Vertica® Analytic Database 5.0

New Features

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Contents

Vertica® Analytic Database 5.0 4

Advanced Analytics and Other SQL 4

Event Series Pattern Matching 4
Event Series Joins 5
Subquery Enhancements 5
New SQL Functions 5
Vertica Geospatial Package 8
New System Tables 8
New Keywords and Reserved Words 9
Comments On Objects 11
LIKEB/ILIKEB Predicates Supported for Single-row Subqueries 11

Custom In-database Analytical Processing 11

User-Defined Functions 12

Manageability and Ease-of-Use 12

Improved Maintenance of Statistics Collection 12
New Database Backup and Copy Utility 13
Workload Analyzer 13
Database Designer Enhancements 14
Roles Support 14
FOREIGN_KEY Constraint Changes 15
New Import and Export Feature 15
Cluster Elasticity 15
Large Cluster Support 16

Performance Improvements 17

Networked Joins 17
Subquery WHERE Clause Predicates 17
Query Plan Quality Improvements 17
Optimizer Improvements 17
Tuple Mover Operations on Replicated Tables 18
LIKE and Regular Expressions Performance Improvements 18
Adding and Removing Node Improvements 18

Behavior Changes 19

Error Messages Improvements 19
EXPLAIN Plans Correlated with Error Messages 19
System Table Updates 20
Timezone Abbreviation Override 20

Administration Tools Metadata Enhancements 22
GROUP BY HASH Sorting Changes 22
Modified Functions 23
Direct Hints Take Optional Spaces 23
Tuple Mover Changes 24
Node Failure Change 24
Conversion from Floating Point to Numeric Data Types Now Rounds 25
Database Size Auditing and License File Changes 25
Prejoin Projection Between Base and Temp Tables Not Allowed 25
DROP TABLE Optional IF EXISTS Argument 26
CREATE VIEW Optional OR REPLACE Argument 26
CREATE TABLE and CREATE PROJECTION New IF NOT EXISTS Argument 26
Quarter Support for INTERVAL Qualifier 26

Deprecated Components **28**

Documentation Updates and Clarification **29**

Packages, Platforms, and Support **30**

Supported Platforms 31
Server Download Package 32
Client Download Package 32
Software Compatibility 33
Version Compatibility and Upgrade Path 34
Installation and Upgrades 35
Technical Support 36

Index **37**

Copyright Notice **39**

Vertica® Analytic Database 5.0

Vertica, An HP Company is pleased to announce the general availability of the Vertica® Analytic Database Release 5.0.

This release includes enhancements on reliability, performance, scalability, and manageability, delivering a more comprehensive and improved out-of-the-box experience. Most of the features implemented in this release are a result of your feedback. We hope you have a great experience with the product and welcome your continued input.

The topics in this book describe important information about this release that you should review before you install or upgrade the product.

IMPORTANT: For a list of customer-reported resolved and known issues, see the Release Notes on the ***Vertica Downloads Page http://myvertica.vertica.com/v-zone/download_vertica***.

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Product and Version

Vertica® Analytic Database 5.0

Media

The Vertica software and documentation are available for download (with registration) on the ***Vertica Downloads Page http://myvertica.vertica.com/v-zone/download_vertica***. To obtain these materials on DVD, contact ***Technical Support*** (page 36).

Advanced Analytics and Other SQL

Event Series Pattern Matching

Vertica introduces a new feature for advanced event series analytics. You can now screen large amounts of historical data in search of event patterns (specified as a regular expression) by applying complex pattern matching on a sequence of input events. You specify pattern match criteria using the new SQL MATCH clause, which is fully described in the SQL Reference Manual.

Used with the MATCH clause, new Vertica pattern matching functions return additional data about the patterns found. For example, these functions return values representing the name of the event that matched the input row, the sequential number of the match, or a partition-wide unique identifier for the instance of the pattern that matched.

There are also two new configuration parameters, PatternMatchingMaxPartition and PatternMatchingMaxPartitionMatches, which allow you to increase the number of rows per partition and matches per partition, respectively. See Pattern Matching Partition Parameters in the Administrator's Guide.

See Also

Event Series Pattern Matching in the Programmer's Guide

Event Series Joins

The event series join is a Vertica SQL extension that lets you analyze two event series when their measurement intervals don't align precisely—such as when timestamps don't match. These joins provide a natural and efficient way to query misaligned event data directly, rather than having to normalize the series to the same measurement interval.

Event series joins are denoted by a new INTERPOLATE predicate that you use within ANSI join syntax. See INTERPOLATE in the SQL Reference Manual.

See also Event Series Joins in the Programmer's Guide for examples.

Subquery Enhancements

Vertica extends support to a larger class of subqueries in the following areas:

- In the SELECT list, including in ORDER BY and GROUP BY clauses.
- In expressions with ANY and ALL comparison predicates.
- On multiple subqueries within complex expressions, for example connected by the logical operator OR.
- On multicolumn NOT IN subqueries in which the columns are not marked NOT NULL.

  Note: Previously, marking the columns NOT NULL was a requirement. In this release, if one of the columns is found to contain a NULL value during query execution, Vertica returns a run-time error.
- In the SET list of UPDATE.

Also in this release, WHERE clause predicates from the containing query are pushed into a subquery or view. This predicate pushdown filters data earlier during query execution, which can improve query performance.

See Subqueries in the Programmer's Guide.

New SQL Functions

The following functions are new in Vertica 5.0. See the SQL Reference Manual for details. See also ***Modified functions*** (page 23) in this guide.

Date/Time Functions

- DATE—Converts a TIMESTAMP, TIMESTAMPTZ, DATE, or VARCHAR to a DATE. You can also use this function to convert an INTEGER to a DATE.
- DAY—Extracts the day of the month from a TIMESTAMP, TIMESTAMPTZ, INTEGER, VARCHAR or INTERVAL input value.
- DAYOFMONTH—Returns an integer representing the day of the month based on a VARCHAR, DATE, TIMESTAMP, OR TIMESTAMPTZ input value.
- DAYOFWEEK—Returns an INTEGER representing the day of the week based on a TIMESTAMP, TIMESTAMPTZ, VARCHAR, or DATE input value.
- DAYOFWEEK_ISO—Returns an INTEGER representing the ISO 8061 day of the week based on a VARCHAR, DATE, TIMESTAMP or TIMESTAMPTZ input value.
- DAYOFYEAR—Returns an INTEGER representing the day of the year based on a TIMESTAMP, TIMESTAMPTZ , VARCHAR, or DATE input value.
- DAYS—Converts a DATE, VARCHAR, TIMESTAMP, or TIMESTAMPTZ to an INTEGER, reflecting the number of days after 0001 AD.
- HOUR—Extracts the hour from a DATE, TIMESTAMP, TIMESTAMPTZ, VARCHAR, or INTERVAL value. The return value is of type INTEGER.
- JULIAN_DAY—Returns an INTEGER representing the Julian day based on an input TIMESTAMP, TIMESTAMPTZ, VARCHAR, or DATE value.
- MICROSECOND—Returns an INTEGER representing the microsecond portion of an input DATE, VARCHAR, TIMESTAMP, TIMESTAMPTZ, or INTERVAL value.
- MIDNIGHT_SECONDS—Returns an INTEGER representing the number of seconds between midnight and the input value.
- MINUTE—Returns an INTEGER representing the minute value of the input value.
- MONTH—Returns an INTEGER representing the month portion of the input value.
- NEXT_DAY—Returns the date of the first instance of a particular day of the week that follows the specified date.
- QUARTER—Returns an INTEGER representing calendar quarter into which the input value falls.
- ROUND [Date/Time]—Rounds a TIMESTAMP, TIMESTAMPTZ, or DATE.
- SECOND—Returns an INTEGER representing the second portion of the input value.
- TIMESTAMP_ROUND— Rounds a TIMESTAMP to a specified *format*.
- TIMESTAMP_TRUNC— Truncates a TIMESTAMP.
- TIMESTAMPADD—Adds a specified number of intervals to a TIMESTAMP or TIMESTAMPTZ.
- TIMESTAMPDIFF—Returns the difference between two TIMESTAMP or TIMESTAMPTZ values, based on the specified start and end arguments.
- TRUNC [Date/Time]— Truncates a TIMESTAMP, TIMESTAMPTZ, or DATE.
- WEEK— Returns an INTEGER representing the week of the year into which the input value falls.
- WEEK_ISO— Returns an INTEGER from 1 - 53 representing the week of the year into which the input value falls.
- YEAR—Returns an INTEGER representing the year portion of the input value.

- YEAR_ISO—Returns an INTEGER representing the year portion of the input value.

Encoding and Decoding Functions

- URI_PERCENT_DECODE—Decodes a percent-encoded Universal Resource Identifier (URI) according to the RFC 3986 standard.
- URI_PERCENT_ENCODE—Encodes a Universal Resource Identifier (URI) according to the RFC 3986 standard for percent encoding.

NULL-handling Functions

- IFNULL—Returns the value of the first non-null expression in the list.
- NULLIFZERO—Evaluates to NULL if the value in the column is 0.
- ZEROIFNULL—Evaluates to 0 if the column is NULL.

Statistic and Workload Management Functions

- ANALYZE_HISTOGRAM()—Lets you trade off accuracy of sampling over speed during histogram collection by setting a percent parameter, which determines what fraction of data to read from disk. See also ***Improved Statistics Collection*** (page 12) in this guide.
- ANALYZE_WORKLOAD()—Runs the Workload Analyzer, which analyzes the workload history and identifies underperforming queries and their root causes, returning recommendations upon which the DBA can act.

Mathematical Functions

- DISTANCE()— Returns the distance (in kilometers) between two points.
- DISTANCEV()—Returns the distance (in kilometers) between two points using the Vincenty formula.

Statistical and Linear Regression Functions

Vertica continues to extend the list of advanced aggregate and analytic functions natively supported by the parallel execution engine. Vertica 5.0 adds support for aggregate statistical / regression functions per SQL-2008:

- CORR—Returns the coefficient of correlation of a set of expression pairs (*expression1* and *expression2*).
- COVAR_POP—Returns the population covariance for a set of expression pairs (*expression1* and *expression2*).
- COVAR_SAMP—Returns the sample covariance for a set of expression pairs (*expression1* and *expression2*).
- REGR_AVGX—Returns the average of the independent expression in an expression pair (*expression1* and *expression2*).
- REGR_AVGY—Returns the average of the dependent expression in an expression pair (*expression1* and *expression2*).
- REGR_COUNT—Returns the number of expression pairs (*expression1* and *expression2*).
- REGR_INTERCEPT—Returns the y-intercept of the regression line determined by a set of expression pairs (*expression1* and *expression2*).
- REGR_R2—Returns the square of the correlation coefficient of a set of expression pairs (*expression1* and *expression2*).

- REGR_SLOPE—Returns the slope of the regression line, determined by a set of expression pairs (*expression1* and *expression2*).
- REGR_SXX—Returns the sum of squares of the independent expression in an expression pair (*expression1* and *expression2*).
- REGR_SXY—Returns the sum of products of the independent expression multiplied by the dependent expression in an expression pair (*expression1* and *expression2*).
- REGR_SYY—Returns the sum of squares of the dependent expression in an expression pair (*expression1* and *expression2*).

String Functions

- CONCAT—Used to concatenate two or more VARBINARY strings.
- INSERT—Inserts a character string into a specified location in another character string.
- SPACE—Inserts blank spaces into a specified location within a character string.

Vertica-specific Functions

- Data Collector Functions (see also ***Workload Analyzer*** (page 13) in this guide)
  - GET_DATA_COLLECTOR_POLICY — retrieves a brief statement about the retention policy of the specified component.
  - SET_DATA_COLLECTOR_POLICY — sets the retention policy for the specified component on all nodes. Failed nodes receive the setting when they rejoin the cluster
- Pattern Matching Functions (see also ***Event Series Pattern Matching*** (page 4) in this guide)
  - EVENT_NAME() – returns a VARCHAR value representing the name of event that matched the row
  - MATCH_ID() – returns an INTEGER value that is the sequential number of the match
  - PATTERN_ID() – returns an INTEGER value that is a partition-wide unique identifier for the instance of the pattern that matched

Vertica Geospatial Package

The Vertica Geospatial package contains a suite of geospatial SQL functions you can install to report on and analyze geographic location data. The Vertica Geospatial Package is optional and so the geospatial functions included in the package are not automatically installed when you install Vertica. Instead, all of the files you need if you want to install the file will be placed here:

```
/opt/vertica/packages/geospatial
```

Complete details on how to install and use the Geospatial Package appear in the SQL Reference Manual.

New System Tables

The following system tables are new in Vertica 5.0.

CATALOG schema

- V_CATALOG.COMMENTS contains information about comments added to objects in the database.
- V_CATALOG.DATABASES contains information about the databases hosted on the cluster.
- V_CATALOG.LICENSE_AUDITS contains the results of Vertica's automatic license compliance audits.
- V_CATALOG.ROLES contains information on all the roles that the user session can access.
- V_CATALOG.USER_AUDITS contains the results of user-initiated audits of database object size.
- V_CATALOG.USER_TRANSFORMS lists the User Defined Transform Functions (UDTF) that are currently defined in the catalog.

MONITOR schema

- V_MONITOR.CRITICAL_NODES lists the nodes whose failure would result in a database shutdown.
- V_MONITOR.DATA_COLLECTOR lists all supported and enabled data collection components.
- V_MONITOR.DATABASE_CONNECTIONS lists the connections to other Vertica used for importing and exporting data.
- V_MONITOR.NODES lists the nodes in the database cluster, along with their state.
- V_MONITOR.TUNING_RECOMMENDATIONS returns the tuning recommendation results from the last ANALYZE_WORKLOAD() call and lets users build filters on the Workload Analyzer result set.
- V_MONITOR.USER_LIBRARIES lists the currently-loaded user libraries.
- V_MONITOR.USER_LIBRARY_MANIFEST lists the User Defined Functions (UDFs) contained in currently-loaded user libraries.

See the SQL Reference Manual for details.

See Also

System Table Updates (page 20) in this guide.

New Keywords and Reserved Words

The following keywords and reserved keywords are new in this release. For a comprehensive list, see Keywords and Reserved Words in the SQL Reference Manual.

New Keywords

- ACTION
- ADMIN
- AVAILABLE
- CONNECT
- DEFINE
- DIRECTPROJ
- DISABLE

- DISCONNECT
- ENABLE
- ENABLED
- EPHEMERAL
- EVENT
- EVENTS
- EXPIRE
- EXPORT
- FAILED_LOGIN_ATTEMPTS
- HOSTNAME
- IDENTIFIED
- IF
- INTERPOLATE
- LIBRARY
- MATCH (also a reserved keyword)
- PASSWORD_GRACE_TIME
- PASSWORD_LIFE_TIME
- PASSWORD_LOCK_TIME
- PASSWORD_MAX_LENGTH
- PASSWORD_MIN_DIGITS
- PASSWORD_MIN_LENGTH
- PASSWORD_MIN_LETTERS
- PASSWORD_MIN_LOWERCASE_LETTERS
- PASSWORD_MIN_SYMBOLS
- PASSWORD_MIN_UPPERCASE_LETTERS
- PASSWORD_REUSE_MAX
- PASSWORD_REUSE_TIME
- PATTERN
- PERCENT
- PERMANENT
- PREVIOUS
- RESULTS
- ROLE
- ROLES
- TIMESTAMPADD
- TIMESTAMPDIFF
- TRANSFORM
- TUNING
- UNCOMPRESSED
- UNLIMITED (also a reserved keyword)

- UNLOCK
- VALUE
- VERTICA
- WAIT

New Reserved Keywords

- MATCH
- UNLIMITED

Comments On Objects

You can now add comments to objects in the database using the following new SQL statements:

- COMMENT ON COLUMN
- COMMENT ON CONSTRAINT
- COMMENT ON FUNCTION
- COMMENT ON LIBRARY
- COMMENT ON NODE
- COMMENT ON PROJECTION
- COMMENT ON SCHEMA
- COMMENT ON SEQUENCE
- COMMENT ON TABLE
- COMMENT ON VIEW

Comments are stored in the V_CATALOG.COMMENTS system table.

LIKEB/ILIKEB Predicates Supported for Single-row Subqueries

Vertica extends support for single-row subqueries as the pattern argument for LIKEB and ILIKEB.

Example:

```
SELECT * FROM t1 WHERE t1.x LIKEB (SELECT MAX (t2.a) FROM t2);
```

Custom In-database Analytical Processing

Vertica opens access to in-database processing by offering a robust development framework to customers, partners, and solution providers seeking to integrate custom analytics inside a Vertica database for the ultimate performance benefits.

User-Defined Functions

Vertica now supports User-Defined Functions (UDFs). You develop these functions in C++, and compile them into a library that Vertica loads and runs within its own process. The performance of UDFs are almost as fast as Vertica's own functions, making well-suited for analytic operations that are difficult to perform in SQL, and need to be performed frequently enough that their speed is a major concern.

See Developing and Using User Defined Functions in the Programmer's Guide for more information.

Manageability and Ease-of-Use

Improved Maintenance of Statistics Collection

To improve the accuracy of statistics and facilitate better query planning, Vertica implements enhanced statistic collection, enabling administrators to maintain regularly updated database statistics that make heavier use of row counts, data pages, histograms, and minimum/maximum values of each column.

The following list provides a high-level summary of the improvements and extensions. Follow the links for details.

- ANALYZE_HISTOGRAM() is a new function that lets administrators choose between sampling accuracy over speed during histogram collection. When you invoke the function, you can include a percent parameter, which determines what fraction of data to read from disk.
- The ANALYZE_STATISTICS() function has been extended and improved in several areas:
  - Lets you analyze tables on a per-column basis for improved performance.
  - Performs faster data sampling, which expedites the analysis of relatively small tables with a large number of columns.
  - Includes data from WOS.
  - Recognizes deleted data, instead of ignoring delete markers.
  - Requires less memory to execute.
  - Lets you cancel the function mid analysis by issuing CTRL-C on vsql or invoking the INTERRUPT_STATEMENT() function.
  - Records the last time statistics were run for a table so that subsequent calls to the function can be optimized. See V_CATALOG.PROJECTION_COLUMNS for details.
- The optimizer can now detect stale or missing statistics. When the optimizer determines that statistics are not current for a particular predicate, Vertica plans those queries using other considerations, such as FK-PK constraints, when available.
- EXPLAIN plans are now annotated with a statistics status; for example, when the histograms are out of date or not available at all. See Reacting to Stale Statistics in the Administrator's Guide.
- DROP_STATISTICS() syntax has been modified to take a new argument called `TYPE`, which lets you drop the following types of statistics:

- `BASE` — drops histograms and row counts (min/max column values, histogram, etc.), leaving extended statistics intact
- `HISTOGRAMS` — drops only the histograms, leaving row counts and extended statistics.
- `EXTENDED` — drops soft unique keys, leaving histograms and row counts.
- `ALL` — drops all types of statistics.

See Also

ANALYZE_HISTOGRAM, ANALYZE_STATISTICS(), DROP_STATISTICS() and V_CATALOG.PROJECTION_COLUMNS in the SQL Reference Manual

Collecting Statistics in the Administrator's Guide

New Database Backup and Copy Utility

Vertica Version 5.0 includes a new backup utility named `vbr.py`. that can back up, restore, and copy the data in your database to another Vertica cluster. This script performs backup faster than the previous versions. It also uses a configuration file, making it easier to configure unattended backups using task schedulers. See Backing Up, Restoring, and Copying the Database in the Administrator's Guide for more information.

Note: The new backup utility does perform incremental backups (just the data that is new or altered since the previous backup is copied to the backup directory). However, you can only restore to the most recently backed up database state. You cannot restore the database to any earlier backed up version. If you need the ability to restore from any previously backed up database state, you should use the older backup scripts which are still supplied with Vertica. See Legacy Backup Procedures in the Administrator's Guide for more information.

Workload Analyzer

The new Workload Analyzer is an advisor tool that intelligently monitors the performance of SQL queries and workloads and recommends tuning actions based on observations of the actual workload history.

Workload Analyzer identifies opportunities for performance improvements and communicates with users in plain English. These recommendations make it easy to tune query performance without a need for sophisticated skills on the part of the database administrator.

You run the Workload Analyzer using the ANALYZE_WORKLOAD() function. You can also query a new system table, V.MONITOR_TUNING_RECOMMENDATIONS, which returns the tuning recommendation results from the last ANALYZE_WORKLOAD() call. See the SQL Reference Manual for details.

Note: The Workload Analyzer is powered by an internal diagnostics utility, called the Data Collector, which collects and retains history of important system activities. Data Collector is on by default, but database administrators can disable it, under Technical Support guidance, if they notice performance issues. A new system table, V_MONITOR.DATA_COLLECTOR provides useful access to performance and resource utilization counters. See the SQL Reference Manual for details.

Database Designer Enhancements

The Vertica 5.0 Database Designer engine now runs faster and has been enhanced in the following areas:

- Recommends buddy projections with the same sort order, which can significantly improve load, recovery, and site node performance.

  Note: If you manually created projections, the Database Designer recommends a buddy with the same sort order, if one does not already exist. By default, the Database Designer recommends both super and non-super segmented projection with a buddy of the same sort order.
- Automatically rebalances data after you add nodes to or remove a node from your Vertica cluster.
- Accepts queries longer than 65K characters as design input.
- Runs the design and deployment processes in the background. This is useful if you have a large design that you want to run overnight. Because an active SSH session is no longer required, the design/deploy operations continue to run uninterrupted, even if the session is terminated. Next time you run the Administration Tools, a message indicates that a design is either running or has completed.

  To stop a design, use CTRL + C at the command line.
- Accepts up to 100 queries in the query input file for a query-specific design. Previously, anything below the first query in the queries file was silently ignored.
- Accepts any number of queries during a comprehensive design.
- Produces higher quality designs by considering UPDATE and DELETE statements.

The Database Designer Memory Allocation

In previous releases, Vertica reserved a set amount of memory for the Database Designer so that it could generate an optimal design. Occasionally, the system had less memory than it required, such as on a virtual machine, and the design would fail.

Now, instead of reserving all the memory up front, the Database Designer reserves memory resource incrementally, as needed. If the system has less memory than it requires, the Database Designer prints a warning and generates a suboptimal design. It no longer fails to create a design.

Tip: If your design finishes with a warning, consider customizing projections manually. See Writing and Deploying Custom Projections in the Administrator's Guide.

Roles Support

Vertica now supports database roles that conform to the SQL 2008 specification (Feature T331, Basic Roles). Roles assist you in managing privileges in your database. Instead of assigning privileges to each user individually, you can assign privileges to a role, then grant users access to the role. All privileges you grant or access to the role automatically affect all the users that have access to the role.

In addition, there are several pre-defined roles that let you grant database administrator and superuser privileges to users.

See Roles in the Administrator's Guide for more details.

FOREIGN_KEY Constraint Changes

Columns with the FOREIGN_KEY constraint are no longer required to also have a NOT_NULL constraint. This change allows for cases where the foreign key may not be known when inserting a row into a fact table. Inserting a row with a null value in a foreign key column no longer results in an error.

Previously, if you created a FOREIGN_KEY constraint on a column without also adding a NOT_NULL constraint, Vertica would issue a warning and automatically add a NOT_NULL constraint to the column. This no longer occurs. If you want your column to have both FOREIGN_KEY and NOT_NULL constraints, you must explicitly add the NOT_NULL constraint.

Foreign key columns used in the join predicates of pre-join projections must have NOT_NULL constraint. If they do not, the CREATE PROJECTION command fails with an error message.

New Import and Export Feature

Vertica has a new statement named COPY FROM VERTICA that lets you import data from another Vertica database cluster. It also has a new EXPORT statement that lets you copy data to another Vertica database. See Importing and Exporting Data in the Administrator's Guide for more information.

Cluster Elasticity

Vertica has improved support for growing and shrinking database clusters. When rebalancing the database after adding or removing nodes, Vertica groups data into easily-transportable storage segments. Organizing the data in this manner makes the rebalancing process much faster.

In addition, the process of adding and removing nodes has been streamlined, eliminating the need to manually distribute configuration files. The add and remove node commands in the Administration Tool also automatically starts the rebalance process, so you do not have to manually do so.

If you plan to grow your cluster in the future, you can choose to enable local data segmentation, which divides stored data into segments that can be moved to other nodes easily. This segmentation further speeds up the process of adding or removing nodes, since Vertica does not have to perform the segmentation when the cluster is being rebalanced. The drawbacks to this method are slightly increased overhead for some database operations (especially inserts) and potential issues caused by highly segmented tables.

For more information, see Elastic Cluster Scaling in the Administrator's Guide.

Large Cluster Support

Vertica now provides support for clusters with more than 128 nodes. Vertica's cluster management subsystem has been tuned and field-validated to ensure efficient and reliable operations of large clusters with over 200 nodes.

If you want to implement a cluster with more than 128 nodes, contact Vertica ***Technical Support*** (page 36) for guidance.

Performance Improvements

This section describes performance improvements in Vertica 5.0.

Networked Joins

Joins execute more quickly when data inputs need to be broadcast or re-segmented across nodes because tables are not identically segmented on join keys.

Subquery WHERE Clause Predicates

In this release, WHERE clause predicates from the containing query are pushed into a subquery or view. This predicate pushdown filters data earlier during query execution, which can improve query performance.

Query Plan Quality Improvements

The Vertica optimizer has been enhanced in the following areas:

- The accuracy of the cost model has been improved.
- Specific cases that lead to suboptimal join orders or projection choice have been resolved.
- Run-time join filtering has been extended, resulting in even faster joins.
- The optimizer automatically detects stale or non-existent statistics and handles them appropriately. See ***Improved Maintenance of Statistic Collection*** (page 12) for details.
- The optimizer provides better information to the Database Designer, producing improved plans and join orders more quickly, which can significantly reduce the need for user intervention.
- The optimizer better handles subqueries that contain GROUP BY clauses, which are used as join keys in the containing query.

Optimizer Improvements

The following are some of the improvements made to the Vertica query optimizer in this release:

- Performance of GROUP BY queries on small number of groups, where the grouping keys are RLE columns, has been improved.
- The optimizer now makes better use of primary/unique constraints on tables, resulting in better plans for some join queries.

Tuple Mover Operations on Replicated Tables

Actions performed by the Tuple Mover on replicated tables are now performed in parallel across all nodes rather than synchronously.

LIKE and Regular Expressions Performance Improvements

The LIKE and LIKEB predicates and regular expressions functions (such as REGEXP_LIKE) now use expression analysis logic to potentially speed up processing. You should see improved performance in these features when:

- The columns are sorted
- The collation=binary are true for LIKE
- The pattern are constant
- The escape character or option field are a constant if present
- The pattern are case-sensitive
- The LIKE pattern do not start with a % or _

The REGEXP_ pattern starts with ^, followed by an ordinary character The results returned by these features are the same as before, just potentially faster.

Adding and Removing Node Improvements

Adding and removing nodes is now faster. See ***Cluster Elasticity*** (page 15) for details.

Behavior Changes

This section highlights behavior changes in Vertica 5.0.

Error Messages Improvements

New PATH ID Identifier

Error messages now include a PATH ID to help you identify issues in your queries. This can be especially useful in helping you identify which joins encountered a problem.

```
ERROR: Nonexistent foreign key value detected in FK-PK join
Hash-Join(public.fact x public.dim) using subquery and dim_p (PATH ID: 1);
value 15
ERROR: Join ((public.ask x public.bid) using ask_super and bid_super (PATH ID: 2))
inner partition did not fit in memory; value Null
```

This new ID also correlates the join error messages with EXPLAIN plans and profiling counters, as denoted by a new PATH_ID column in the V_MONITOR.EXECUTION_ENGINE_PROFILES system table.

See EXPLAIN and EXECUTION_ENGINE_PROFILES in the SQL Reference Manual for details.

Join Error Messages Contain Fully Qualified Names

Error messages that idenfity joins now contain the fully qualified table name (schema.table). For example:

Previous error message	New error message
`ERROR: Join inner did not fit in memory ((B x A) using B_sp and A_sp (PATH ID: 1))`	`ERROR: Join inner did not fit in memory ((public.B x public.A) using B_sp and A_sp (PATH ID: 1))`

Note: New error messages also include a new PATH ID number, which is described in ***EXPLAIN Plans Correlated with Error Messages*** (page 19).

EXPLAIN Plans Correlated with Error Messages

EXPLAIN plans are now annotated with a new **PATH ID** that correlates with errors messages and assists in query profiling. See EXPLAIN and EXECUTION_ENGINE_PROFILES in the SQL Reference Manual.

See Also

Correlating EXPLAIN Plan Output with Error Messages in the Troubleshooting Guide

System Table Updates

The following enhancements have been made to the monitoring APIs (system tables) in this release.

- V_CATALOG.PROJECTION_COLUMNS has two new columns with the primary goal of providing information about which table column has no statistics:
  - STATISTICS_TYPE—The type of statistics the column contains (NONE, ROWCOUNT, or FULL).
  - STATISTICS_COLLECTION_TIME—Returns the last time statistics were collected on the specified table.

  See also ***Improved Statistics Collection*** (page 12)
- V_MONITOR.EXECUTION_ENGINE_PROFILES has a new column, PATH_ID, which correlates EXPLAIN plans with profiling counters and join error messages.
- V_MONITOR.LOAD_STREAMS has the following new columns:
  - SESSION_ID—The identification of the session for which load streams information is captured. This identifier is unique within the cluster at any point in time but can be reused when the session closes.
  - TRANSACTION_ID—An identifier for the transaction within the session if any; otherwise NULL.
  - STATEMENT_ID— A unique numeric ID for the currently-running statement. NULL indicates that no statement is currently being processed.
  - SCHEMA_NAME—The schema name for which load stream information is listed.
- V_MONITOR.LOCKS has two new columns: REQUEST_TIMESTAMP and GRANT_TIMESTAMP, which return lock acquisition and grant times, respectively.
- In V_MONITOR.SESSIONS:
  - The STATEMENT_START column has changed from DATE to TIMESTAMP data type.
  - A LAST_STATEMENT column was added.

See Also

New System Tables (page 8)

SQL System Tables (Monitoring APIs) in the SQL Reference Manual

Timezone Abbreviation Override

If you set the timezone using POSIX format, the timezone abbreviation you use now overrides the default timezone abbreviation. If the DATESTYLE is set to POSTGRES, the timezone abbreviation you use is also used when outputting a timestamp.

```
=> SET TIME ZONE 'cst-8'; -- Asia/Shanghai
SET
=> SELECT TIMESTAMPTZ '2010-07-15 15:46 cst';
        ?column?
-----------------------
```

```
 2010-07-15 15:46:00+08
(1 row)

=> SET DATESTYLE TO postgres;
SET
=> SELECT TIMESTAMPTZ '2010-07-15 15:46 +08';
           ?column?
------------------------------
 Thu Jul 15 15:46:00 2010 CST
(1 row)
```

In the final output, CST stands for China Standard Time, not Central Standard Time, since the timezone was set to CST-8.

Administration Tools Metadata Enhancements

The Administration Tools configuration data (metadata) contains information that defined databases need to start, including the hostname/IP address of each host in the cluster. In previous releases, there was no simple way to resolve hostnames inside the Administration Tools, on the command line, and inside the installation utility.

Vertica 5.0 resolves this issue by enforcing all hostnames you provide via the Administration Tools to use IP addresses. For example:

- **During installation.**

  Vertica immediately converts any hostname you provide via command line options `-s`, `-A` or `-R` to its IP address equivalent.
  - If you provide a hostname during installation that resolves to multiple IP addresses (as in multi-homed systems), the installer prompts you to choose one IP address.
  - Vertica retains the name you give for messages and prompts only; internally it stores these hostnames as IP addresses.
- **Within the Administration Tools.**

  All hosts are in IP form to allow for direct comparisons (for example db = database = database.verticacorp.com).
- **At the command line.**

  Vertica converts any hostname value to an IP address that it uses to look up the host in the configuration metadata. If a host has multiple IP addresses that are resolved, Vertica tests each IP address to see if it resides in the metadata, choosing the first match. No match indicates that the host is not part of the database cluster.

Metadata is more portable because Vertica does not require the names of the hosts in the cluster to be exactly the same when you install or upgrade your database.

GROUP BY HASH Sorting Changes

Queries that have a GROUP BY expression are not guaranteed to produce values that are sorted according to the GROUP BY columns, such as in the following query:

```
=> SELECT x, y FROM t1 GROUP BY x, y;
```

In versions 4.0 and earlier, Vertica output the results sorted on x, y even though the SQL standard did not require this behavior.

For versions after 4.0, Vertica no longer necessarily produces sorted values unless the query explicitly specifies it. For example, if you want the output to be sorted a specific way, include the ORDER BY clause in the query:

```
=> SELECT x, y FROM t1 GROUP BY x, y ORDER BY x, y;
```

There is no additional performance cost for sorting this way, compared to previous versions.

Modified Functions

The following functions have been enhanced in Vertica 5.0. See the SQL Reference Manual for details.

- ANALYZE_STATISTICS() has been improved and extended in several areas:
  - Lets you analyze tables on a per-column basis for improved performance.
  - Performs faster data sampling, which expedites the analysis of relatively small tables with a large number of columns.
  - Includes data from WOS.
  - Recognizes deleted data, instead of ignoring delete markers.
  - Requires less memory to execute.
  - Lets you cancel the function mid analysis by issuing CTRL-C on vsql or invoking the INTERRUPT_STATEMENT() function.
  - Records the last time statistics were run for a table so that subsequent calls to the function can be optimized. See V_CATALOG.PROJECTION_COLUMNS for details.
- DEGREES() syntax has been modified to take three additional arguments: degrees, minutes, and seconds.
- DROP_STATISTICS() syntax has been modified to take a new argument called `TYPE`, which lets you drop the following types of statistics:
  - `BASE` — drops histograms and row counts (min/max column values, histogram, etc.), leaving extended statistics intact
  - `HISTOGRAMS` — drops only the histograms, leaving row counts and extended statistics.
  - `EXTENDED` — drops soft unique keys, leaving histograms and row counts.
  - `ALL` — drops all types of statistics.
- RADIANS() syntax has been modified to take three arguments: degrees, minutes, and seconds.
- EXPLAIN plans are now annotated with a statistics status; for example, when the histograms are out of date or not available at all. See Reacting to Stale Statistics in the Administrator's Guide.
- SUBSTRB, SUBSTR, AND SUBSTRING now accept input values of DOUBLE PRECISION.

See Also

Improved Statistics Collection (page 12)

New Functions (page 5)

Direct Hints Take Optional Spaces

Vertica now accepts optional spaces before and after the plus sign in direct hints (between the `/*` and the `+`).

Example

```
=> CREATE TABLE rostab(x TIMESTAMP);
```

Both of the following commands load data into the ROS:

```
=> INSERT /*+direct */ INTO rostab VALUES ('2011-02-10 12:01:00');
=> INSERT /* +direct */ INTO rostab VALUES ('2011-02-15 12:01:00');
```

Note the space between the * and + in the second statement above.

Results:

```
=> SELECT wos_row_count, ros_row_count FROM column_storage
   WHERE anchor_table_name = 'rostab';
 wos_row_count | ros_row_count
---------------+---------------
             0 |             2
             0 |             2
(2 rows)
```

Tuple Mover Changes

The Tuple Mover has a number of behavioral changes that increase its efficiency:

- The Tuple Mover no longer combines partitioned ROS containers into a single container when a mergeout is trigged by a call to DO_TM_TASK('mergeout','*table*'). This makes the behavior of a mergeout triggered by DO_TM_TASK equivalent to the behavior of the automated mergeout performed by the Tuple Mover.
- Purges triggered by PURGE_PROJECTION also do not combine partitioned ROS containers into a single ROS.

Node Failure Change

In previous versions of Vertica, a K-safe database would automatically shut down when more than K nodes in the database cluster failed.

In Vertica Version 5.0, Vertica continues to run after nodes fail as long as:

- all of the data in the database is still available.
- at least half of the nodes in the database are still running.

This new behavior potentially allows up to half the nodes in the cluster to fail while Vertica continues to run.

Nodes in the database whose failure would result in the database becoming unsafe and forcing a shutdown considered critical nodes. You can monitor which nodes in your database are critical by using the new CRITICAL_NODES system table.

Conversion from Floating Point to Numeric Data Types Now Rounds

In prior versions of Vertica, numbers converted from floating point values to NUMERIC were truncated if the floating point value contained more decimal places than the precision dictated in the numeric data type. In Vertica Version 5.0, FLOAT values are rounded rather than truncated when converted to NUMERIC.

Database Size Auditing and License File Changes

When licensed with a data allowance, Vertica now periodically audits the size of the database to ensure it remains in compliance with the license. See Managing Your License Key in the Administrator's Guide for more information.

Prior to Vertica Version 5.0, license files did not have an "unlimited" data size allowance option. Therefore, licenses for an unlimited data size were actually given an extremely large data allowance that is unlikely to ever be reached. From Version 5.0 onwards, Vertica license files can have "unlimited" as an allowance option.

See Viewing Your License Status in the Administrator's Guide for instructions on how to view the details of your license.

If you licensed Vertica for an unlimited data size, your current license file remains valid for Version 5.0. However, you can request that Vertica generate a new license file that has the unlimited data size allowance option rather than the very large allowance used in previous license files.

Note: The "unlimited" data size allowance option is only recognized by Vertica Version 5.0 and later. Version 4.1 and earlier versions do not recognize this option in the license file.

Please contact ***Technical Support*** (page 36) for more information.

Prejoin Projection Between Base and Temp Tables Not Allowed

You can no longer use temporary tables as dimensions when the fact table is non-temporary in pre-join projections

All dimension tables in a pre-join projection must be at least as persistent as the fact table and other snowflake dimension tables.

The persistence scale is:

Normal > session-scoped temporary table > transaction-scoped temporary table

The implications are as follows:

- If the the anchor table of a pre-join projection is a transaction-scoped temp table, you can use any type of table (temp or normal) in the pre-join.

- If the anchor table of a pre-join is a normal table, you can use only normal tables as dimension tables.
- If there is a snowflake dimension session-scoped temporary table, its dimension tables may not be a transaction-scoped temporary tables.

DROP TABLE Optional IF EXISTS Argument

The DROP TABLE statement now has an optional IF EXISTS argument. If you supply the IF EXISTS argument, DROP TABLE does not generate an error if it cannot find a table in the list of tables you want to drop. This option is useful for SQL scripts where you want to drop a table if it exists before recreating it.

CREATE VIEW Optional OR REPLACE Argument

The CREATE VIEW statement now has an optional OR REPLACE argument that tells Vertica to replace an existing view with the same name. If you do not supply the OR REPLACE argument, the CREATE VIEW statement returns an error if it finds an existing view with the same name. See CREATE VIEW in the SQL Reference Manual.

CREATE TABLE and CREATE PROJECTION New IF NOT EXISTS Argument

The CREATE TABLE and CREATE PROJECTION statements have a new IF NOT EXISTS argument. If you supply this argument to these statements, they do not generate errors if they find an existing table or projection with the name you specify. If you do not use this argument, and these statements find an existing table or projection, they report an error message and perform a rollback.

See CREATE TABLE and CREATE PROJECTION in the SQL Reference Manual.

Quarter Support for INTERVAL Qualifier

INTERVAL data types now accept quarter and its synonyms (quarters, qtr, qtrs, q) as interval-literals.

```
=> SELECT INTERVAL '1 quarter';
 ?column?
----------
 90
=> SELECT INTERVALYM '1 quarter';
 ?column?
----------
 0-3
```

Units less than a month are invalid for YEAR TO MONTH intervals. Previously these values were ignored. So the following command now returns an error message:

```
=> SELECT INTERVAL '1 y 30 days' YEAR TO MONTH;
ERROR: invalid input syntax for type interval year to month: "1 y 30 days"
```

The following interval literals are not supported:

- ISO-8601 'durations'
- Time zone and its aliases (timezone, timezone_h, timezone_m)

Deprecated Components

The functionality listed in the following table has been deprecated or removed from Vertica:

Functionality	Component	Obsolete Version	Deprecated Version	Removed in Version
MANAGED load	Server, clients	4.1	5.0	—
getNumAcceptedRows	ODBC, JDBC clients	4.1	5.0	—
getNumRejectedRows	ODBC, JDBC clients	4.1	5.0	—
use35CopyParameters	ODBC, JDBC clients	4.1	4.1	5.0
BatchAutoComplete	All clients	4.1	4.1	5.0
ReportParamSuccess	All clients	4.1	4.1	5.0
VT_ tables		4.0	4.1	5.0
EpochAdvancementMode	Server	4.0	4.1	5.0
EnableStrataBasedMrgOutPolicy	Server	4.1	4.1	5.0
MergeOutPolicySizeList	Server	4.1	4.1	5.0

Notes

- The vsql `\copy` command has been removed from the product. If you were using `\copy`, use the `COPY ... FROM ...` command instead.
- The manageTupleMover script has been deprecated. Use the stop_tuple_mover and start_tuple_mover functions instead.

Documentation Updates and Clarification

This section describes updates, clarifications, corrections, and notifications of structural changes to the document set in Vertica 5.0.

Administrator's Guide

The elimination of restrictions on dropping constraints on tables with projections has now been documented.

Programmer's Guide

- Vertica's Hadoop Connector is now documented. See Using the Hadoop Connector in the Programmer's Guide.
- When doing INSERT-SELECT operations, if the projection sort order of the target table is the same as the input select query, the SORT phase of the insert can be avoided. See INSERT-SELECT Optimizations in the Programmer's Guide for examples.

SQL Reference Manual

The TIMESERIES Clause topic now includes a clarifying statement that TIMESERIES only supports the DAY TO SECOND interval-qualifier.

Troubleshooting Guide

In rare circumstances, a user design space (workspace) created by the Database Designer might not be dropped, such as if the terminal window closed mid design. See Error creating design.

Packages, Platforms, and Support

Supported Platforms

Hardware

Constructing a hardware platform for your Vertica database involves a number of decisions including your data volumes, number of users and performance requirements. For guidance or questions, contact Technical Support.

For information on recommended RAM requirements, see Construct a Hardware Platform, in the Installation Guide.

Operating Systems for Vertica Database Servers

Supported for All Purposes Including Production

- Red Hat Enterprise Linux 5, 64-bit
- SUSE Linux Enterprise Server 10, 64-bit
- SUSE Linux Enterprise Server 11, 64-bit
- Debian Linux 5.0, 64 bit

Supported for Non-production (Testing and Evaluation) Purposes Only

- Red Hat Enterprise Linux 5, 32-bit
- SUSE Linux Enterprise Server 10, 32-bit
- SUSE Linux Enterprise Server 11, 32-bit
- Fedora Core 10, 32-bit
- Fedora Core 10, 64-bit
- Fedora Core 11, 32-bit
- Fedora Core 11, 64-bit

Supported Client Interfaces and Platforms:

- 32-bit and 64-bit JDBC on all platforms
- 32-bit and 64-bit ODBC for Windows
- 32-bit and 64-bit ODBC for Linux (all supported server platforms)
- 32-bit and 64 bit ODBC for Solaris SPARC 10
- 32-bit ODBC for Solaris 10 x86 10
- 32-bit ODBC for AIX
- 32-bit and 64-bit ADO.NET provider for Microsoft .NET Framework 3.0

Informatica Server and Client Plug-ins for 32- and 64-bit Windows, Linux, and Solaris SPARC The Vertica ODBC driver is ODBC 3.5 compliant.

The Vertica JDBC driver is JDBC 3.0 compliant and based on JDK 5.

Server Download Package

Download the Vertica® Analytic Database server package that matches the word size (32-bit or 64-bit) of the operating system on which you intend to install it. If the installer reports multiple dependency problems, you are probably trying to install the wrong package. For example, if you install a 64-bit Vertica database package on a 64-bit computer and get dependency errors, you are probably running a 32-bit version of Linux and need a 32-bit RPM package.

Use a Web browser to download the Vertica server package from the ***Vertica Website Download Page http://myvertica.vertica.com/v-zone/download_vertica***.

After you have installed the server package, read the Known Issues section in the Resolved and Known Issues before you run the `install_vertica` installation script. The Resolved and Known Issues is available on the Downloads site after you choose your server package and accept the license agreement.

Client Download Package

The client driver version should match the version of the server on which the database runs. For example, all Vertica client drivers 3.0 require Vertica® Analytic Database server version 3.0 or later.

Note: Vertica Server Version 4.1 is backwards compatible with the Vertica Version 4.0 client drivers. Use the older version of the drivers if you want to preserve the client behavior of Vertica Version 4.0. Future versions of Vertica may not be backwards compatible with older drivers, so you should migrate your client applications to the new client drivers as soon as possible.

For additional information about supported drivers, see Driver Prerequisites in the Programmer's Guide.

Software Compatibility

For optimal performance, Vertica is designed to use all available resources on each host machine. Vertica recommends that you:

- Remove or disable all non-essential applications from cluster hosts
- Deploy Vertica as the only active process on each host—other than Linux processes

Version Compatibility and Upgrade Path

Vertica can be upgraded, as follows:

- Vertica 2.0 to 2.1.
- Vertica 2.1 to 2.5.
  Note: Upgrading from 2.1 to 2.5 is permanent because the process of loading data into the upgraded system modifies VARCHAR types.
- Vertica 2.5 to 3.0.
- Vertica 3.0 to 3.5.
- Vertica 3.5 to 4.0.
- Vertica 4.0 to 4.1.
- Vertica 4.1 to 5.0.

IMPORTANT NOTE: Vertica strongly recommends that you follow the above upgrade path. If you decide to skip a release and upgrade, for example, from 4.0 directly to 5.0, be sure to read the New Features and New Features for each version you skip. The Vertica documentation is available in the rpm, as well as on the ***Downloads Web page http://www.vertica.com/v-zone/download_vertica*** (which also provides access to previous versions of the documentation).See the Installation Guide for instructions, particularly Upgrading Vertica.

Installation and Upgrades

This section contains special announcements about installation, upgrade, migration, and packaging. For complete information, see the Installation Guide.

Installing Vertica without parameters

If you run the Vertica installation script without parameters, the script performs a single-node install on `localhost`. This means that if you try to add a node later, you must first uninstall Vertica before you can proceed. See Installing Vertica in the Installation Guide.

Upgrading Vertica

Upgrading Vertica from version 2.1 to 2.5 is permanent because the process of loading data into the upgraded system modifies `VARCHAR` data types.

Technical Support

To submit problem reports, questions, comments, and suggestions, use the Technical Support page on the Vertica Web site.

Notes:

- You must be a registered user in order to access the ***MyVertica Portal http://myvertica.vertica.com/v-zone/overview***.
- If you are not a registered user, you can request access at the ***Technical Support Web page http://www.vertica.com/support***.

Before you report a problem, run the Diagnostics Utility described in the Troubleshooting Guide and attach the resulting `.zip` file to your ticket.

Index

A

Adding and Removing Node Improvements • 18
Administration Tools Metadata Enhancements • 22
ADO.NET • 31
Advanced Analytics and Other SQL • 4

B

Behavior Changes • 19

C

Client Download Package • 32
Cluster Elasticity • 16, 18
Cognos • 31
Comments On Objects • 11
Conversion from Floating Point to Numeric Data Types Now Rounds • 25
Copyright Notice • 39
CREATE TABLE and CREATE PROJECTION New IF NOT EXISTS Argument • 26
CREATE VIEW Optional OR REPLACE Argument • 26
Custom In-database Analytical Processing • 12

D

Database Designer Enhancements • 14
Database Size Auditing and License File Changes • 25
Deprecated Components • 28
Direct Hints Take Optional Spaces • 23
Documentation Updates and Clarification • 29
DROP TABLE Optional IF EXISTS Argument • 26

E

Error Messages Improvements • 19
Event Series Joins • 5
Event Series Pattern Matching • 4, 8
EXPLAIN Plans Correlated with Error Messages • 19, 20

F

FOREIGN_KEY Constraint Changes • 15

G

GROUP BY HASH Sorting Changes • 22

I

Improved Maintenance of Statistics Collection • 7, 12, 17, 20, 23
Installation and Upgrades • 35

J

Java Virtual Machine • 31
JDBC • 31
JVM • 31

L

Large Cluster Support • 16
LIKE and Regular Expressions Performance Improvements • 18
LIKEB/ILIKEB Predicates Supported for Single-row Subqueries • 11
Linux • 31

M

Manageability and Ease-of-Use • 12
MicroStrategy • 31
Modified Functions • 6, 23

N

Networked Joins • 17
New Database Backup and Copy Utility • 13
New Import and Export Feature • 15
New Keywords and Reserved Words • 9
New SQL Functions • 6, 23
New System Tables • 9, 20
Node Failure Change • 24

O

ODBC • 31
Optimizer Improvements • 17

P

Packages, Platforms, and Support • 30
Performance Improvements • 17
Prejoin Projection Between Base and Temp Tables Not Allowed • 25

Q

Quarter Support for INTERVAL Qualifier • 26
Query Plan Quality Improvements • 17

R

Red Hat Enterprise Linux 4, 64 bit • 31
Red Hat Enterprise Linux 5, 64 bit • 31
Roles Support • 15

S

Server Download Package • 32
Software Compatibility • 33
Subquery Enhancements • 5
Subquery WHERE Clause Predicates • 17
Sun Solaris • 31
Supported Platforms • 31
SUSE Linux • 31
System Table Updates • 9, 20

T

Technical Support • 4, 16, 25, 36
Timezone Abbreviation Override • 21
Tuple Mover Changes • 24
Tuple Mover Operations on Replicated Tables • 18

U

User-Defined Functions • 12

V

Version Compatibility and Upgrade Path • 34
Vertica Geospatial Package • 8
Vertica® Analytic Database 5.0 • 4
VMWare • 31
vSphere • 31

W

Windows • 31
Workload Analyzer • 8, 13

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bzip2

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bzip2/libbzip2 version 1.0 of 21 March 2000

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The implementations of GSSAPI mechglue in GSSAPI-SPNEGO in src/lib/gssapi, including the following files:

- lib/gssapi/generic/gssapi_err_generic.et
- lib/gssapi/mechglue/g_accept_sec_context.c
- lib/gssapi/mechglue/g_acquire_cred.c
- lib/gssapi/mechglue/g_canon_name.c
- lib/gssapi/mechglue/g_compare_name.c
- lib/gssapi/mechglue/g_context_time.c
- lib/gssapi/mechglue/g_delete_sec_context.c
- lib/gssapi/mechglue/g_dsp_name.c
- lib/gssapi/mechglue/g_dsp_status.c
- lib/gssapi/mechglue/g_dup_name.c
- lib/gssapi/mechglue/g_exp_sec_context.c
- lib/gssapi/mechglue/g_export_name.c
- lib/gssapi/mechglue/g_glue.c
- lib/gssapi/mechglue/g_imp_name.c

- lib/gssapi/mechglue/g_imp_sec_context.c
- lib/gssapi/mechglue/g_init_sec_context.c
- lib/gssapi/mechglue/g_initialize.c
- lib/gssapi/mechglue/g_inquire_context.c
- lib/gssapi/mechglue/g_inquire_cred.c
- lib/gssapi/mechglue/g_inquire_names.c
- lib/gssapi/mechglue/g_process_context.c
- lib/gssapi/mechglue/g_rel_buffer.c
- lib/gssapi/mechglue/g_rel_cred.c
- lib/gssapi/mechglue/g_rel_name.c
- lib/gssapi/mechglue/g_rel_oid_set.c
- lib/gssapi/mechglue/g_seal.c
- lib/gssapi/mechglue/g_sign.c
- lib/gssapi/mechglue/g_store_cred.c
- lib/gssapi/mechglue/g_unseal.c
- lib/gssapi/mechglue/g_userok.c
- lib/gssapi/mechglue/g_utils.c
- lib/gssapi/mechglue/g_verify.c
- lib/gssapi/mechglue/gssd_pname_to_uid.c
- lib/gssapi/mechglue/mglueP.h
- lib/gssapi/mechglue/oid_ops.c
- lib/gssapi/spnego/gssapiP_spnego.h
- lib/gssapi/spnego/spnego_mech.c

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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see http://www.cnri.reston.va.us) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see http://www.zope.com). In 2001, the Python Software Foundation (PSF, see http://www.python.org/psf/) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

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1.3 thru 1.5.2	1.2	1995-1999	CNRI	yes
1.6	1.5.2	2000	CNRI	no
2.0	1.6	2000	BeOpen.com	no
1.6.1	1.6	2001	CNRI	yes (2)
2.1	2.0+1.6.1	2001	PSF	no
2.0.1	2.0+1.6.1	2001	PSF	yes
2.1.1	2.1+2.0.1	2001	PSF	yes
2.2	2.1.1	2001	PSF	yes
2.1.2	2.1.1	2002	PSF	yes
2.1.3	2.1.2	2002	PSF	yes
2.2.1	2.2	2002	PSF	yes
2.2.2	2.2.1	2002	PSF	yes
2.2.3	2.2.2	2003	PSF	yes
2.3	2.2.2	2002-2003	PSF	yes
2.3.1	2.3	2002-2003	PSF	yes
2.3.2	2.3.1	2002-2003	PSF	yes
2.3.3	2.3.2	2002-2003	PSF	yes
2.3.4	2.3.3	2004	PSF	yes
2.3.5	2.3.4	2005	PSF	yes
2.4	2.3	2004	PSF	yes
2.4.1	2.4	2005	PSF	yes
2.4.2	2.4.1	2005	PSF	yes
2.4.3	2.4.2	2006	PSF	yes
2.5	2.4	2006	PSF	yes
2.7	2.6	2010	PSF	yes

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Python Dialog

The Administration Tools part of this product uses Python Dialog, a Python module for doing console-mode user interaction.

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zlib.h -- interface of the 'zlib' general purpose compression library version 1.2.3, July 18th, 2005

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