inputs. With such a transition function, aggregate execution behaves as follows. Rows with any null input values are ignored (the function is not called and the previous state value is retained). If the initial state value is NULL, then at the first row with all non-null input values, the first argument value replaces the state value, and the transition function is invoked at subsequent rows with all non-null input values. This is useful for implementing aggregates like max. Note that this behavior is only available when *state\_data\_type* is the same as the first *input\_data\_type*. When these types are different, you must supply a non-null initial condition or use a nonstrict transition function.

If the state transition function is not declared STRICT, then it will be called unconditionally at each input row, and must deal with NULL inputs and NULL transition values for itself. This allows the aggregate author to have full control over the aggregate handling of NULL values.

If the final function is declared STRICT, then it will not be called when the ending state value is NULL; instead a NULL result will be returned automatically. (This is the normal behavior of STRICT functions.) In any case the final function has the option of returning a NULL value. For example, the final function for avg returns NULL when it sees there were zero input rows.

Single argument aggregate functions, such as min or max, can sometimes be optimized by looking into an index instead of scanning every input row. If this aggregate can be so optimized, indicate it by specifying a sort operator. The basic requirement is that the aggregate must yield the first element in the sort ordering induced by the operator; in other words

```
SELECT agg(col) FROM tab;
```

must be equivalent to:

```
SELECT col FROM tab ORDER BY col USING sortop LIMIT 1;
```

Further assumptions are that the aggregate ignores null inputs, and that it delivers a null result if and only if there were no non-null inputs. Ordinarily, a data type's < operator is the proper sort operator for MIN, and > is the proper sort operator for MAX. Note that the optimization will never actually take effect unless the specified operator is the "less than" or "greater than" strategy member of a B-tree index operator class.



## Ordered Aggregates

If the optional qualification ORDERED appears, the created aggregate function is an *ordered aggregate*. In this case, the preliminary aggregation function, *prefunc* cannot be specified.

An ordered aggregate is called with the following syntax.

```
name ( arg [ , ... ] [ORDER BY sortspec [ , ...]] )
```

If the optional ORDER BY is omitted, a system-defined ordering is used. The transition function of an ordered aggregate *sfunc* is called on its input arguments in the specified order and on a single segment. There is a new column *aggordered* in the *pg\_aggregate* table to indicate the aggregate function is defined as an ordered aggregate.

### 7.11.3 Parameters

*name*

The name (optionally schema-qualified) of the aggregate function to create.

*input\_data\_type*

An input data type on which this aggregate function operates. To create a zero-argument aggregate function, write *\** in place of the list of input data types. An example of such an aggregate is *count(\*)*.

*sfunc*

The name of the state transition function to be called for each input row. For an N-argument aggregate function, the *sfunc* must take N+1 arguments, the first being of type *state\_data\_type* and the rest matching the declared input data type(s) of the aggregate. The function must return a value of type *state\_data\_type*. This function takes the current state value and the current input data value(s), and returns the next state value.

*state\_data\_type*

The data type for the aggregate's state value.

*prefunc*

The name of a preliminary aggregation function. This is a function of two arguments, both of type *state\_data\_type*. It must return a value of *state\_data\_type*. A preliminary function takes two transition state values and returns a new transition state value representing the combined aggregation. In HAWQ, if the result of the aggregate function is computed in a segmented fashion, the preliminary aggregation function is invoked on the individual internal states in order to combine them into an ending internal state.

Note that this function is also called in hash aggregate mode within a segment. Therefore if you call this aggregate function without a preliminary function, hash aggregate is never chosen. Since hash aggregate is efficient, consider defining preliminary function whenever possible.

PREFUNC is optional. If defined, it is executed on master. Input to PREFUNC is partial results from segments, and not the tuples. If PREFUNC is not defined, the aggregate cannot be executed in parallel. PREFUNC and `gp_enable_multiphase_agg` are used as follows:

- `gp_enable_multiphase_agg = off`: SFUNC is executed sequentially on master. PREFUNC, even if defined, is unused.
- `gp_enable_multiphase_agg = on` and PREFUNC is defined: SFUNC is executed in parallel, on segments. PREFUNC is invoked on master to aggregate partial results from segments.

```
CREATE OR REPLACE FUNCTION my_avg_accum(bytea,bigint) returns bytea as 'int8_avg_accum'
language internal strict immutable;
CREATE OR REPLACE FUNCTION my_avg_merge(bytea,bytea) returns bytea as 'int8_avg_amalg'
language internal strict immutable;
CREATE OR REPLACE FUNCTION my_avg_final(bytea) returns numeric as 'int8_avg' language
internal strict immutable;
CREATE AGGREGATE my_avg(bigint) (  stype = bytea,sfunc = my_avg_accum,prefunc =
my_avg_merge,finalfunc = my_avg_final,initcond = '' );
```

`ffunc`

The name of the final function called to compute the aggregate's result after all input rows have been traversed. The function must take a single argument of type `state_data_type`. The return data type of the aggregate is defined as the return type of this function. If `ffunc` is not specified, then the ending state value is used as the aggregate's result, and the return type is `state_data_type`.

`initial_condition`

The initial setting for the state value. This must be a string constant in the form accepted for the data type `state_data_type`. If not specified, the state value starts out null.

`sort_operator`

The associated sort operator for a MIN- or MAX-like aggregate. This is just an operator name (possibly schema-qualified). The operator is assumed to have the same input data types as the aggregate (which must be a single-argument aggregate).

## 7.11.4 Notes

The ordinary functions used to define a new aggregate function must be defined first. Note that in this release of HAWQ, it is required that the `sfunc`, `ffunc`, and `prefunc` functions used to create the aggregate are defined as IMMUTABLE.

Any compiled code (shared library files) for custom functions must be placed in the same location on every host in your HAWQ array (master and all segments). This location must also be in the `LD_LIBRARY_PATH` so that the server can locate the files.

## 7.11.5 Examples

Create a sum of cubes aggregate:

```
CREATE FUNCTION scube_accum(numeric, numeric) RETURNS numeric
AS 'select $1 + $2 * $2 * $2'
LANGUAGE SQL
IMMUTABLE
RETURNS NULL ON NULL INPUT;
CREATE AGGREGATE scube(numeric) (
    SFUNC = scube_accum,
    STYPE = numeric,
    INITCOND = 0 );
```

To test this aggregate:

```
CREATE TABLE x(a INT);
INSERT INTO x VALUES (1),(2),(3);
SELECT scube(a) FROM x;
```

Correct answer for reference:

```
SELECT sum(a*a*a) FROM x;
```

## 7.11.6 Compatibility

CREATE AGGREGATE is a HAWQ language extension. The SQL standard does not provide for user-defined aggregate functions.

## 7.11.7 See Also

ALTER AGGREGATE, DROP AGGREGATE, CREATE FUNCTION

## 7.12 CREATE DATABASE

Creates a new database.

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

### 7.12.1 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*.

## 7.12.2 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 possible. The default of -1 means there is no limitation.

## 7.12.3 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.

## 7.12.4 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';
```

## 7.12.5 Compatibility

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

## 7.12.6 See Also

DROP DATABASE

## 7.13 CREATE EXTERNAL TABLE

Defines a new external table.

### 7.13.1 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://outpuhost[: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 ]

```

## 7.13.2 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.

## 7.13.3 Parameters

READABLE | WRITABLE

Specifies 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 writable 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.

## 7.13.4 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;
```

## 7.13.5 Compatibility

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

## 7.13.6 See Also

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

## 7.14 CREATE FUNCTION

Defines a new function.

### 7.14.1 Synopsis

```
CREATE [OR REPLACE] FUNCTION name
( [ [argmode] [argname] argtype [, ...] ] )
[ RETURNS { [ SETOF ] rettype
```

```

    | TABLE ([{ argname argtype | LIKE other table }
      [, ...]])
    } ]
{ LANGUAGE langname
| IMMUTABLE | STABLE | VOLATILE
| CALLED ON NULL INPUT | RETURNS NULL ON NULL INPUT | STRICT
| [EXTERNAL] SECURITY INVOKER | [EXTERNAL] SECURITY DEFINER
| AS 'definition'
| AS 'obj_file', 'link_symbol' } ...
[ WITH ({ DESCRIBE = describe_function
        } [, ...] ) ]

```

## 7.14.2 Description

CREATE FUNCTION defines a new function. CREATE OR REPLACE FUNCTION will either create a new function, or replace an existing definition.

The name of the new function must not match any existing function with the same argument types in the same schema. However, functions of different argument types may share a name (overloading).

To update the definition of an existing function, use CREATE OR REPLACE FUNCTION. It is not possible to change the name or argument types of a function this way (this would actually create a new, distinct function). Also, CREATE OR REPLACE FUNCTION will not let you change the return type of an existing function. To do that, you must drop and recreate the function. If you drop and then recreate a function, you will have to drop existing objects (rules, views, triggers, and so on) that refer to the old function. Use CREATE OR REPLACE FUNCTION to change a function definition without breaking objects that refer to the function.

For more information about creating functions, see the User Defined Functions section of the PostgreSQL documentation.

### Limited Use of VOLATILE and STABLE 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 level if it contains SQL or modifies the database in any way. For example, functions such as random() or timeofday() are not allowed to execute on distributed data in HAWQ because they could potentially cause inconsistent data between the segment instances.

To ensure data consistency, VOLATILE and STABLE functions can safely be used in statements that are evaluated on and execute from the master. For example, the following statements are always executed on the master (statements without a FROM clause):

```

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

```

In cases where a statement has a FROM clause containing a distributed table *and* the function used in the FROM clause simply returns a set of rows, execution may be allowed on the segments:

```
SELECT * FROM foo();
```

One exception to this rule are functions that return a table reference (angeFuncs) or functions that use the refCursor data type. These types of functions cannot be used at all in Greenplum Database. However, they are not very commonly used anyways.

## 7.14.3 Parameters

name

The name (optionally schema-qualified) of the function to create.

argmode

The mode of an argument: either IN, OUT, or INOUT. If omitted, the default is IN.

argname

The name of an argument. Some languages (currently only PL/pgSQL) let you use the name in the function body. For other languages the name of an input argument is just extra documentation. But the name of an output argument is significant, since it defines the column name in the result row type. (If you omit the name for an output argument, the system will choose a default column name.)

argtype

The data type(s) of the function's arguments (optionally schema-qualified), if any. The argument types may be base, composite, or domain types, or may reference the type of a table column.

Depending on the implementation language it may also be allowed to specify pseudotypes such as cstring. Pseudotypes indicate that the actual argument type is either incompletely specified, or outside the set of ordinary SQL data types.

The type of a column is referenced by writing *tablename.columnname*%TYPE. Using this feature can sometimes help make a function independent of changes to the definition of a table.

rettype

The return data type (optionally schema-qualified). The return type can be a base, composite, or domain type, or may reference the type of a table column. Depending on the implementation language it may also be allowed to specify pseudotypes such as cstring. If the function is not supposed to return a value, specify void as the return type.

When there are OUT or INOUT parameters, the RETURNS clause may be omitted. If present, it must agree with the result type implied by the output parameters: RECORD if there are multiple output parameters, or the same type as the single output parameter.

The SETOF modifier indicates that the function will return a set of items, rather than a single item.

The type of a column is referenced by writing *tablename.columnname*%TYPE.

langname

The name of the language that the function is implemented in. May be SQL, C, internal, or the name of a user-defined procedural language. See CREATE LANGUAGE for the procedural languages supported in Greenplum Database. For backward compatibility, the name may be enclosed by single quotes.

IMMUTABLE

STABLE

VOLATILE

These attributes inform the query optimizer about the behavior of the function. At most one choice may be specified. If none of these appear, VOLATILE is the default assumption. Since HAWQ currently has limited use of VOLATILE functions, if a function is truly IMMUTABLE, you must declare it as so to be able to use it without restrictions.

IMMUTABLE indicates that the function cannot modify the database and always returns the same result when given the same argument values. It does not do database lookups or otherwise use information not directly present in its argument list. If this option is given, any call of the function with all-constant arguments can be immediately replaced with the function value.

STABLE indicates that the function cannot modify the database, and that within a single table scan it will consistently return the same result for the same argument values, but that its result could change across SQL statements. This is the appropriate selection for functions whose results depend on database lookups, parameter values (such as the current time zone), and so on. Also note that the *current\_timestamp* family of functions qualify as stable, since their values do not change within a transaction.

VOLATILE indicates that the function value can change even within a single table scan, so no optimizations can be made. Relatively few database functions are volatile in this sense; some examples are random(), curval(), timeofday(). But note that any function that has side-effects must be classified volatile, even if its result is quite predictable, to prevent calls from being optimized away; an example is setval().

CALLED ON NULL INPUT RETURNS NULL ON NULL INPUT STRICT

CALLED ON NULL INPUT (the default) indicates that the function will be called normally when some of its arguments are null. It is then the function author's responsibility to check for null values if necessary and respond appropriately. RETURNS NULL ON NULL INPUT or STRICT indicates that the function always returns null whenever any of its arguments are null. If this parameter is specified, the function is not executed when there are null arguments; instead a null result is assumed automatically.

[EXTERNAL] SECURITY INVOKER [EXTERNAL] SECURITY DEFINER

SECURITY INVOKER (the default) indicates that the function is to be executed with the privileges of the user that calls it. SECURITY DEFINER specifies that the function is to be executed with the privileges of the user that created it. The key word EXTERNAL is allowed for SQL conformance, but it is optional since, unlike in SQL, this feature applies to all functions not just external ones.

definition

A string constant defining the function; the meaning depends on the language. It may be an internal function name, the path to an object file, an SQL command, or text in a procedural language.

`obj_file, link_symbol`

This form of the AS clause is used for dynamically loadable C language functions when the function name in the C language source code is not the same as the name of the SQL function. The string *obj\_file* is the name of the file containing the dynamically loadable object, and *link\_symbol* is the name of the function in the C language source code. If the link symbol is omitted, it is assumed to be the same as the name of the SQL function being defined. It is recommended to locate shared libraries either relative to \$libdir (which is located at \$GPHOME/lib) or through the dynamic library path (set by the `dynamic_library_path` server configuration parameter). This simplifies version upgrades if the new installation is at a different location.

`describe_function`

The name of a callback function to execute when a query that calls this function is parsed. The callback function returns a tuple descriptor that indicates the result type.

## 7.14.4 Notes

Any compiled code (shared library files) for custom functions must be placed in the same location on every host in your HAWQ array (master and all segments). This location must also be in the `LD_LIBRARY_PATH` so that the server can locate the files. It is recommended to locate shared libraries either relative to \$libdir (which is located at \$GPHOME/lib) or through the dynamic library path (set by the `dynamic_library_path` server configuration parameter) on all master segment instances in the HAWQ array.

The full SQL type syntax is allowed for input arguments and return value. However, some details of the type specification (such as the precision field for type *numeric*) are the responsibility of the underlying function implementation and are not recognized or enforced by the `CREATE FUNCTION` command. HAWQ allows function overloading. The same name can be used for several different functions so long as they have distinct argument types. However, the C names of all functions must be different, so you must give overloaded C functions different C names (for example, use the argument types as part of the C names).

Two functions are considered the same if they have the same names and input argument types, ignoring any OUT parameters. Thus for example these declarations conflict:

```
CREATE FUNCTION foo(int) ...  
CREATE FUNCTION foo(int, out text) ...
```

When repeated `CREATE FUNCTION` calls refer to the same object file, the file is only loaded once. To unload and reload the file, use the `LOAD` command.

To be able to define a function, the user must have the `USAGE` privilege on the language.

It is often helpful to use dollar quoting to write the function definition string, rather than the normal single quote syntax. Without dollar quoting, any single quotes or backslashes in the function definition must be escaped by doubling them. A dollar-quoted string constant consists of a dollar sign (\$), an optional tag of zero or more characters, another dollar sign, an arbitrary sequence of characters that makes up the string content, a dollar sign, the same tag that began this dollar quote, and a dollar sign. Inside the dollar-quoted string, single quotes, backslashes, or any character can be used without escaping. The string content is



always written literally. For example, here are two different ways to specify the string "Dianne's horse" using dollar quoting:

```
$$Dianne's horse$$  
$SomeTag$Dianne's horse$SomeTag$
```

## 7.14.5 Examples

A very simple addition function:

```
CREATE FUNCTION add(integer, integer) RETURNS integer  
  AS 'select $1 + $2;'  
  LANGUAGE SQL  
  IMMUTABLE  
  RETURNS NULL ON NULL INPUT;
```

Increment an integer, making use of an argument name, in PL/pgSQL:

```
CREATE OR REPLACE FUNCTION increment(i integer) RETURNS integer AS $$  
  BEGIN  
    RETURN i + 1;  
  
  END;  
$$ LANGUAGE plpgsql;
```

Return a record containing multiple output parameters:

```
CREATE FUNCTION dup(in int, out f1 int, out f2 text)  
  AS $$ SELECT $1, CAST($1 AS text) || ' is text' $$  
  LANGUAGE SQL;  
SELECT * FROM dup(42);
```

You can do the same thing more verbosely with an explicitly named composite type:

```
CREATE TYPE dup_result AS (f1 int, f2 text);  
CREATE FUNCTION dup(int) RETURNS dup_result  
  AS $$ SELECT $1, CAST($1 AS text) || ' is text' $$  
  LANGUAGE SQL;  
SELECT * FROM dup(42);
```

## 7.14.6 Compatibility

CREATE FUNCTION is defined in SQL:1999 and later. The HAWQ version is similar but not fully compatible. The attributes are not portable, neither are the different available languages.

For compatibility with some other database systems, *argmode* can be written either before or after *argname*. But only the first way is standard-compliant.

## 7.14.7 See Also

ALTER FUNCTION, DROP FUNCTION, LOAD

## 7.15 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
```

### 7.15.1 Description

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

### 7.15.2 Compatibility

There is no CREATE GROUP statement in the SQL standard.

### 7.15.3 See Also

CREATE ROLE

## 7.16 CREATE LANGUAGE

---

Defines a new procedural language.

## 7.16.1 Synopsis

```
CREATE [PROCEDURAL] LANGUAGE name
CREATE [TRUSTED] [PROCEDURAL] LANGUAGE name HANDLER call_handler [VALIDATOR valfunction]
```

## 7.16.2 Description

CREATE LANGUAGE registers a new procedural language with a Greenplum database. Subsequently, functions and trigger procedures can be defined in this new language. You must be a superuser to register a new language. The PL/pgSQL language is already registered in all databases by default.

CREATE LANGUAGE effectively associates the language name with a call handler that is responsible for executing functions written in that language. For a function written in a procedural language (a language other than C or SQL), the database server has no built-in knowledge about how to interpret the function's source code. The task is passed to a special handler that knows the details of the language. The handler could either do all the work of parsing, syntax analysis, execution, and so on or it could serve as a bridge between Pivotal HAWQ Database and an existing implementation of a programming language. The handler itself is a C language function compiled into a shared object and loaded on demand, just like any other C function. A language handler has also been added for PL/R, but the PL/R language package is not pre-installed with Greenplum Database. See the section on Procedural Languages in the PostgreSQL documentation for more information on developing functions using these procedural languages.

The PL/R libraries require the correct version R to be installed. Download the appropriate extensions from the EMC Download Center, then install the extensions. See the Pivotal HAWQ Installation Guide for details. This ensures that all underlying dependencies are installed along with the extensions.

To use the PL/R procedural language you must make sure that the systems that run Pivotal HAWQ Database (master and all segments) have the R language installed and the PL/R package library (plr.so) added to their Pivotal HAWQ installation on all hosts. Pivotal provides compiled packages for R and PL/R that you can install.

There are two forms of the CREATE LANGUAGE command. In the first form, the user supplies just the name of the desired language, and the Pivotal HAWQ Database server consults the *pg\_pltemplate* system catalog to determine the correct parameters. In the second form, the user supplies the language parameters along with the language name. The second form can be used to create a language that is not defined in *pg\_pltemplate*.

When the server finds an entry in the *pg\_pltemplate* catalog for the given language name, it will use the catalog data even if the command includes language parameters. This behavior simplifies loading of old dump files, which are likely to contain out-of-date information about language support functions.

## 7.16.3 Parameters

## TRUSTED

Ignored if the server has an entry for the specified language name in *pg\_pltemplate*. Specifies that the call handler for the language is safe and does not offer an unprivileged user any functionality to bypass access restrictions. If this key word is omitted when registering the language, only users with the superuser privilege can use this language to create new functions.

## PROCEDURAL

This is a noise word.

name

The name of the new procedural language. The language name is case insensitive. The name must be unique among the languages in the database. Built-in support is included for plpgsql, plpython, plpythonu, and plr. plpgsql is already installed by default in Greenplum Database.

HANDLER *call\_handler*

Ignored if the server has an entry for the specified language name in *pg\_pltemplate*. The name of a previously registered function that will be called to execute the procedural language functions. The call handler for a procedural language must be written in a compiled language such as C with version 1 call convention and registered with Greenplum Database as a function taking no arguments and returning the language\_handler type, a placeholder type that is simply used to identify the function as a call handler.

VALIDATOR *valfunction*

Ignored if the server has an entry for the specified language name in *pg\_pltemplate*. *valfunction* is the name of a previously registered function that will be called when a new function in the language is created, to validate the new function. If no validator function is specified, then a new function will not be checked when it is created. The validator function must take one argument of type oid, which will be the OID of the to-be-created function, and will typically return void.

A validator function would typically inspect the function body for syntactical correctness, but it can also look at other properties of the function, for example if the language cannot handle certain argument types. To signal an error, the validator function should use the ereport() function. The return value of the function is ignored.

## 7.16.4 Notes

The PL/pgSQL language is installed by default in Greenplum Database.

The system catalog *pg\_language* records information about the currently installed languages.

To create functions in a procedural language, a user must have the USAGE privilege for the language. By default, USAGE is granted to PUBLIC (everyone) for trusted languages. This may be revoked if desired.

Procedural languages are local to individual databases. However, a language can be installed into the *template1* database, which will cause it to be available automatically in all subsequently-created databases.

The call handler function and the validator function (if any) must already exist if the server does not have an entry for the language in *pg\_pltemplate*. But when there is an entry, the functions need not already exist; they will be automatically defined if not present in the database.

Any shared library that implements a language must be located in the same LD\_LIBRARY\_PATH location on all segment hosts in your Greenplum Database array.

## 7.16.5 Examples

The preferred way of creating any of the standard procedural languages:

```
CREATE LANGUAGE plpgsql;
CREATE LANGUAGE plr;
```

For a language not known in the *pg\_pltemplate* catalog:

```
CREATE FUNCTION plsample_call_handler() RETURNS language_handler
AS '$libdir/plsample'
LANGUAGE C;
CREATE LANGUAGE plsample
HANDLER plsample_call_handler;
```

## 7.16.6 Compatibility

CREATE LANGUAGE is a Pivotal HAWQ Database extension.

## 7.16.7 See Also

CREATE FUNCTION

## 7.17 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' ]
```

## 7.17.1 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. Pivotal 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.

## 7.17.2 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.

## 7.17.3 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.

## 7.17.4 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);
```

## 7.17.5 Compatibility

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

## 7.17.6 See Also

ALTER ROLE, CREATE ROLE, DROP RESOURCE QUEUE

## 7.18 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]
```

## 7.18.1 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.

## 7.18.2 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
```

## 7.18.3 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.

## 7.18.4 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';
```

## 7.18.5 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.

## 7.18.6 See Also

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

## 7.19 CREATE SCHEMA

Defines a new schema.

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

### 7.19.1 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.

## 7.19.2 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.

## 7.19.3 Notes

To create a schema, the invoking user must have the CREATE privilege for the current database or be a superuser.

## 7.19.4 Examples

Create a schema:

```
CREATE SCHEMA myschema;
```

Create a schema for role *joe* (the schema will also be named *joe*):

```
CREATE SCHEMA AUTHORIZATION joe;
```

## 7.19.5 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.

## 7.19.6 See Also

DROP SCHEMA

## 7.20 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 }]
```

### 7.20.1 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.

## 7.20.2 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.

## 7.20.3 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.

## 7.20.4 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');
```

## 7.20.5 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.

## 7.20.6 See Also

DROP SEQUENCE

## 7.21 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 [, ... ] )

```

## 7.21.1 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.

## 7.21.2 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. `DISTRIBUTED 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_givename.
```

**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.

## 7.21.3 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.

## 7.21.4 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);
```

## 7.21.5 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.

## 7.21.6 See Also

ALTER TABLE, DROP TABLE, CREATE EXTERNAL TABLE, CREATE TABLE AS

## 7.22 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]
```

## 7.22.1 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.

## 7.22.2 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.

## 7.22.3 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.
```

## 7.22.4 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');
```

## 7.22.5 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.

## 7.22.6 See Also

CREATE EXTERNAL TABLE, EXECUTE, SELECT, SELECT INTO

## 7.23 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
```

### 7.23.1 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.

### 7.23.2 Compatibility

There is no CREATE USER statement in the SQL standard.

### 7.23.3 See Also

CREATE ROLE

## 7.24 CREATE VIEW

---



Defines a new view.

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

## 7.24.1 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.

## 7.24.2 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.

## 7.24.3 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.

## 7.24.4 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;
```

## 7.24.5 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.
- **CASCADE** — Check for integrity on this view and on any dependent view. CASCADE is assumed if neither CASCADE nor LOCAL is specified.

CREATE OR REPLACE VIEW is a Greenplum Database language extension. So is the concept of a temporary view.

## 7.25 DEALLOCATE

Deallocates a prepared statement.

```
DEALLOCATE [PREPARE] name
```

### 7.25.1 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.

### 7.25.2 Parameters

PREPARE

Optional key word which is ignored.

name

The name of the prepared statement to deallocate.

### 7.25.3 Examples

Deallocated the previously prepared statement named *insert\_names*:

```
DEALLOCATE insert_names;
```

### 7.25.4 Compatibility

The SQL standard includes a DEALLOCATE statement, but it is only for use in embedded SQL.

## 7.25.5 See Also

EXECUTE, PREPARE

## 7.26 DECLARE

---

Defines a cursor.

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

### 7.26.1 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.

### 7.26.2 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.

## 7.26.3 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.

## 7.26.4 Examples

Declare a cursor:

```
DECLARE mycursor CURSOR FOR SELECT * FROM mytable;
```

## 7.26.5 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.

## 7.26.6 See Also

CLOSE, FETCH, SELECT

## 7.27 DROP DATABASE

---

Removes a database.

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

### 7.27.1 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!

### 7.27.2 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.

## 7.27.3 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.

## 7.27.4 Examples

Drop the database named *testdb*:

```
DROP DATABASE testdb;
```

## 7.27.5 Compatibility

There is no DROP DATABASE statement in the SQL standard.

## 7.27.6 See Also

CREATE DATABASE

# 7.28 DROP EXTERNAL TABLE

Removes an external table definition.

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

## 7.28.1 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.

## 7.28.2 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.

## 7.28.3 Examples

Remove the external table named *staging* if it exists:

```
DROP EXTERNAL TABLE IF EXISTS staging;
```

## 7.28.4 Compatibility

There is no DROP EXTERNAL TABLE statement in the SQL standard.

## 7.28.5 See Also

CREATE EXTERNAL TABLE

## 7.29 DROP FILESPACE

Removes a filesystem.

```
DROP FILESPACE [IF EXISTS] filesystemname
```

### 7.29.1 Description

DROP FILESPACE removes a filesystem 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.

## 7.29.2 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.

## 7.29.3 Examples

Remove the tablespace *myfs*:

```
DROP FILESPACE myfs;
```

## 7.29.4 Compatibility

There is no `DROP FILESPACE` statement in the SQL standard or in PostgreSQL.

## 7.29.5 See Also

`gpfilespace` , `DROP TABLESPACE`

## 7.30 DROP GROUP

---

Removes a database role.

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

### 7.30.1 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.

## 7.30.2 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.

## 7.30.3 Compatibility

There is no DROP GROUP statement in the SQL standard.

## 7.30.4 See Also

DROP ROLE

# 7.31 DROP OWNED

Removes database objects owned by a database role.

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

## 7.31.1 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.

## 7.31.2 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.

## 7.31.3 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.

## 7.31.4 Examples

Remove any database objects owned by the role named *sally*:

```
DROP OWNED BY sally;
```

## 7.31.5 Compatibility

The DROP OWNED statement is a HAWQ extension.

## 7.31.6 See Also

REASSIGN OWNED, DROP ROLE

## 7.32 DROP RESOURCE QUEUE

Removes a resource queue.

```
DROP RESOURCE QUEUE queue_name
```

### 7.32.1 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.

### 7.32.2 Parameters

`queue_name`

The name of a resource queue to remove.

## 7.32.3 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;
```

## 7.32.4 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;
```

## 7.32.5 Compatibility

The DROP RESOURCE QUEUE statement is a HAWQ extension.

## 7.32.6 See Also

CREATE RESOURCE QUEUE, ALTER ROLE

## 7.33 DROP ROLE

Removes a database role.

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

## 7.33.1 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.

## 7.33.2 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.

## 7.33.3 Examples

Remove the roles named *sally* and *bob*:

```
DROP ROLE sally, bob;
```

## 7.33.4 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.

## 7.33.5 See Also

REASSIGN OWNED, DROP OWNED, CREATE ROLE, ALTER ROLE, SET ROLE

## 7.34 DROP SCHEMA

---

Removes a schema.

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

### 7.34.1 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.

### 7.34.2 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.

### 7.34.3 Examples

Remove the schema *mystuff* from the database, along with everything it contains:

```
DROP SCHEMA mystuff CASCADE;
```

### 7.34.4 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.

### 7.34.5 See Also

## CREATE SCHEMA

## 7.35 DROP SEQUENCE

---

Removes a sequence.

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

### 7.35.1 Description

DROP SEQUENCE removes a sequence generator table. You must own the sequence to drop it (or be a superuser).

### 7.35.2 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.

### 7.35.3 Examples

Remove the sequence *myserial*:

```
DROP SEQUENCE myserial;
```

### 7.35.4 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.

## 7.35.5 See Also

CREATE SEQUENCE

## 7.36 DROP TABLE

---

Removes a table.

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

### 7.36.1 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.

### 7.36.2 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.

### 7.36.3 Examples

Remove the table *mytable*:

```
DROP TABLE mytable;
```



## 7.36.4 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.

## 7.36.5 See Also

CREATE TABLE, ALTER TABLE, TRUNCATE

## 7.37 DROP TABLESPACE

---

Removes a tablespace.

```
DROP TABLESPACE [IF EXISTS] name [, ...] tablespacename
```

### 7.37.1 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.

### 7.37.2 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.

### 7.37.3 Examples

Remove the tablespace *mystuff*:

```
DROP TABLESPACE mystuff;
```

### 7.37.4 Compatibility

DROP TABLESPACE is a HAWQ extension.

## 7.38 DROP USER

---

Removes a database role.

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

### 7.38.1 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.

### 7.38.2 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.

### 7.38.3 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

## 7.39 DROP VIEW

---

Removes a view.

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

### 7.39.1 Description

DROP VIEW will remove an existing view. Only the owner of a view can remove it.

## 7.39.2 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.

## 7.39.3 Examples

Remove the view *topten*;

```
DROP VIEW topten;
```

## 7.39.4 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.

## 7.39.5 See Also

CREATE VIEW

## 7.40 END

Commits a current transaction.

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

## 7.40.1 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.

## 7.40.2 Parameters

WORK  
TRANSACTION

Optional keywords. They have no effect.

## 7.40.3 Examples

Commit the current transaction:

```
END;
```

## 7.40.4 Compatibility

END is a HAWQ extension that provides functionality equivalent to COMMIT, which is specified in the SQL standard.

## 7.40.5 See Also

BEGIN, ROLLBACK, COMMIT

## 7.41 EXECUTE

---

Executes a prepared SQL statement.

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

### 7.41.1 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.

## 7.41.2 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.

## 7.41.3 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);
```

## 7.41.4 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.

## 7.41.5 See Also

DEALLOCATE, PREPARE

## 7.42 EXPLAIN

Shows the query plan of a statement.

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

## 7.42.1 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:

## 7.42.2 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.

## 7.42.3 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.

## 7.42.4 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 *slice 1* 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.

## 7.42.5 Compatibility

There is no EXPLAIN statement defined in the SQL standard.

## 7.42.6 See Also

ANALYZE

## 7.43 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
```

### 7.43.1 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.

## 7.43.2 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.

## 7.43.3 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.

## 7.43.4 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.

## 7.43.5 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;
```

## 7.43.6 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.

## 7.43.7 See Also

DECLARE, CLOSE

## 7.44 GRANT

Defines access privileges.

```
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

```

## 7.44.1 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
```

## 7.44.2 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.

## 7.44.3 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.

## 7.44.4 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;
```

## 7.44.5 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.

## 7.44.6 See Also

REVOKE

## 7.45 INSERT

Creates new rows in a table.

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

### 7.45.1 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.

## 7.45.2 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.

## 7.45.3 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 VALUES ('UA502', 'Bananas', 105,  
'1971-07-13', 'Comedy', '82 minutes');
```

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';
```

## 7.45.4 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.

## 7.45.5 See Also

COPY, SELECT, CREATE EXTERNAL TABLE

## 7.46 PREPARE

---

Prepare a statement for execution.

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

### 7.46.1 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.

### 7.46.2 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.

## 7.46.3 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.

## 7.46.4 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);
```

## 7.46.5 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.

## 7.46.6 See Also

EXECUTE, DEALLOCATE

## 7.47 REASSIGN OWNED

---

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

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

### 7.47.1 Description

REASSIGN OWNED reassigns all the objects in the current database that are owned by `old_role` to `new_role`. Note that it does not change the ownership of the database itself.

### 7.47.2 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.

### 7.47.3 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.

### 7.47.4 Examples

Reassign any database objects owned by the role named `sally` and `bob` to `admin`,

```
REASSIGN OWNED BY sally, bob TO admin;
```

## 7.47.5 Compatibility

The REASSIGN OWNED statement is a HAWQ extension.

## 7.47.6 See Also

DROP OWNED, DROP ROLE

# 7.48 RELEASE SAVEPOINT

Destroys a previously defined savepoint.

```
RELEASE [SAVEPOINT] savepoint_name
```

## 7.48.1 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.

## 7.48.2 Parameters

savepoint\_name

The name of the savepoint to destroy.

## 7.48.3 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.

## 7.48.4 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.

## 7.48.5 See Also

`BEGIN`, `SAVEPOINT`, `ROLLBACK TO SAVEPOINT`, `COMMIT`

## 7.49 RESET

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

```
RESET configuration_parameter  
RESET ALL
```

### 7.49.1 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.

### 7.49.2 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.

## 7.49.3 Examples

Set the *work\_mem* configuration parameter to its default value:

```
RESET work_mem;
```

## 7.49.4 Compatibility

RESET is a HAWQ extension.

## 7.49.5 See Also

SET

## 7.50 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]
```

## 7.50.1 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.

## 7.50.2 Parameters

See GRANT.

## 7.50.3 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;
```

## 7.50.4 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

## 7.51 ROLLBACK

Aborts the current transaction.

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

### 7.51.1 Description

ROLLBACK rolls back the current transaction and causes all the updates made by the transaction to be discarded

### 7.51.2 Parameters

WORK

TRANSACTION

Optional key words. They have no effect.

### 7.51.3 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.

### 7.51.4 Examples

To discard all changes made in the current transaction:

```
ROLLBACK ;
```

## 7.51.5 Compatibility

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

## 7.51.6 See Also

BEGIN, COMMIT, SAVEPOINT, ROLLBACK TO SAVEPOINT

## 7.52 ROLLBACK TO SAVEPOINT

Rolls back the current transaction to a savepoint.

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

### 7.52.1 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.

### 7.52.2 Parameters

WORK

TRANSACTION

Optional key words. They have no effect.

savepoint\_name

The name of a savepoint to roll back to.

### 7.52.3 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.

## 7.52.4 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.

## 7.52.5 See Also

`BEGIN`, `COMMIT`, `SAVEPOINT`, `RELEASE SAVEPOINT`, `ROLLBACK`

## 7.53 SAVEPOINT

Defines a new savepoint within the current transaction.

```
SAVEPOINT savepoint_name
```

## 7.53.1 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.

## 7.53.2 Parameters

savepoint\_name

The name of the new savepoint.

## 7.53.3 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.

## 7.53.4 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.

## 7.53.5 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

## 7.53.6 See Also

BEGIN, COMMIT, ROLLBACK, RELEASE SAVEPOINT, ROLLBACK TO SAVEPOINT

## 7.54 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 [, ...] )]
```

## 7.54.1 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.

## 7.54.2 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, JOINS 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.

## 7.54.3 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);
```

## 7.54.4 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, a 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.

## 7.54.5 See Also

EXPLAIN

## 7.55 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]
[...]
```

### 7.55.1 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.

## 7.55.2 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.

## 7.55.3 Examples

Create a new table *films\_recent* consisting of only recent entries from the table *films*:

## 7.55.4 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.

## 7.55.5 See Also

SELECT, CREATE TABLE AS

## 7.56 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}
```

### 7.56.1 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” 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.

## 7.56.2 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”.

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.

## 7.56.3 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';
```

## 7.56.4 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.

## 7.56.5 See Also

RESET, SHOW

## 7.57 SET ROLE

Sets the current role identifier of the current session.

```
SET [SESSION | LOCAL] ROLE rolename
SET [SESSION | LOCAL] ROLE NONE
RESET ROLE
```

## 7.57.1 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.

## 7.57.2 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).

## 7.57.3 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.

## 7.57.4 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
```

## 7.57.5 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.

## 7.57.6 See Also

SET SESSION AUTHORIZATION

# 7.58 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
```

## 7.58.1 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.

## 7.58.2 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.

## 7.58.3 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
```

## 7.58.4 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.

## 7.58.5 See Also

SET ROLE

## 7.59 SHOW

Shows the value of a system configuration parameter.

```
SHOW configuration_parameter
SHOW ALL
```

### 7.59.1 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”.

### 7.59.2 Parameters

`configuration_parameter`

The name of a system configuration parameter. See “Server Configuration Parameters”.

ALL

Shows the current value of all configuration parameters.

### 7.59.3 Examples

Show the current setting of the parameter *search\_path*:

```
SHOW search_path;
```

Show the current setting of all parameters:

```
SHOW ALL;
```

## 7.59.4 Compatibility

SHOW is a HAWQ extension.

## 7.59.5 See Also

SET, RESET

# 7.60 TRUNCATE

Empties a table of all rows.

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

## 7.60.1 Description

TRUNCATE quickly removes all rows from a table or set of tables. This is most useful on large tables.

## 7.60.2 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.

## 7.60.3 Notes

Only the owner of a table may TRUNCATE it. TRUNCATE will not perform the following:

- Run any user-defined ON DELETE triggers that might exist for the tables.
- Truncate any tables that inherit from the named table. Only the named table is truncated, not its child tables.

## 7.60.4 Examples

Empty the table films:

```
TRUNCATE films;
```

## 7.60.5 Compatibility

There is no TRUNCATE command in the SQL standard.

## 7.60.6 See Also

DROP TABLE

## 7.61 VACUUM

Garbage-collects and optionally analyzes a database.

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

### 7.61.1 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 don 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.

### 7.61.2 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.

## 7.61.3 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.

## 7.61.4 Notes

`VACUUM` cannot be executed inside a transaction block. Pivotal 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

## 7.61.5 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;
```

## 7.61.6 Compatibility

There is no VACUUM statement in the SQL standard.

## 7.61.7 See Also

ANALYZE

## 8 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:

### 8.1 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.

Program Name	Description	Alternative
initdb	This program is called by gpinitssystem when initializing a HAWQ array. It is used internally to create the individual segment instances and the master instance.	gpinitssystem
ipclean	Cleans up shared memory and semaphores from aborted PostgreSQL backends.	N/A
gypsyncmaster	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 transactionlog 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)



Program Name	Description	Alternative
		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.

## 8.2 gpactivatestandby

Activates a standby master host and makes it the active master for the HAWQ system.

### 8.2.1 Synopsis

```
gpactivatestandby -d standby_master_datadir
[-c new_standby_master] [-f] [-a] [-q] [-l logfile_directory]
gpactivatestandby -? | -h | --help
gpactivatestandby -v
```

### 8.2.2 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;'
```

## 8.2.3 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.

## 8.2.4 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
```

## 8.3 gpcheckperf

Verifies the baseline hardware performance of the specified hosts.

### 8.3.1 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
```

## 8.3.2 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 the HAWQ 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.

## 8.3.3 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 addresses 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](http://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](http://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.

## 8.3.4 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 director 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
```

## 8.4 gpconfig

Sets server configuration parameters on all segments within a HAWQ system.

### 8.4.1 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
```

### 8.4.2 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`

## 8.4.3 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 | --sho 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

## 8.4.4 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
```

## 8.4.5 See Also

gpstop

## 8.5 gpextract

---

Extracts the metadata of a specified table into a YAML file.

### 8.5.1 Synopsis

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

### 8.5.2 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.

### 8.5.3 Arguments

<tablename>

Name of the table that you need to extract metadata. You can use 'namespace\_name.table\_name'.

### 8.5.4 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

## 8.5.5 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`.

## 8.5.6 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
```

## 8.5.7 Examples

Run gpextract to extract 'rank' table's metadata into a file 'rank\_table.yaml'.

```
$ gpextract -o rank_table.yaml rank
```

## 8.5.8 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

```

## 8.5.9 See Also

gpload

## 8.6 gpfdist

Serves data files to or writes data files out from HAWQ segments.

### 8.6.1 Synopsis

```
gpfdist [-d directory ] [-p http_port ] [-l log_file ] [-t timeout ]  
[-S ] [-v | -V ] [-m max_length ] [--ssl certificate_path]  
gpfdist -?  
gpfdist --version
```

## 8.6.2 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.

## 8.6.3 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:

1. Open a Windows command window
2. 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 gpfdist N binpath= "path_to _gpfdist.exe -p 8082 -d  
External\load\files\path -l Log\file\path"
```

3. Activate the gpfdist service:

1. Open the Windows Control Panel and select **Administrative Tools>Services** .
2. Highlight then right-click on the gpfdist service in the list of services.
3. 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.
4. Optional: Change the **Startup Type** to **Automatic** (after a system restart, this service will be running), then under **Service** status, click **Start** .
5. Click **OK** .

- Repeat the above steps for each instance of gpfdist that you created.

## 8.6.4 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
```

## 8.6.5 See Also

CREATE EXTERNAL TABLE, gpload

## 8.7 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.

### 8.7.1 Synopsis

```
gpfilespace
[connection_option ...] [-l logfile_directory] [-o
[
output_file_name]]
gpfilespace
[connection_option ...] [-l logfile_directory] -c
fs_config_file
gpfilespace -v
| -?
```

### 8.7.2 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.

### 8.7.3 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.

## 8.7.4 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 filespace.

`-W | --password`

Force a password prompt.

**Note:** gpfilespace, showfilespace, showtempfilespace, movetransfilespace, showtransfilespace, movetempfilespace are not supported.

## 8.7.5 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
```

## 8.8 gpinitstandby

Adds and/or initializes a standby master host for a HAWQ system.

### 8.8.1 Synopsis

```
gpinitstandby
{ -s standby_hostname | -r | -n }
[-M smart | -M fast] [-a] [-q] [-D] [-L]
[-l logfile_directory]
gpinitstandby -? | -v
```

### 8.8.2 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.

### 8.8.3 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.

## 8.8.4 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.

## 8.9 gpinitssystem

Initializes a HAWQ system using configuration parameters specified in the gpinitssystem\_config file.

### 8.9.1 Synopsis

```
gpinitssystem -c gpinitssystem_config
    [-h hostfile_gpinitssystem]
    [-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]
gpinitssystem -?
gpinitssystem -v
```

### 8.9.2 Description

The `gpinitssystem` 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 `gpinitssystem` utility takes care of initializing the

HAWQ master and each segment instance, and configuring the system as a whole.

Before running `gpinitssystem`, 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.

## 8.9.3 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 gpinitssystem_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_gpinitssystem`

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 `gpinitssystem_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.

## 8.10 gpload

Runs a load job as defined in a YAML formatted control file.

### 8.10.1 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
```

### 8.10.2 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](http://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).

## 8.10.3 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.

## 8.10.4 Options

`-f control_file`

Required. A YAML file that contains the load specification details. See "Control File Format"

`--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.

## 8.10.5 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.

## 8.10.6 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
GLOAD:
  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
```

## 8.10.7 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)"
```

## 8.10.8 See Also

gpfdist, CREATE EXTERNAL TABLE

## 8.11 gplogfilter

Searches through HAWQ log files for specified entries.

### 8.11.1 Synopsis

```
gplogfilter
[timestamp_options] [pattern_options][output_options] [input_options] [input_file]
gplogfilter --help
gplogfilter --version
```

### 8.11.2 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.

## 8.11.3 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 preceded 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.

## 8.11.4 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
```

## 8.11.5 See Also

gpssh, gpscp

## 8.12 gprecoverseg

Recovers a segment instance that has been marked as down.

### 8.12.1 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
```

## 8.12.2 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
```

## 8.12.3 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>:...]
```

## 8.12.4 Comments

Lines beginning with `#` are treated as comments and ignored.

## Filespace Order



The first comment line that is not a comment specifies filesystem ordering. This line starts with `filesystemOrder=` and is followed by list of filesystem names delimited by a colon. For example:

```
filesystemOrder=raid1:raid2
```

The default `pg_system` filesystem should not appear in this list. The list should be left empty on a system with no filesystems other than the default `pg_system` filesystem. For example:

```
filesystemOrder=
```

## 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:failedDataDirectorySPACEnewAddress:newPort:newReplicationPort:newDataDirectory
```

On a system with additional filesystems, the second group of fields is expected to be followed with a list of the corresponding filesystem locations separated by additional colons. For example, on a system with two additional filesystems, 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:location1:location2
```

## 8.12.5 Examples

### In-place recovery of a single mirror

```
filesystemOrder=  
sdw1-1:50001:/data1/mirror/gpseg16
```

### Recovery of a single mirror to a new host

```
filesystemOrder=  
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 filesystem

```
filesystemOrder=fs1  
sdw1-1:50001:/data1/mirror/gpseg16SPACE  
sdw4-1:50001:51001:/data1/recover1/gpseg16:/data1/fs1/gps  
egl6
```

## 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 filesystem_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 filesystem configuration file is in the format of:

```
pg_system=default fselocation
```

If your system does have additional filesystems configured, this file will only have one location for the default filesystem, *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 filesystem configuration file in the format that is required by the `-s` option. This file should be edited to supply the correct alternate filesystem locations.

`-v (verbose)`

Sets logging output to verbose.

`--version (version)`

Displays the version of this utility.

`-? (help)`

Displays the online help.

## 8.12.6 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
```

## 8.12.7 See Also

`gpstart`, `gpstop`

## 8.13 gpscp

Copies files between multiple hosts at once.

## 8.13.1 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
```

## 8.13.2 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.

## 8.13.3 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.

## 8.13.4 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 *sdw*:

```
gpscp -h sdw1 -h sdw2 myfuncs.so \  
=:/usr/local/greenplum-db/lib
```

## 8.14 gpssh

Provides ssh access to multiple hosts at once.

### 8.14.1 Synopsis

```
gpssh { -f hostfile_gpssh | -h hostname [-h hostname ...] } [-u  
userid] [-v] [-e] [bash_command]
```

```
gpssh -?  
gpssh --version
```

## 8.14.2 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.

## 8.14.3 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.

## 8.14.4 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 -l | wc -l'
```

## 8.15 gpssh-exkeys

Exchanges SSH public keys between hosts.

### 8.15.1 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
```

### 8.15.2 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).

## 8.15.3 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.

## 8.15.4 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
```

## 8.15.5 See Also

gpssh, gpscp

## 8.16 gpstart

Starts a HAWQ system.

### 8.16.1 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
```

## 8.16.2 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 gpinitssystem first.

## 8.16.3 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.

## 8.16.4 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 -?
```

## 8.16.5 See Also

gpstop

## 8.17 gpstate

---

Shows the status of a running HAWQ system.

### 8.17.1 Synopsis

```
gpstate
[-d master_data_directory] [-B parallel_processes]
[-s | -b | -Q] [-p] [-i] [-f] [-v | -q] [-l log_directory]
gpstate -? | -h | --help
```

### 8.17.2 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.

### 8.17.3 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.

## 8.17.4 Output Field Definitions

The following output fields are reported by `gpstate -s` for the master:

**Table - gpstate output data for the master**

Output Data	Description
Master host	Host name of the master
Master postgres process ID	PID of the mater database istener
Master data dictionary	File system location of the master database

Output Data	Description
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	HAWQ version when system was first initialized
HAWQ current version	Current version of HAWQ
postgres version	The version of Postgres that HAWQ is based on
HAWQ mirroring status	Physical mirroring, SAN or none
Master standby	Host name of the standby master, active or passive

The following output fields are reported by `gpstate -s` for each segment:

**Table - 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: <i>Primary</i>
Preferred Role	Role at system initialization time: <i>Primary</i>
File postmaster.pid	Status of postmaster.pid lock file: <i>Found</i> or <i>Missing</i>
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: <i>Up</i> or <i>Down</i>

Output Data	Description
Database status	Status of HAWQ to incoming requests: <i>Up</i> , <i>Down</i> , or <i>Suspended</i> . A <i>Suspended</i> state means database activity is temporarily paused while a segment transitions from one state to another.

## 8.17.5 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
```

## 8.17.6 See Also

gpstart, gplogfilter

## 8.18 gpstop

Stops or restarts a HAWQ system.

### 8.18.1 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
```



## 8.18.2 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.

## 8.18.3 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.

## 8.18.4 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 HAWQ 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 shut down the HAWQ array:

```
gpstop -U
```

## 8.18.5 See also

gpstart

## 9 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:

### 9.1 createdb

---

Creates a new database.

#### 9.1.1 Synopsis

```
createdb [connection_option ...] [-D tablespace] [-E encoding]
[-O owner] [-T template] [-e] [dbname ['description']] createdb --help | --version
```

#### 9.1.2 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.

#### 9.1.3 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*.

## 9.1.4 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.

## 9.1.5 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
```

## 9.1.6 See Also

CREATE DATABASE

## 9.2 createlang

Defines a new procedural language for a database.

### 9.2.1 Synopsis

```
createlang[connection_option ...] [-e] langname [[-d]dbname]
createlang [connection_option ...] -l dbname
createlang --help | --version
```

### 9.2.2 Description

createlang is a utility for adding a new programming language to a database. createlang is a wrapper around the CREATE LANGUAGE SQL command.

There are currently four procedural language packages included in the standard HAWQ Database distribution: PL/pgSQL, PL/Perl, and PL/Python. The PL/pgSQL language is already registered in all databases by default.

A language handler has also been added for PL/R, but the PL/R language package is not pre-installed with HAWQ Database. See the section on Procedural Languages in the PostgreSQL documentation for more information.

### 9.2.3 Options

*langname*

Specifies the name of the procedural programming language to be defined.

*[-d] dbname* | *[--dbname] dbname*

Specifies to which database the language should be added. The default is to use the PGDATABASE environment variable setting, or the same name as the current system user.

*-e* | *--echo*

Echo the commands that createlang generates and sends to the server.

*-l dbname* | *--list dbname*

Show a list of already installed languages in the target database.

## 9.2.4 Connection Options

`-h host | --host host`

The host name of the machine on which the Greenplum 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 Greenplum master database server is listening for connections. If not specified, reads from 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 -W | --password`

Never issue a password prompt. If the server requires password authentication and a password is not available by other means such as a .pgpass file, the connection attempt will fail. This option can be useful in batch jobs and scripts where no user is present to enter a password.

`-W | --password`

Force a password prompt.

## 9.2.5 See Also

CREATE LANGUAGE, droplang

## 9.3 createuser

---

Creates a new database role.

### 9.3.1 Synopsis

```
createuser [connection_option ...] [role_attribute ...] [-e] role_name
createuser --help | --version
```

### 9.3.2 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`.

### 9.3.3 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.

## 9.3.4 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.

## 9.3.5 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.

## 9.3.6 See Also

CREATE ROLE

## 9.4 dropdb

Removes an existing database.

### 9.4.1 Synopsis

```
dropdb [connection_option ...] [-e] [-i] dbname
dropdb --help | --version
```

### 9.4.2 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

## 9.4.3 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.

## 9.4.4 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.

## 9.4.5 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
```

## 9.4.6 See Also

DROP DATABASE

## 9.5 dropuser

---

Removes a database role.

### 9.5.1 Synopsis

```
dropuser [connection_option ...] [-e] [-i] role_name
dropuser --help | --version
```

### 9.5.2 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.

### 9.5.3 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.

## 9.5.4 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.

## 9.5.5 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
```

## 9.5.6 See Also

DROP ROLE

## 9.6 pg\_dump

Extracts a database into a single script file or other archive file.

## 9.6.1 Synopsis

```
pg_dump[connection_option ...] [dump_option ...] dbname
```

## 9.6.2 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`.

## 9.6.3 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`.

```
-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 use `-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.

## 9.6.4 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.

## 9.6.5 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.

## 9.6.6 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
```

## 9.6.7 See Also

`pg_dumpall`, `pg_restore`, `psql`

## 9.7 pg\_dumpall

Extracts all databases in a HAWQ system to a single script file or other archive file.

### 9.7.1 Synopsis

```
pg_dumpall [connection_option ...] [dump_option ...]
```

### 9.7.2 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 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.

## 9.7.3 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 file space 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.

`-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`.

`-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.

## 9.7.4 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.

## 9.7.5 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.

## 9.7.6 Examples

To dump all databases:

```
pg_dumpall > db.out
```

To reload this file:

```
pg_dumpall > db.outpsql template1 -f db.out
```

To dump only global objects (including tablespaces and resource queues):

```
pg_dumpall -g -f -r
```

## 9.7.7 See Also

`pg_dump`

## 9.8 `pg_restore`

---

Restores a database from an archive file created by `pg_dump`.

### 9.8.1 Synopsis

```
pg_restore [connection_option ...] [restore_option ...]filename
```

### 9.8.2 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.

### 9.8.3 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 outfile | --file=outfile`

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.

## 9.8.4 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.

## 9.8.5 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.

## 9.8.6 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
```

## 9.8.7 See Also

`pg_dump`

## 9.9 psql

Interactive command-line interface for HAWQ.

### 9.9.1 Synopsis

```
psql [option...] [dbname [username]]
```

### 9.9.2 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.

### 9.9.3 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.

## 9.9.4 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.



## 9.9.5 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.

## 9.9.6 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.

### 9.9.7 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 `\lpwd`.

```
\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 filesystem 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_
```

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 oid 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 **u**naligned, **a**ligned, **h**tml, **l**atex, **t**roff-ms, or **w**rapped. 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 width 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 itself 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. 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.

## 9.9.8 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 `*.*`.

## 9.9.9 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 a 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.

## 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.

## 9.9.10 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;
```

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" -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.

**%, 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
```

## 9.9.11 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.

## 9.9.12 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.

## 9.9.13 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.

## 9.9.14 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.

## 9.9.15 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
```

## 9.10 vacuumdb

Garbage-collects and analyzes a database.

### 9.10.1 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
```

### 9.10.2 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.

## 9.10.3 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.

## 9.10.4 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.

## 9.10.5 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
```

## 9.10.6 See Also

VACUUM, ANALYZE

## 10 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.

### 10.1 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.

### 10.2 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: Settable Classifications**

Set classification	Description
master or local	<p>A <i>master</i> 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.</p> <p>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.</p>
session or system	<p>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).</p> <p>A <i>system</i> parameter can only be changed via the postgresql.conf file(s).</p>
restart or reload	When changing parameter values in the postgresql.conf file(s), some require a <i>restart</i> 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.
readonly	These parameters are not settable by database users or superusers. The current value of the parameter can be shown but not altered.

## 10.3 Server Configuration Parameters

Parameter	Value Range	Description	Set Classification
add_missing_from	Boolean <b>Default:</b> 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	String <b>Default:</b> On	Sets the application name for a client session. For example, if connecting via psql, this will be set to psql.	master session reload

Parameter	Value Range	Description	Set Clas
		Setting an application name allows it to be reported in log messages and statistics views.	
array_null	Boolean <b>Default:</b> On	<p>This controls whether the array input parser recognizes unquoted NULL as specifying a null array element.</p> <p>By default, this is on, allowing array values containing null values to be entered.</p> <p>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'.</p>	mast sessi reloa
authentication_timeout	Any valid time expression (number and unit) <b>Default:</b> 1 min	Maximum time to complete client authentication. This prevents hung clients from occupying a connection indefinitely.	local syste resta
backslash_quote	on (allow '\always) off (reject always) safe_encoding (allow only if client encoding does not allow ASCII \ within a multibyte character)	<p>This controls whether a quote mark can be represented by \' in a string literal.</p> <p>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 \.</p>	mast sessi reloa
block_size	number of bytes <b>Default:</b> 32768	Reports the size of a disk block.	read
bonjour_name	string <b>Default:</b> 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.	mast syste resta
check_function_bodies	boolean <b>Default:</b> 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.	mast sessi reloa



Parameter	Value Range	Description	Set Class
client_encoding	character set <b>Default:</b> 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 <b>Default:</b> 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 <b>Default:</b> 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 <b>Default:</b> 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 <b>Default:</b> 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 classnames <b>Default:</b> 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
DataStyle			

Parameter	Value Range	Description	Set Class
	<p>&lt;format&gt;,&lt;date style&gt;</p> <p>where &lt;format&gt; is SO, Postgres, SQL, or German and &lt;date style&gt; is DMY, MDY, or YMD.</p> <p><b>Default:</b> ISO, MDY</p>	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	<p>Boolean</p> <p><b>Default:</b> Off</p>	This enables per-database user names. If on, you should create users as <code>username@dbname</code> . To create ordinary global users, simply append @ when specifying the user name in the client.	local system reload
deadlock_timeout	<p>Any valid time expression (number and unit)</p> <p><b>Default:</b> 1s</p>	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	<p>Boolean</p> <p><b>Default:</b> Off</p>	Turns on various assertion checks	local system restart
debug_pretty_print	<p>Boolean</p> <p><b>Default:</b> Off</p>	Indents debug output to produce a more readable but much longer output format.	master session reload
		client_min_messages or log_min_messages must be DEBUG1 or lower.	
debug_print_parse	<p>Boolean</p> <p><b>Default:</b> Off</p>	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	<p>Boolean</p> <p><b>Default:</b> Off</p>	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	<p>Boolean</p> <p><b>Default:</b> Off</p>	For each executed query, prints the preliminary query plan. client_min_messages or	

Parameter	Value Range	Description	Set Class
		log_min_messages must be DEBUG1 or lower.	master session reload
gp_autostats_mode	none on_change on_no_stats  <b>Default:</b> 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_threshold	integer  <b>Default:</b> 2147483647	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  <b>Default:</b> 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	master session reload

Parameter	Value Range	Description	Set Clas
		setting may improve performance for power-users that want to issue many complex queries in a row.	
gp_command_count	integer > 0 <b>Default:</b> 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-
gp_connectemc_mode	on, off, local, remote <b>Default:</b> 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: <ul style="list-style-type: none"> <li>on (the default) - log events to the gpperfmon database and send dial-home notifications to EMC Support</li> <li>off - turns off ConnectEMC event logging and dial-home capabilities local - log events to the gpperfmon database only</li> <li>remote - sends dial-home notifications to EMC Support (does not log events to the gpperfmon database).</li> </ul>	mast syste resta supe
gp_connections_per_thread	integer <b>Default:</b> 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	mast sessi reloa

Parameter	Value Range	Description	Set Clas
		known throughput performance problem.	
gp_content	integer	The local content id of a segment.	read
gp_dbid	integer	The local content dbid of a segment.	read
gp_debug_linger	Any valid time expression  (number and unit)  <b>Default:</b> 0	Number of seconds for a HAWQ process to linger after a fatal internal error.	mast sessi reloa
gp_dynamic_partition_pruning	on/off  <b>Default:</b> on	Enables plans that can dynamically eliminate the scanning of partitions.	mast sessi reloa
gp_email_from	string	The email address used to send email alerts, in the format of:  <i>'username @ domain.com'</i>  or  <i>'Name &lt;username @ domain.com &gt;'</i>	mast syste resta
gp_email_smtp_password	string	The password/passphrase used to authenticate with the SMTP server.	mast syste resta
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	mast syste resta
gp_email_smtp_userid	string	The user id used to authenticate with the SMTP server.	mast syste resta
gp_email_to	string	A semi-colon (;) separated list of email addresses to receive email alert messages to in the format of:  <i>'username @ domain.com'</i>  or  <i>'Name &lt;username @ domain.com &gt;'</i>	mast syste resta

Parameter	Value Range	Description	Set Clas
		If this parameter is not set, then email alerts are disabled.	
gp_enable_adaptive_nestloop	Boolean <b>Default:</b> 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.	mast sessi reloa
gp_enable_agg_distinct	Boolean <b>Default:</b> 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.	mast syste resta
gp_enable_agg_distinct_pruning	Boolean <b>Default:</b> 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.	mast sessi reloa
gp_enable_direct_dispatch	Boolean <b>Default:</b> 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.	mast syste resta
gp_enable_fallback_plan	Boolean <b>Default:</b> On	Allows use of disabled plan types when a query would not be feasible without them.	mast sessi reloa
gp_enable_fast_sri	Boolean <b>Default:</b> 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	mast sessi

Parameter	Value Range	Description	Set Class
		operation required). This significantly improves performance of single-row-insert statements.	
gp_enable_gpperfmon	Boolean <b>Default:</b> On	Enables or disables the data collection agents of HAWQ Performance Monitor.	local system restart
gp_enable_grouptext_distinct_gather	Boolean <b>Default:</b> 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_grouptext_distinct_pruning are both enabled, the planner uses the cheaper plan.	master session reload
gp_enable_grouptext_distinct_pruning	Boolean <b>Default:</b> 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 <b>Default:</b> 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 <b>Default:</b> 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 <b>Default:</b> 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	master session reload

Parameter	Value Range	Description	Set Clas
		rows, this extra SORT DISTINCT is much cheaper than the cost of sending the rows across the Interconnect.	
gp_enable_sequential_window_plans	Boolean <b>Default:</b> 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.	mast sessi reloa
gp_enable_sort_distinct	Boolean <b>Default:</b> On	Enable duplicates to be removed while sorting.	mast sessi reloa
gp_enable_sort_limit	Boolean <b>Default:</b> On	Enable LIMIT operation to be performed while sorting. Sorts more efficiently when the plan requires the first <i>limit_number</i> of rows at most.	mast sessi reloa
gp_external_enable_exec	Boolean <b>Default:</b> 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.	mast sessi reloa
gp_external_grant_privileges	Boolean <b>Default:</b> On	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.	mast sessi resta
gp_external_max_segs	integer <b>Default:</b> 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.	mast sessi resta



Parameter	Value Range	Description	Set Class
gp_filerep_tcp_keepalives_count	number of lost keepalives  <b>Default:</b> 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.	master session restart
gp_filerep_tcp_keepalives_idle	number of seconds  <b>Default:</b> 1 min	Number of seconds between sending keepalives on an otherwise idle connection. A value of 0 uses the system default. If TCP_KEEPIPLE 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  <b>Default:</b> 30 seconds	How many seconds to wait for a response to a keepalive before retransmitting. A value of 0 uses the system default. If TCP_KEEPIPLE 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  <b>Default:</b> 1 min	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 session restart
gp_fts_probe_threadcount	1 - 128  <b>Default:</b> 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 session restart
gp_fts_probe_timeout	10 secs or greater  <b>Default:</b> 10 secs	Specifies the allowed timeout for the fault detection process (ftsprobe) to establish a connection to a segment before declaring it down.	master session restart
p_gpperfmon_send_interval	Any valid time expression	Sets the frequency that the HAWQ server processes send query execution updates to	master

Parameter	Value Range	Description	Set Class
	(number and unit) <b>Default:</b> 10 min	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.	system restart
gp_hashjoin_tuples_per_bucket	integer <b>Default:</b> 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
gp_interconnect_default_rtt	1-1000ms <b>Default:</b> 20ms	Sets the default rtt (in ms) for UDP interconnect.	master session reload
gp_interconnect_fc_method	"capacity" or "loss" <b>Default:</b> "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 <b>Default:</b> 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 <b>Default:</b> 20ms	Sets the min rto (in ms) for UDP interconnect.	master session reload
gp_interconnect_min_retries_before_timeout	1-4096 <b>Default:</b> 100	Sets the min retries before reporting a transmit timeout in the interconnect	master session reload

Parameter	Value Range	Description	Set Clas
gp_interconnect_queue_depth	1-2048 <b>Default:</b> 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.	mast sessi reloa
gp_interconnect_setup_timeout	Any valid time expression (number and unit) <b>Default:</b> 5 min	Time to wait for the Interconnect to complete setup before it times out.	mast sessi reloa
gp_interconnect_snd_queue_depth	1-4096 <b>Default:</b> 2	Used to specify the average size of a send queue. The buffer pool size for each send process can be calculated by using <code>gp_interconnect_snd_queue_depth * number of processes in the downstream gang</code> .	mast sessi reloa
gp_interconnect_timer_period	1-100ms <b>Default:</b> 5ms	Sets the timer period (in ms) for UDP interconnect. Default value is 5ms	mast sessi reloa
gp_interconnect_timer_checking_period	1-100ms <b>Default:</b> 20ms	Sets the timer checking period (in ms) for UDP interconnect	mast sessi reloa
gp_interconnect_transmit_timeout	1-7200s <b>Default:</b> 3600	Timeout (in seconds) on interconnect to transmit a packet.	mast sessi
gp_interconnect_type	TCP UDP  <b>Default:</b> 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.	

Parameter	Value Range	Description	Set Clas
		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.	
gp_log_format	csv text  <b>Default:</b> csv	Specifies the format of the server log files. If using <i>gp_toolkit</i> administrative schema, the log files must be in csv format.	local system restart
gp_max_csv_line_length	number of bytes  <b>Default:</b> 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 <i>gp_toolkit</i> administrative schema to read HAWQ log files.	local system restart
gp_max_databases	1-64  <b>Default:</b> 16	The maximum number of databases allowed in a HAWQ system.	master system restart
gp_max_filespaces	1-32  <b>Default:</b> 8	The maximum number of tablespaces allowed in a HAWQ system.	master system restart
gp_max_local_distributed_cache	Integer  <b>Default:</b> 1024	Sets the number of local to distributed transactions to cache. Higher settings may improve performance.	master system restart
gp_max_packet_size	512-65536  <b>Default:</b> 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  <b>Default:</b> 16	The maximum number of tablespaces allowed in a HAWQ system.	master system restart
gp_motion_cost_per_row	floating point  <b>Default:</b> 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 twotimes the value of <i>cpu_tuple_cost</i> .	master session reload

Parameter	Value Range	Description	Set Class
gp_num_contents_in_cluster	-	The number of primary segments in the HAWQ system	read
gp_reject_percent_threshold	1-n <b>Default:</b> 300	For single row error handling on COPY and external table SELECTs, sets the number of rows processed before SEGMENT REJECT LIMIT <i>n</i> PERCENT starts calculating.	master session reload
gp_reraise_signal	Boolean <b>Default:</b> 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 <b>Default:</b> 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
gp_resqueue_priority		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_cpuscores_per_segment	0.1 - 25.0 <b>Default:</b> 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
gp_resqueue_priority_sweeper_interval	500 - 15000 ms <b>Default:</b> 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		The role of this server process — set to dispatch for the master and <i>execute</i> for a segment.	read

Parameter	Value Range	Description	Set Class
	dispatch execute utility		
gp_safefswritesize	Integer <b>Default:</b> 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) <b>Default:</b> 10mins	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 restart
gp_segments_for_planner	0-n <b>Default:</b> 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 system restart
gp_session_id	1-n <b>Default:</b> 14	A system assigned ID number for a client session. Starts counting from 1 when the master instance is first started.	read
gp_set_proc_affinity	Boolean <b>Default:</b> 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 <b>Default:</b> off	Set to on to disable writes to the database. Any in progress transactions must finish before read-only mode takes affect.	master system restart

Parameter	Value Range	Description	Set Class
gp_snmp_community	SNMP community name  <b>Default:</b> public	Set to the community name you specified for your environment.	master system reload
gp_snmp_monitor_address	hostname:port	The <i>hostname:port</i> 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  <b>Default:</b> 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  <b>Default:</b> on	Enables the query planner to utilize statistics from child tables when planning queries on the parent table.	master system reload
gp_statistics_use_fkeys	Boolean  <b>Default:</b> 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 system reload
gp_vmem_idle_resource_timeout	Any valid time expression (number and unit)  <b>Default:</b> 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
gp_vmem_protect_limit	Integer  <b>Default:</b> 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:  $(X * \text{physical\_memory}) / \text{primary\_segments}$  Where	

Parameter	Value Range	Description	Set Clas
		<p><math>X</math> is a value between 1.0 and 1.5.  <math>X=1</math> offers the best system performance.  <math>X=1.5</math> may cause more swapping on the system, but less queries will be cancelled.</p> <p>For example, on a segment host with 16GB physical memory and 4 primary segment instances the calculation would be:</p> $(1 * 16) / 4 = 4\text{GB}$ $4 * 1024 = 4096\text{MB}$ <p>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.</p>	
gp_vmem_protect_segworker_cache_limit	number of megabytes  <b>Default:</b> 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.	mast  syste resta
gp_workfile_checksumming	Boolean  <b>Default:</b> 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	mast  syste reloa
gp_workfile_compress_algorithm	none zlib  <b>Default:</b> 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.	mast  syste reloa
gpperfmon_port	Integer  <b>Default:</b> 8888	Sets the port on which all performance monitor agents communicate with the	mast  syste resta



Parameter	Value Range	Description	Set Clas
		master.	
pxf_enable_stat _collection	Boolean  <b>Default:</b> on	Collects statistical information about PXF.	
integer_datetimes	Boolean  <b>Default:</b> on	Reports whether PostgreSQL was built with support for 64-bit-integer dates and times.	read
IntervalStyle	postgres  postgres_verbose sql_standard iso_8601  <b>Default:</b> postgres	<p>Sets the display format for interval values. The value <i>sql_standard</i> produces output matching SQL standard interval literals.</p> <p>The value <i>postgres</i> produces output matching PostgreSQL releases prior to 8.4 when the <code>DateStyle</code> parameter was set to ISO. The value <i>postgres_verbose</i> produces output matching HAWQ releases prior to 3.3 when the <code>DateStyle</code> parameter was set to non-ISO output.</p> <p>The value <i>iso_8601</i> will produce output matching the time interval <i>format with</i> designators defined in section 4.4.3.2 of ISO 8601. See the PostgreSQL 8.4 documentation for more information.</p>	mast sessi reloa
join_collapse_limit	1-n  <b>Default:</b> 20	<p>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 <code>from_collapse_limit</code>, 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 <code>from_collapse_limit</code> might be useful to trade off planning time against the quality of the chosen plan (higher values produce better plans).</p>	mast sessi reloa
krb_caseins_users	Boolean  <b>Default:</b> off	Sets whether Kerberos user names should be treated case-insensitively. The default is case sensitive (off).	mast sessi reloa
krb_server_keyfile	path and file  name	Sets the location of the Kerberos server key file.	

Parameter	Value Range	Description	Set Clas
	<b>Default:</b> unset		mast sessi resta
krb_srvname	service name  <b>Default:</b> postgres	Sets the Kerberos service name.	mast sessi
krb5_ccname	path and file name  <b>Default:</b> /tmp/ postgres.ccname	Set the location of the Kerberos ticket  cache.	mast sessi
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
lc_ctype	<system dependent>	Reports the locale that determines character classifications. The value is determined when the HAWQ array is initialized.	read
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 <i>locale -a</i> 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 syste resta
lc_monetary	<system dependent>	Sets the locale to use for formatting monetary amounts, for example with the <i>to_char</i> family of functions. The locales available depends on what was installed with your operating system - use <i>locale -a</i> to list available locales. The default value is inherited from the execution environment of the server.	local syste resta
lc_numeric	<system dependent>	Sets the locale to use for formatting numbers, for example with the <i>to_char</i> family of functions. The	

Parameter	Value Range	Description	Set Class
		locales available depends on what was installed with your operating system - use <i>locale -a</i> 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
log_autostats	Boolean	Logs information about automatic ANALYZE operations related to  gp_autostats_mode and gp_autostats_on_change_threshold	master session reload superuser
log_connections	Boolean  <b>Default:</b> 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  <b>Default:</b> 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  <b>Default:</b> 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  <b>Default:</b> off	Causes the duration of every completed statement which satisfies	master

Parameter	Value Range	Description	Set Class
		<i>log_statement</i> to be logged.	sessi reloa supe
log_error_verbosity	TERSE DEFAULT VERBOSE  <b>Default:</b> DEFAULT	Controls the amount of detail written in the server log for each message that is logged.	mast  sessi reloa supe
log_executor_stats	Boolean  <b>Default:</b> 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 <i>log_statement_stats</i> .	local  syste resta
log_hostname	Boolean  <b>Default:</b> 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  syste resta
log_min_duration_statement	number of milliseconds, 0, -1  <b>Default:</b> -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.	mast  sessi reloa supe
log_min_error_statement	DEBUG5  DEBUG4 DEBUG3 DEBUG2, DEBUG1 INFO NOTICE WARNING ERROR FATAL PANIC	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.	mast  sessi supe

Parameter	Value Range	Description	Set Clas
	<b>Default:</b> ERROR		
log_min_messages	DEBUG5 DEBUG4 DEBUG3 DEBUG2 DEBUG1 INFO NOTICE WARNING ERROR LOG FATAL PANIC  <b>Default:</b> 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.	mast  sessi reloa supe
log_parser_stats	Boolean  <b>Default:</b> 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	mast  sessi reloa supe
log_planner_stats	Boolean  <b>Default:</b> 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 <i>log_statement_stats</i> .	mast  sessi reloa supe
log_rotation_age	Any valid time expression (number and unit)  <b>Default:</b> 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.	mast  sessi resta
log_rotation_size	number of kilobytes	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.	mast  sessi resta
log_statement	NONE  DDL MOD 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	mast  sessi reloa supe

Parameter	Value Range	Description	Set Clas
	<b>Default:</b> ALL	FROM. PREPARE and EXPLAIN ANALYZE statements are also logged if their contained command is of an appropriate type.	
log_statement_stats	Boolean <b>Default:</b> 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.	mast sessi reloa supe
log_timezone	string	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 syste resta
log_truncate_on_rotation	Boolean <b>Default:</b> 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 syste resta
max_appendonly_tables	2048 <b>Default:</b> 2048	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.	mast sessi resta
max_connections	10-n <b>Default:</b> 250 on master 750 on segment	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 syste resta
	Integer		

Parameter	Value Range	Description	Set Class
max_files_per_process	<b>Default:</b> 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 <b>Default:</b> 20000	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 <b>Default:</b> 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 <b>Default:</b> 100	Reports the maximum number of function arguments.	read
max_identifier_length	Integer <b>Default:</b> 63	Reports the maximum identifier length.	read
max_locks_per_transaction	Integer <b>Default:</b> 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	Sets the maximum number of transactions that can be in the prepared state simultaneously. HAWQ uses prepared transactions internally to	local system restart

Parameter	Value Range	Description	Set Clas
	<b>Default:</b> 250 on master 250 on segments	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.	
max_resource _portals_per _transaction	Integer  <b>Default:</b> 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.	mast syste resta
max_resource_queues	Integer  <b>Default:</b> 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	mast syste resta
max_stack_depth	number of kilobytes  <b>Default:</b> 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 syste resta
max_statement_mem	number of kilobytes  <b>Default:</b> 200MB	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 memoryusage. Taking into account the configuration of a single segment host, calculate this setting as follows:(segghost_physical_memory)/(average_number_concurrent_queries)	mast sessi reloa supe
optimizer_log	Boolean  <b>Default:</b> 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 "About Query Processing"	



Parameter	Value Range	Description	Set Clas
optimizer_minidump	ONERROR/ALWAYS  <b>Default:</b> ONERROR	<p>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.</p> <p>The minidump file is located under the master data directory and uses the following naming format:</p> <p>Minidump_&lt;date&gt;_&lt;time&gt;.mpd</p> <p>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.</p>	
password_encryption		<p>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.</p>	
port	any valid port number  <b>Default:</b> 5432	<p>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</p>	local system restart

Parameter	Value Range	Description	Set Clas
		numbers.	
random_page_cost	floating point <b>Default:</b> 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.	most sessi reloa
regex_flavor	advanced extended basic <b>Default:</b> advanced	The 'extended' setting may be useful for exact backwards compatibility with pre-7.4 releases of PostgreSQL.	most sessi reloa
resource_cleanup_gangs _on_wait	Boolean <b>Default:</b> 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.	most sessi resta
resource_select_only	Boolean <b>Default:</b> 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.	most sessi reloa
search_path	a comma-separated list of schema names <b>Default:</b> \$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, <i>pg_catalog</i> , 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 <i>current_schemas()</i> . <i>current_schemas()</i> shows how the requests appearing in <i>search_path</i> were resolved.	most sessi reloa
seq_page_cost	floating point <b>Default:</b> 1		

Parameter	Value Range	Description	Set Class
		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> <b>Default:</b> 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 <i>client_encoding</i> .	read
server_ticket_renew_interval	Integer <b>Default:</b> 43200000	Set the kerberos ticket renew interval in milliseconds	master system restart
server_version	String <b>Default:</b> 8.12.15	Reports the version of PostgreSQL that this release of HAWQ is based on.	read
server_version_num	Integer <b>Default:</b> 80215	Reports the version of PostgreSQL that this release of HAWQ is based on as an integer.	read
shared_buffers	integer > 16K * max_connections <b>Default:</b> 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 pgsq, 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.	master system restart
ssl	Boolean <b>Default:</b> off	Enables SSL connections.	master system restart
ssl_ciphers	string <b>Default:</b> 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.	read

Parameter	Value Range	Description	Set Class
standard_conforming_strings	Boolean <b>Default:</b> off	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.	
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 <b>Default:</b> 0	Abort any statement that takes over the specified number of milliseconds. 0 turns off the limitation.	master session reload
stats_queue_level	Boolean <b>Default:</b> off	Collects resource queue statistics on database activity.	local system restart
superuser_reserved_connections	integer < max_connections <b>Default:</b> 3	Determines the number of connection slots that are reserved for HAWQ superusers.	local system restart
tcp_keepalives_count	number of keepalives <b>Default:</b> 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.	local system restart

Parameter	Value Range	Description	Set Class
		Use <code>gp_filerep_tcp_keepalives_count</code> for settings that are between a primary and mirror segment.	
<code>tcp_keepalives_idle</code>	number of seconds  <b>Default:</b> 0	Number of seconds between sending keepalives on an otherwise idle connection. A value of 0 uses the system default. If <code>TCP_KEEPI</code> is not supported, this parameter must be 0. Use this parameter for all connections that are not between a primary and mirror segment. Use <code>gp_filerep_tcp_keepalives_idle</code> for settings that are between a primary and mirror segment.	local system restart
<code>tcp_keepalives_interval</code>	number of seconds  <b>Default:</b> 0	How many seconds to wait for a response to a keepalive before retransmitting. A value of 0 uses the system default. If <code>TCP_KEEPI</code> is not supported, this parameter must be 0. Use this parameter for all connections that are not between a primary and mirror segment. Use <code>gp_filerep_tcp_keepalives_interval</code> for settings that are between a primary and mirror segment.	local system restart
<code>temp_buffers</code>	Integers  <b>Default:</b> 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
<code>TimeZone</code>	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	local system restart

Parameter	Value Range	Description	Set Clas
		Date/Time Keywords in the PostgreSQL documentation.	
timezone_abbreviations	string	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.	mast sessi reloa
track_activities	Boolean <b>Default:</b> 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 <i>pg_stat_activity</i> system view.	mast sessi reloa
track_counts	Boolean <b>Default:</b> 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 <i>pg_stat</i> and <i>pg_statio</i> family of system views.	local syste resta
transaction_isolation	read committed serializable	Sets the current transaction's isolation level.	mast syste reloa
transaction_read_only	Boolean <b>Default:</b> off	Sets the current transaction's read-only status.	mast sessi reloa
transform_null_equals	Boolean <b>Default:</b> off	When on, expressions of the form <i>expr</i> = NULL (or NULL = <i>expr</i> ) are treated as <i>expr</i> IS NULL, that is, they return true if <i>expr</i> evaluates to the null value, and false otherwise. The correct SQL-spec-compliant behavior of <i>expr</i> = NULL is to always return null (unknown).	mast sessi reloa
unix_socket_directory	directory path		

Parameter	Value Range	Description	Set Class
	<b>Default:</b> 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 <b>Default:</b> 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 <i>chmod</i> or <i>umask</i> commands) <b>Default:</b> 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 <b>Default:</b> 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 <i>ps</i> command.	local system restart
vacuum_cost_delay	milliseconds < 0 (in multiples of 10) <b>Default:</b> 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 <b>Default:</b> 200	The accumulated cost that will cause the vacuuming process to sleep.	local system restart
vacuum_cost_page_dirty	Integer > 0 <b>Default:</b> 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 <b>Default:</b> 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
vacuum_cost_page_miss	Integer > 0 <b>Default:</b> 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	local system restart

Parameter	Value Range	Description	Set Clas
		scan its content.	
vacuum_freeze_min_age	Integer  0-1000000000000  <b>Default:</b> 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 syste resta



## 11 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.

### 11.1 Required Environment Variables

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**Note:** GPHOME, PATH and LD\_LIBRARY\_PATH can be set by sourcing the greenplum\_path.sh file from your HAWQ installation directory.

#### 11.1.1 GPHOME

This is the installed location of your HAWQ software. For example:

```
GPHOME=/usr/local/greenplum-db-4.1.x.x
export GPHOME
```

#### 11.1.2 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=$GPHOME/bin:/usr/local/bin:/usr/sbin:/usr/sfw/bin:/opt/sfw/bin:$PATH
export PATH
```

#### 11.1.3 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
```

#### 11.1.4 MASTER\_DATA\_DIRECTORY

This should point to the directory created by the `gpinitssystem` utility in the master data directory location. For example:

```
MASTER_DATA_DIRECTORY=/data/master/gpseg-1
export MASTER_DATA_DIRECTORY
```

## 11.2 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.

### 11.2.1 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.

### 11.2.2 PGDATABASE

The name of the default database to use when connecting.

### 11.2.3 PGHOST

The HAWQ master host name.

### 11.2.4 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.

### 11.2.5 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.

### 11.2.6 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.

## 11.2.7 PGOPTIONS

Sets additional configuration parameters for the HAWQ master server.

## 11.2.8 PGPORT

The port number of the HAWQ server on the master host. The default port is 5432.

## 11.2.9 PGUSER

The HAWQ user name used to connect.

## 11.2.10 PGDATESTYLE

Sets the default style of date/time representation for a session. (Equivalent to `SET datestyle TO....`)

## 11.2.11 PGTZ

Sets the default time zone for a session. (Equivalent to `SET timezone TO ....`)

## 11.2.12 PGCLIENTENCODING

Sets the default client character set encoding for a session. (Equivalent to `SET client_encoding TO....`)

## 12 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: HAWQ Built-in Data Types**

Name	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 + binarystring	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
				variable-length with limit

Name	Alias	Size	Range	Description
character varying [ (n) ]	varchar [ (n) ]	1 byte + binarystring	strings up to n characters in length	
cidr		12 or 24 bytes		IPv4 networks
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, inexact
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 path in the plane - not allowed in distribution key columns.
polygon		40+16n bytes	[(x1,y1),...]	closed geometric path in the plane - not allowed in the distribution key columns.
real	float4	4 bytes	6 decimal digits precision	variable-precision, inexact

Name	Alias	Size	Range	Description
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
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

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.

## 13 MADlib References

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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](http://doc.madlib.net/v0.5/group_grp_linreg.html)
- Logistic regression: [http://doc.madlib.net/v0.5/group\\_grp\\_logreg.html](http://doc.madlib.net/v0.5/group_grp_logreg.html)
- Multinomial Logistic regression: [http://doc.madlib.net/v0.5/group\\_grp\\_mlogreg.html](http://doc.madlib.net/v0.5/group_grp_mlogreg.html)
- Association rules: [http://doc.madlib.net/v0.5/group\\_grp\\_assoc\\_rules.html](http://doc.madlib.net/v0.5/group_grp_assoc_rules.html)
- K-means: [http://doc.madlib.net/v0.5/group\\_grp\\_kmeans.html](http://doc.madlib.net/v0.5/group_grp_kmeans.html)

## 14 hawq\_toolkit Reference

Pivotal provides an administrative schema called *hawq\_toolkit* that you can use to query the system catalogs, log files, and operating environment for system status information. The *hawq\_toolkit* schema contains a number of views that you can access using SQL commands. The *hawq\_toolkit* schema is accessible to all database users, although some objects may require superuser permissions. For convenience, you may want to add the *hawq\_toolkit* schema to your schema search path. For example:

```
=> ALTER ROLE myrole SET search_path TO my schema,hawq_toolkit;
```

This topic describes the HAWQ administrative schema views and their usages.

- Viewing HAWQ Database Server Log Files
- Checking for Tables that Require Routine Maintenance
- Checking Database Object Sizes and Disk Space

### 14.1 Viewing HAWQ Database Server Log Files

Each component of a HAWQ Database system (master, standby master and primary segments) keeps its own server log files. The *hawq\_log\_\** family of views allows you to issue SQL queries against the server log files to find particular entries of interest. The user of these views require superuser permissions.

#### 14.1.1 hawq\_log\_command\_timings

This view uses an external table to read the log files on the master and report the execution time of SQL commands executed in a database session. The user of this view requires superuser permissions.

Column	Description
logsession	The session identifier (prefixed with "con").
logcmdcount	The command number within a session (prefixed with "cmd").
logdatabase	The name of the database.
loguser	The name of the database user.
logpid	The process id (prefixed with "p").
logtimemin	The time of the first log message for this command.
logtimemax	The time of the last log message for this command.
logduration	Statement duration from start to end time.



## 14.1.2 hawq\_log\_database

This view uses an external table to read log files of the entire HAWQ system (master and segments) and lists log entries associated with the current database. Associated log entries can be identified by the session id (*logsession*) and command id (*logcmdcount*). The use of this view requires superuser permissions.

Column	Description
logtime	The timestamp of the log message.
loguser	The name of the database user.
logdatabase	The name of the database.
logpid	The associated process id (prefixed with "p").
logthread	The associated thread count (prefixed with "th").
loghost	The segment or master host name.
logport	The segment or master port.
logsessiontime	Time session connection was opened.
logtransaction	Global transaction id.
logsession	The session identifier (prefixed with "con").
logcmdcount	The command number with in a session (prefixed with "cmd").
logsegment	The segment content identifier (prefixed with "seg". The master always has a content id of -1).
logslice	The slice id (portion of the query plan being executed).
logdistxact	Distributed transaction id.
loglocalxact	Local transaction id.
logsubxact	Subtransaction id.
logseverity	LOG, ERROR, FATAL, PANIC, DEBUG1 or DEBUG2.
logstate	SQL state code associated with the log message.
logmessage	Log or error message text.
logdetail	Detail message test associated with an error message.
loghint	Hint message test associated with an error message.
logquery	The internally-generated query text.
logquerypos	The cursor index into the internally-generated query text.

Column	Description
logcontext	The context in which this message gets generated.
logdebug	Query string with full detail for debugging.
logcursorpos	The cursor index into the query string.
logfunction	The function in which this message is generated.
logfile	The log file in which this message is generated.
logline	The line in the log file in which this message is generated.
logstack	Full text of the stack trace associated with this message.

### 14.1.3 hawq\_log\_master\_concise

This view uses an external table to read a subset of the log fields from the master log files. The use of this view requires superuser permissions.

Column	Description
logtime	The timestamp of the log message.
logdatabase	The name of the database.
logsession	The session identifier (prefixed with "con").
logcmdcount	The command number within a session (prefixed with "cmd").
logseverity	LOG, ERROR, FATAL, PANIC, DEBUG1, DEBUG2.
logmessage	Log or error message text.

### 14.1.4 hawq\_log\_system

This view uses an external table to read the server log files of the entire HAWQ system (master and segments) and lists all log entries. Associated log entries can be identified by session id (*logsession*) and command id (*logcmdcount*). The use of this view requires superuser permissions.

Column	Description
logtime	The timestamp of the log message.
loguser	The name of the database user.
logdatabase	The name of the database.
logpid	The associated process id (prefixed with "p").

Column	Description
logthread	The associated thread count (prefixed with "th").
loghost	The segment or master host name.
logport	The segment or master port.
logsessiontime	Time session connection was opened.
logtransaction	Global transaction id.
logsession	The session identifier (prefixed with "con").
logcmdcount	The command number with in a session (prefixed with "cmd").
logsegment	The segment content identifier (prefixed with "seg". The master always has a content id of -1).
logslice	The slice id (portion of the query plan being executed).
logdistxact	Distributed transaction id.
loglocalxact	Local transaction id.
logsubxact	Subtransaction id.
logseverity	LOG, ERROR, FATAL, PANIC, DEBUG1 or DEBUG2.
logstate	SQL state code associated with the log message.
logmessage	Log or error message text.
logdetail	Detail message test associated with an error message.
loghint	Hint message test associated with an error message.
logquery	The internally-generated query text.
logquerypos	The cursor index into the internally-generated query text.
logcontext	The context in which this message gets generated.
logdebug	Query string with full detail for debugging.
logcursorpos	The cursor index into the query string.
logfunction	The function in which this message is generated.
logfile	The log file in which this message is generated.
logline	The line in the log file in which this message is generated.
logstack	Full text of the stack trace associated with this message.

## 14.2 Checking for Tables that Require Routine Maintenance

### 14.2.1 hawq\_stats\_missing

This view shows tables that do not have statistics and therefore may require an ANALYZE be run on the table.

Column	Description
smischema	The schema name.
smitable	The table name.
smisize	Does this table have statistics? False if the table does not have row count and row sizing statistics recorded  in the system catalog, which may indicated that the tables needs to be analyzed. This will also be false if the  table does not contain any rows. For example, parent tables of partitioned tables are always empty and will  always return a false result.
smicols	The number of columns in the table.
smirecs	The number of rows in the table.

## 14.3 Checking Database Object Sizes and Disk Space

### 14.3.1 hawq\_size\_of\_table\_disk

This view shows the size of a table on disk. This view is accessible to all users, however non-superusers will only be able to see tables that they have permissions to access.

Column	Description
sotdoid	The object ID of the table.
sotdsize	The total size of the table in bytes (main relation, plus oversized (toast) attributes, plus additional storage objects  for AO tables.
sotdtoastsize	The size of the TOAST table (oversized attribute storage), if there is one.

Column	Description
sotdadditionalsize	Reflects the segment and block directory table sizes for append-only (AO) tables.
sotdschemaname	The schema name.
sotdtablename	The table name.

### 14.3.2 hawq\_size\_of\_table\_uncompressed

This view shows the uncompressed table size for append-only (AO) tables. Otherwise, the table size on disk is shown. The use of this view requires superuser permissions.

Column	Description
sotuid	The object ID of the table.
sotusize	The uncompressed size of the table in bytes if it is a compressed AO table. Otherwise, the table size on disk.
sotuschemaname	The schema name.
sotutablename	The table name.

### 14.3.3 hawq\_size\_of\_table\_and\_indexes\_disk

This view shows the size on disk of tables and their indexes. This view is accessible to all users, however non-superusers will only be able to see relations that they have permissions to access.

Column	Description
sotaidoid	The object ID of the parent table.
sotaidtablesize	The disk size of the table.
sotaididsize	The total size of all indexes on the table.
sotaid schemaname	The name of the schema.
sotaidtablename	The name of the table.

### 14.3.4 hawq\_size\_of\_schema\_disk

This view shows schema sizes for the schemas in the current database. This view is accessible to all users, however non-superusers will only be able to see schemas that they have permissions to access.

Column	Description
sosdnsp	The name of the schema.
sodschematablesize	The total size of tables in the schema in bytes.
sodschemaidxsize	The total size of indexes in the schema in bytes.

### 14.3.5 hawq\_size\_of\_table\_and\_indexes\_licensing

This view shows the total size of tables and their indexes for licensing purposes. The use of this view requires superuser permissions.

Column	Description
sotailoid	The object ID of the table.
sotailtablesizedisk	The total disk size of the table.
sotailtablesizeuncompressed	If the table is a compressed append-only table, shows the uncompressed table size in bytes.
sotailindexessize	The total size of all indexes in the table.
sotailschemaname	The schema name.
sotailtablename	The table name.

### 14.3.6 hawq\_size\_of\_database

This view shows the total size of a database. This view is accessible to all users, however non-superusers will only be able to see databases that they have permissions to access.

Note: In HAWQ, the data of a database consists of data stored in the local storage of the master, and data stored in HDFS. When the HDFS is online, the sodddatsize includes the sizes of both two kinds of data; while the HDFS is offline, the sodddatsize only includes the size of data stored in the local storage of the master.

Column	Description
sodddatname	The name of the database.
sodddatsize	The size of the database in bytes.