



Upgrade Guide

Abstract

This book explains how to upgrade from one major version of Volt Active Data to another.

Upgrade Guide

V13

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Preface

This book helps existing customers upgrade the Volt Active Data software from one major version to another. New features and improvements that require changes to existing syntax or client applications are reserved for major releases of the product only (e.g. V8, V9, V10, and so on). To make the upgrade to these major versions smoother for existing users, this book describes any incompatible changes for each major version and the steps necessary when migrating to it from previous releases.

The best way to use this book is before you upgrade to a new major version, read the chapters for each of the intervening releases and take the appropriate actions. For example, if you are planning to upgrade from V8 to V11, you should read the chapters on migrating to V9, V10, and V11.

1. Structure of This Book

The first two chapters of this book describe the Volt Active Data release strategy and the upgrade process. The release strategy describes the schedule for specific releases and the role of the Long-Term Support release for each major version. The upgrade process gives you an overview of the steps to take when preparing to upgrade to a new major version of Volt Active Data. Subsequent chapters describe specific tasks for upgrading to each of the major releases:

- Chapter 1, *Software Releases and Long-Term Support (LTS)*
- Chapter 2, *The Software Upgrade Process*
- Chapter 3, *Upgrading to Volt Active Data V8*
- Chapter 4, *Upgrading to Volt Active Data V9*
- Chapter 5, *Upgrading to Volt Active Data V10*
- Chapter 6, *Upgrading to Volt Active Data V11*
- Chapter 7, *Upgrading to Volt Active Data V12*
- Chapter 8, *Upgrading to Volt Active Data V13*

2. Related Documents

This book does not describe how to design or develop Volt Active Data databases. For a complete description of the development process for Volt and all of its features, please see the accompanying manual *Using VoltDB*. For new users, see the *VoltDB Tutorial*. These and other books describing Volt Active Data are available on the web from <http://docs.voltactivedata.com/>.

Chapter 1. Software Releases and Long-Term Support (LTS)

Volt Active Data provides best-in-class throughput of ACID transactions, enabling intelligent streaming applications and real-time decision making. To maintain its industry leadership and help customers meet current and future business goals, Volt is constantly improving and expanding its capabilities by adding new features.

At the same time, it is important to provide the most stable software possible for production use. So Volt provides frequent product updates to ensure timely and proactive solutions to potential issues within the software. Balancing cutting edge features with bug fixes is the primary goal of the Volt Active Data release strategy and, specifically, its Long-Term Support (LTS) designation as described in the following section.

The Release Schedule The latest releases of Volt Active Data usually contain a combination of new features and bug fixes for known issues in previous releases. Releases fall into three categories: Major releases (V1.0, V2.0, V3.0 etc.) Major releases are normally reserved for significant new features. They are also where older features are deprecated or removed. In particular, any incompatible or behavioral changes that require user action to complete the upgrade process are reserved for major releases. Point releases (V3.1, V3.2, V3.3 etc.) Point releases are normally only applied to the latest version of the software or LTS releases. On the latest release branch, point releases contain both bug fixes and new features under development. On LTS branches, point releases contain only bug fixes. Long-Term Support releases (LTS) For each major release, after a few point releases to stabilize the product we announce one point release as the Long-Term Support (LTS) release. This means this version will receive all applicable bug fixes for the full term of its support period, which is three years from its initial release. These bug fixes will be applied as minor updates to the point release (for example, if V11.4 is the LTS release, bug fix updates will be V11.4.1, V11.4.2 etc.). Note that the LTS releases receive bug fixes only, they do not receive any additional new features. New features are applied to the latest release branch only. The goal of the LTS release is to clearly identify the most stable version available for any major release. If you encounter any issues with point releases prior to the LTS release, we will ask you to update to the LTS release to receive the fixes you need.

1.1. The Software Release Schedule

The latest releases of Volt Active Data usually contain a combination of new features and bug fixes for known issues in previous releases. Releases fall into three categories:

- **Major releases** (V1.0, V2.0, V3.0 etc.) Major releases are normally reserved for significant new features. They are also where older features are deprecated or removed. In particular, any incompatible or behavioral changes that require user action to complete the upgrade process are reserved for major releases.
- **Minor releases** (V3.1, V3.2, V3.3 etc.) Minor releases are normally only applied to the latest version of the software or LTS releases. On the latest release branch, minor releases contain both bug fixes and new features under development. On LTS branches, point updates to the minor release contain only bug fixes.
- **Long-Term Support releases (LTS)** For each major release, after a few minor releases to stabilize the product we announce one minor release as the Long-Term Support (LTS) release. This means this version will receive all applicable bug fixes for the full term of its support period, which is three years from its initial release. These bug fixes will be applied as point updates to the minor release (for example, if V11.4 is the LTS release, bug fix updates will be V11.4.1, V11.4.2 etc.). Note that, once named, the

LTS releases receive security and bug fixes only, they do not receive any additional new features. New features are applied to the latest release branch only.

The goal of the LTS release is to clearly identify the most stable version available for each major release. If you encounter any issues with minor releases prior to the LTS release, Volt Support will recommend updating to the LTS release to receive the fixes you need.

1.2. Staying Current

For customers who want to take advantage of the latest features of Volt Active Data, we recommend you install and test the latest version of the software. Your feedback is invaluable to the continual improvement of the product. In cases where your business application is dependent on features introduced in the latest major release, Volt provided timely updates to the latest version for bug fixes and functional improvements.

For customers focused on stability, we recommend working with the latest LTS release. Even though it may not be the most recent version, all LTS releases are maintained and patched as necessary to provide you with the most stable software platform possible. When it comes time to upgrade, we recommend upgrading from one LTS version to the most recent LTS version, to provide continuity and stability in your base platform.

For customers who need both stability and cutting edge capabilities, we recommend using LTS releases in production and developing on the latest version. By doing planning, development and testing on the latest release, you are ensured you are ready to roll out the latest features into production as soon as a new LTS release is announced. As an added benefit, you have the opportunity to help influence new features to fit your business requirements before production starts.

Chapter 2. The Software Upgrade Process

Upgrading from one major version of Volt to another may involve changes to the supported features and/or configuration of the software. In addition, each cluster must reboot as part of the upgrade process. Which is why it is important you plan ahead before starting the upgrade process.

There are essentially two flavors of the upgrade process. You can upgrade an individual Volt cluster, which will require some minimal downtime while the cluster reboots. Or you can use cross datacenter replication (XDCR) to upgrade each cluster sequentially, so although each cluster must reboot, the service as a whole remains available throughout the upgrade process. The advantage of an XDCR upgrade is that your business systems do not incur any interruption.

Once you decide on your approach, there are three steps to the upgrade process:

1. Prepare for the upgrade by reviewing the applicable changes to the Volt software, making any necessary changes to your business applications and/or schema, saving a copy of your current configuration and any special settings, and backing up the database.
2. Test the upgrade on a development server to ensure your applications run as expected after the upgrade.
3. Perform the upgrade in the production environment.

Since the process is the same for upgrading a test environment or upgrading production systems, the process is only described once for each platform in the following sections. However, the process is different for Kubernetes compared to bare metal or servers hosted on generic virtual machines; so there are separate sections for each platform type.

Finally, it is a good idea to review your upgrade plans in advance with your Volt Customer Success representative. So we strongly encourage you to engage them during the preparation phase where they can help you evaluate your business solutions for any obsolete coding or features, as well as identifying new features or improvements that could provide significant benefits to your specific business case.

2.1. Preparing for the Upgrade

Before upgrading the Volt Active Data software to a new major version, you should:

1. **Read the upgrade notes** (later in the manual) for all major versions included in the update.
2. **Read the latest release notes** for the final version you are upgrading to.
3. **Update your applications and schema** accordingly.
4. **Test your changes** on updated development systems to verify they work as expected.
5. **Backup your database and schema** as a VoltDB snapshot.
6. **Make a record of your database and server configuration** to capture any customisations you have made to your implementation.

As the product evolves, features are extended to improve performance and enhance their capabilities. At the same time, old and obsolete features are sometimes removed from the product. These feature changes occur primarily at major releases. The later chapters in this book provide notes on such changes in each of the major versions of VoltDB. So before upgrading, be sure to read the chapters for each of the major versions involved in the upgrade. For example, if you are upgrading from V9 to V10, read the chapter on

upgrading to V10. If you are upgrading from V9 to V12, read the chapters on upgrading to V10, V11, and V12.

There may be additional improvements found after the initial release of any major version. Which is why you should also read the latest release notes for any minor updates to your target version.

Once you know what product changes need to be addressed, compare the upgrade notes for the major versions with your current application source code and schema. Be sure to make appropriate revisions where necessary to avoid obsolete functions and to take advantage of new features where possible.

Once any changes are complete, it is a good idea to test your planned upgrade on a development system to ensure it works as expected.

When you are ready to start the upgrade, be sure to backup your database as a safety precaution. You can use the **voltadmin save** command to take a snapshot of the current database schema and contents.

You should also save a copy of the current database configuration. There are actually two parts to saving the configuration. While logged onto one of the database servers, you can save the current configuration file using the **voltldb get deployment** command, specifying the location of the database root directory:

```
$ voltldb get deployment -D ~/myvoltserver/ --output=config.xml
```

You should also make a note of any environment variables or command switches used when starting the database. In particular, make sure you capture the current settings for the following environment variables that can significantly impact the server process:

```
LOG4J_CONFIG_PATH  
VOLTDB_GC_OPTS  
VOLTDB_HEAPMAX  
VOLTDB_OPTS
```

Once you complete the preceding steps, you are ready to perform the upgrade.

2.2. Upgrading Volt Databases on Managed Servers

For customers who manage their own servers, there are two options for upgrading the VoltDB software for an existing database:

1. Using the **voltadmin save** and **restore** commands before and after shutting down and upgrading the software.
2. Using two (or more) XDCR clusters to upgrade the clusters one at a time without a service interruption.

The following sections describe how to update the software itself and the two options for upgrading existing installations.

2.2.1. Upgrading the VoltDB Software

Updating the VoltDB software is very simple. However, you must make sure you perform this step at the right stage in the upgrade process, as described in the following sections. The product comes as a .tar.gz file. When the time comes to upgrade the software, you unpack the tar file and move the resulting folder to replace your current installation. For example, if you have the VoltDB software installed as /var/voltldb,

the software installation looks like the following, where you delete the previous version and replace it with the new one:

```
$ tar -zxvf vltddb-ent-x.x.x.tar.gz -C /var
$ cd /var
$ rm -vr vltddb
$ mv vltddb-ent-x.x.x vltddb
```

Remember, when upgrading an existing installation with a running database, you need to upgrade both the software *and* the database itself. Which means you must make sure you perform the update steps in the correct order. The following sections explain the different options for updating existing installations, including at what stage in the process you should replace the software.

2.2.2. Upgrading VoltDB Using Save and Restore

Upgrading the VoltDB software on a single database cluster is easy. All you need to do is perform an orderly shutdown saving a final snapshot, upgrade the VoltDB software on all servers in the cluster, then restart the database. The steps to perform this procedure are:

1. Shutdown the database and save a final snapshot (**voltadmin shutdown --save**).
2. Upgrade the VoltDB software on all cluster nodes (instructions).
3. Restart the database (**voltddb start**).

This process works for any recent (V6.8 or later) release of VoltDB.

2.2.3. Performing an Online Upgrade Using Multiple XDCR Clusters

It is also possible to upgrade the VoltDB software using cross data center replication (XDCR), by simply shutting down, upgrading, and then re-initializing each cluster, one at a time. This process requires no downtime, assuming your client applications are already designed to switch between the active clusters.

Use of XDCR for upgrading the VoltDB software is easiest if you are already using XDCR because it does not require any additional hardware or reconfiguration. The following instructions assume that is the case. Of course, you could also create a new cluster and establish XDCR replication between the old and new clusters just for the purpose of upgrading VoltDB. The steps for the upgrade outlined in the following sections are the same. But first you must establish the cross data center replication between the two (or more) clusters. See the chapter on Database Replication in the *Using VoltDB* manual for instructions on completing this initial step.

Once you have two clusters actively replicating data with XDCR (let's call them clusters A and B), the steps for upgrading the VoltDB software on the clusters is as follows:

1. Pause and shutdown cluster A (**voltadmin pause --wait** and **shutdown**).
2. Clear the DR state on cluster B (**voltadmin dr reset**).
3. Update the VoltDB software on cluster A.
4. Start a new database instance on A, making sure to use the old deployment file so the XDCR connections are configured properly (**voltddb init --force** and **voltddb start**).
5. Load the schema on Cluster A so replication starts.

6. Once the two clusters are synchronized, repeat steps 1 through 4 for cluster B.

Note that since you are upgrading the software, you must create a new instance after the upgrade (step #3). When upgrading the software, you cannot recover the database using just the **voltldb start** command; you must use **voltldb init --force** first to create a new instance and then reload the existing data from the running cluster B.

Also, be sure all data has been copied to the upgraded cluster A after step #4 and before proceeding to upgrade the second cluster. You can do this by checking the @Statistics system procedure selector DR-CONSUMER on cluster A. Once the DRCONSUMER statistics State column changes to "RECEIVE", you know the two clusters are properly synchronized and you can proceed to step #5.

2.3. Upgrading Volt in Kubernetes

For customers who run Volt Active Data in Kubernetes, the steps for upgrading the database software are:

1. Update your copy of the VoltDB Helm repository.
2. Update the custom resource definition (CRD) for the VoltDB Operator.
3. Upgrade the VoltDB Operator and software.

The following sections explain how to perform each step of this process, including a full example of the entire process in Example 2.1, “Process for Upgrading the VoltDB Software” However, when upgrading an XDCR cluster, there is an additional step required to ensure the cluster's schema is maintained during the upgrade process. Section 2.3.4, “Updating VoltDB for XDCR Clusters” explains the extra step necessary for XDCR clusters.

2.3.1. Updating Your Helm Repository

The first step when upgrading VoltDB is to make sure your local copy of the VoltDB Helm repository is up to date. You do this using the **helm repo update** command:

```
$ helm repo update
```

Once you update your local copy of the charts, you can determine which version — of both the charts and the software — you want to use by listing all available versions. You do this with the **helm search repo** command.

```
helm search repo voltdb/voltdb --versions
NAME          CHART VERSION  APP VERSION  DESCRIPTION
voltdb/voltdb 2.1.1          12.3.1       The Helm chart for VoltDB
voltdb/voltdb 2.1.0          12.3.0       The Helm chart for VoltDB
voltdb/voltdb 2.0.2          12.2.2       The Helm chart for VoltDB
voltdb/voltdb 2.0.1          12.2.1       The Helm chart for VoltDB
voltdb/voltdb 2.0.0          12.2.0       The Helm chart for VoltDB
voltdb/voltdb 1.10.1         12.1.1       The Helm chart for VoltDB
voltdb/voltdb 1.10.0         12.1.0       The Helm chart for VoltDB
voltdb/voltdb 1.9.0          12.0.0       The Helm chart for VoltDB
voltdb/voltdb 1.8.8          11.4.10      The Helm chart for VoltDB
voltdb/voltdb 1.8.7          11.4.9       The Helm chart for VoltDB
. . .
```

The display shows the available versions, including for each release a version number for the chart and one for the VoltDB software (app version). Make a note of the pair of version numbers you want to use

because you will need them both to complete the following steps of the process. All of the examples in this document use the chart version *2.1.1* and the software version *12.3.1* for the purposes of demonstration.

2.3.2. Updating the Custom Resource Definition (CRD)

The second step is to update the custom resource definition (CRD) for the VoltDB Operator. This allows the Operator to be upgraded to the latest version.

To update the CRD, you must first save a copy of the latest chart, then extract the CRD from the resulting tar file. The **helm pull** command saves the chart as a gzipped tar file and the **tar** command lets you extract the CRD. For example:

```
$ helm pull voltdb/voltdb --version 2.1.1
$ tar --strip-components=2 -xzf voltdb-2.1.1.tgz \
    voltdb/crds/voltdb.com_voltdbclusters_crd.yaml
```

Note that the file name of the resulting tar file includes the chart version number. Once you have extracted the CRD as a YAML file, you can use it to replace the CRD in Kubernetes:

```
$ kubectl replace -f voltdb.com_voltdbclusters_crd.yaml
```

2.3.3. Upgrading the VoltDB Operator and Software

Once you update the CRD, you are ready to upgrade VoltDB, including both the Operator and the server software. You do this using the **helm upgrade** command and specifying the version numbers for both items on the command line. As soon as you make this change, the Operator will pause the database, take a final snapshot, shutdown the database and then restart with the new version, restoring the snapshot in the process. For example:

```
$ helm upgrade mydb voltdb/voltdb --reuse-values \
    --set operator.image.tag=2.1.1 \
    --set cluster.clusterSpec.image.tag=12.3.1
```

Example 2.1, “Process for Upgrading the VoltDB Software” summarizes all of the commands needed to update a database release to VoltDB version *12.3.1*.

Example 2.1. Process for Upgrading the VoltDB Software

```
$ # Update the local copy of the charts
$ helm repo update
$ helm search repo voltdb/voltdb --versions
NAME          CHART VERSION  APP VERSION  DESCRIPTION
voltdb/voltdb 2.1.1          12.3.1       The Helm chart for VoltDB
voltdb/voltdb 2.1.0          12.3.0       The Helm chart for VoltDB
voltdb/voltdb 2.0.2          12.2.2       The Helm chart for VoltDB
voltdb/voltdb 2.0.1          12.2.1       The Helm chart for VoltDB
voltdb/voltdb 2.0.0          12.2.0       The Helm chart for VoltDB
[ . . . ]
$
$ # Extract and replace the CRD
$ helm pull voltdb/voltdb --version 2.1.1
$ tar --strip-components=2 -xzf voltdb-2.1.1.tgz \
    voltdb/crds/voltdb.com_voltdbclusters_crd.yaml
$ kubectl replace -f voltdb.com_voltdbclusters_crd.yaml
```

```
$  
$ # Upgrade the Operator and VoltDB software  
$ helm upgrade mydb voltdb/voltdb --reuse-values \  
  --set operator.image.tag=2.1.1 \  
  --set cluster.clusterSpec.image.tag=12.3.1
```

2.3.4. Updating VoltDB for XDCR Clusters

When upgrading an XDCR cluster, there is one extra step you must pay attention to. Normally, during the upgrade, VoltDB saves and restores a snapshot between versions and so all data and schema information is maintained. When upgrading an XDCR cluster, the data and schema is deleted, since the cluster will need to reload the data from another cluster in the XDCR relationship once the upgrade is complete.

Loading the data is automatic. But loading the schema depends on the schema being stored properly before the upgrade begins.

If the schema was loaded through the YAML properties `cluster.config.schemas` and `cluster.config.classes` originally and has not changed, the schema and classes will be restored automatically. However, if the schema was loaded manually or has been changed since it was originally loaded, you must make sure a current copy of the schema and classes is available after the upgrade. There are two ways to do this.

For both methods, the first step is to save a copy of the schema and the classes. You can do this using the **voltdb get schema** and **voltdb get classes** commands. For example, using Kubernetes port forwarding you can save a copy of the schema and class JAR file to your local working directory:

```
$ kubectl port-forward mydb-voltdb-cluster-0 21212 &  
$ voltdb get schema -o myschema.sql  
$ voltdb get classes -o myclasses.jar
```

Once you have copies of the current schema and class files, you can either set them as the default schema and classes for your database release before you upgrade the software or you can set them in the same command as you upgrade the software. For example, the following commands set the default schema and classes first, then upgrade the Operator and server software. Alternately, you could put the two `--set-file` and two `--set` arguments in a single command.

```
$ helm upgrade mydb voltdb/voltdb --reuse-values \  
  --set-file cluster.config.schemas.mysql=myschema.sql \  
  --set-file cluster.config.classes.myjar=myclasses.jar  
$ helm upgrade mydb voltdb/voltdb --reuse-values \  
  --set operator.image.tag=2.1.1 \  
  --set cluster.clusterSpec.image.tag=12.3.1
```

Chapter 3. Upgrading to Volt Active Data V8

This chapter describes what new features are introduced in V8.0 and what upgrade tasks may be required of existing customers.

3.1. What's New in Volt V8.0

Volt 8 is a major release incorporating features from recent point releases plus new capabilities. The major new features in V8 include:

- **More Network Security** — Volt now provides SSL/TLS encryption as an option on all inter-node and inter-cluster communication, including internal, external, and DR ports. See the chapter on "Security" in the *Using VoltDB* manual for details.
- **User-Defined Functions** — It is now possible to define and declare your own functions for use in SQL statements. User-defined functions are written in Java and declared using the CREATE FUNCTION statement. See the chapter on "Creating Custom SQL Functions" in the *Volt Guide to Performance and Customization* manual for details.
- **Common Table Expressions** — Volt SQL queries can now include common table expressions, using the WITH clause. Common table expressions help organize complex SQL queries and make them easier to read. Volt also supports recursive common table expressions, making it possible to evaluate complex tree and graph structures within a single statement. See the description of the SELECT statement in the *Using VoltDB* manual for details.
- **Kafka Enhancements** — Volt now supports the latest releases of Apache Kafka, by default. The Kafka export connector continues to support all Kafka versions starting with 0.8.2. For import, the Kafka import connector and the kafkaloader command line utility now support Kafka 0.10.2 and later, up through and including the recently released version 1.0.0. For customers still using earlier versions of Kafka, Kafka 8 support is available as a configurable option for both the import connector and a legacy kafkaloader8 command line tool.
- **Python V3 API** — Volt now supports the use of Python V3.x for developing client applications. The Volt Python client library (available from GitHub) supports both Python 2.7 and 3.x.

3.2. Special Considerations for Existing Customers

Most of the new features and capabilities in Volt V8.0 do not impact existing applications. However, there are a few changes that do require minor changes to the configuration when upgrading from earlier versions. Existing customers should take note of the following changes:

- **Change to default Kafka versions for import**

For the kafka import connector and the **kafkaloader** command line utility, the default Kafka version has changed from 0.8.2 to 0.10.2 or later. For customers already using Kafka 0.10.2 or later, there are no changes needed to their configuration, scripts, or applications. For customers who wish to continue using the older Kafka version 0.8.2, they will need to add the attribute `version="8"` to the import connector configuration and/or use the command line utility **kafkaloader8** instead of the default **kafkaloader**.

- **The "elastic" attribute removed from <cluster>**

An artifact of an old feature provided for backwards compatibility, the `elastic` attribute of the `<cluster>` element in the configuration file was disabled and deprecated several years ago. It has now been removed. Although it is unlikely any still exist, configuration files that do include this attribute will now fail to parse. Simply remove the attribute and try again.

- **The `<consistency>` element removed from the configuration file**

The `<consistency>` element was recently deprecated, since "fast" read consistency no longer provides any significant performance improvement over "safe" mode but does introduce potential risks during failure scenarios. It has now been removed from the allowable configuration file syntax. If you included `<consistency>` in your configuration file, please remove it before starting a Volt 8.0 cluster.

- **Old commands for starting Volt are no longer supported**

Volt 6.6 introduced two new integrated commands, `init` and `start`, for starting Volt servers. At that time the old commands (`add`, `create`, `recover`, and `rejoin`) were deprecated. The old commands have now been removed from the product. If you still use the older commands, please update your scripts to use the new commands as described in the chapter "Starting the Database" in the *Using VoltDB* manual.

Chapter 4. Upgrading to Volt Active Data V9

This chapter describes what new features are introduced in V9.0 and what upgrade tasks may be required of existing customers.

4.1. What's New in Volt V9.0

Volt 9.0 is a major release incorporating features from previous point releases plus new capabilities. The major new features in V9.0 include:

- **Automated Deletion of Old Data** — Volt 8.4 introduced a new feature, USING TTL ("time to live"), that lets you define when records expire and can be deleted. This feature simplifies application design by automatically removing old data from the database based on settings you define in the table schema. With Volt 9.0, this feature is extended to include the migration of deleted data to other systems for archival purposes, as described next.
- **New Export Capabilities** — The code that supports export of data to external systems has been rewritten to provide flexibility, improve reliability, reduce system resource utilization, and support new and future product features. The new export system reinforces the durability of data queued to the export connectors across unexpected system and network failures and allows export to be extended to add new capabilities.

The first two new capabilities are:

- **ALTER STREAM** — The ability to modify an existing stream. You can use the new ALTER STREAM statement to modify the schema of the stream or the target for export without interrupting any already queued export data. See the description of ALTER STREAM in the *Using VoltDB* manual for details.
- **Automated Data Migration** — You can now automate the export of data from Volt database tables to other systems as part of the data aging process. For tables declared with the USING TTL clause you can now add a MIGRATE TO TARGET clause. With MIGRATE TO TARGET, data that exceeds its "time to live" is queued to the specified export connector. Once the data is exported and acknowledged by the external system, it is then deleted from the Volt database. This automated process not only automates the archiving of old data it ensures that the data stays in the Volt database until it is confirmed as received by the export target. See the description of the CREATE TABLE statement in the *Using VoltDB* manual for more information about the USING TTL and MIGRATE TO TARGET options.

Two important aspects of the new export infrastructure are the effect on the overall export process:

- Export now starts when the stream is defined, not when the target is defined. Previously, stream data was not queued for export until a valid export connector was configured and connected. This meant data written to a stream might be dropped rather than queued for export if the connector was not configured correctly. Starting with Volt 9.0, data written to streams declared with the EXPORT TO TARGET clause are queued for export whether the target is configured or not. Similarly, the queued data is removed as soon as the stream itself is removed with the DROP STREAM statement.

This change makes the queuing of export data much more reliable, easier to understand, and easier to control. Data is queued for export as soon as the stream is defined and purged as soon as the stream is dropped. The new ALTER STREAM statement further lets you modify the stream definition without having to clear any existing export queues.

- Export is now an enterprise feature. The Volt Community Edition provides access to two streams per database, so users have access to basic export functionality. But for unlimited access to export and migration features, the Enterprise Edition is required. (See Special Considerations for more information about upgrading community databases that use export.)
- **"Live" Schema Updates with Database Replication** — Previously, database replication (DR) required the schema of the cooperating databases to match for all DR tables. So updating the schema required a pause while all of the affected databases were updated. Starting with 9.0, this limitation has been loosened. DR continues even if the schema are different. So it is possible to update the schema without interrupting ongoing transactions.

Of course, it is not possible for Volt to resolve individual transactions if the schema differ. So if a DR consumer (either a replica in passive DR or an XDCR cluster in active replication) receives a binary log where the schema of the affected table(s) does not match, DR will stall and wait for the schema to be updated to match the incoming data. Therefore, care must be taken when updating the schema to ensure that no transactions that are affected by the schema change are processed during the interval when the clusters' schema do not match. See the sections on updating DR schema for passive and active DR for more information.

- **Simplified JSON interface** — A new version of the Volt JSON API, 2.0, is now available. The original JSON interface provides complete information about the schema for the data being returned, including separate entries for the data, the column names, and datatypes. The 2.0 API returns a much more compact result set with each row represented by an associative array with each element consisting of the column name and value.

The 1.0 API is useful if you do not know what data is returned and want to deconstruct the results in detail. The 2.0 API is more useful for rapidly fetching and using known results. Both versions of the API accept the same parameters, as described in the section on using the JSON API in the *Using VoltDB* manual. So the following calls return the same data except at different levels of detail.

```
http://myserver:8080/api/1.0/?Procedure=@Statistics&Parameters=["TABLE",0]
http://myserver:8080/api/2.0/?Procedure=@Statistics&Parameters=["TABLE",0]
```

- **Support for Java 11** — Volt now supports both Java 8 and Java 11.

4.2. Special Considerations for Existing Customers

Many of the new features and capabilities in Volt V9.0 do not impact existing applications. However, there are a few changes that may require action for users upgrading from earlier versions. Existing customers should take note of the following changes:

- **Change to how stream data is queued for export**

Previously, if you defined a stream with the EXPORT TO TARGET clause but no matching target was configured, any data inserted into the stream was dropped. No data was queued until the specified target was both configured and successfully connected. With Volt 9.0 export queuing has been simplified: data is queued as soon as the stream is declared and the queue is deleted as soon as the stream is dropped.

This means that if you declare a stream and it is being written to, but you do not configure the associated target, the data inserted into the stream will be queued in the `export_overflow` directory, consuming disk space that would not have been used in earlier versions of the product.

- **Change to the reporting of streams in @Statistics**

In Volt 8.4, a new @Statistics selector, EXPORT, was introduced to provide improved visibility and more detail concerning the export lifecycle. At that time, export streams continued to be reported under the TABLE selector, so as not to disrupt existing scripts or procedures users might have that rely on that information. With Volt 9.0, export streams have been removed from the TABLE selector results. Now the TABLE selector only reports on tables and streams that are not associated with an export target. Information on streams declared with the EXPORT TO TARGET clause is provided under the EXPORT selector.

- **Managing export queues during outages**

In most cases, Volt manages the export queues even in unusual cases where nodes go down in a K-safe cluster. If at any time the node managing an export partition finds a gap in the export queue (due to the current server having been down when that data was written to the stream), the system queries the other servers to find one with the missing data and export continues. In the rare case where Volt cannot find the missing records in any of the current server export queues, the export connector for that queue will stop, waiting for a server that has the data.

Even if servers stop and rejoin frequently, the data will eventually be found on a rejoining node. However, in the unusual case that, say, failed nodes are replaced by new, initialized servers, it is possible that the gap in the queue cannot be resolved. Previously, Volt would eventually (once the cluster was at a full complement of servers) skip the missing data and restart the connector at the next available export record. Starting with Volt 9.0, export will not skip over gaps automatically. The queue will stop and warnings will be logged to the console and reported via SNMP. You must issue the **voltadmin export release** command to resume processing of the export connector at the next available record.

- **Limits on streams in Community Edition**

Export is now an Enterprise Edition feature and the Community Edition is limited to two streams per database. This means if you try to restore a database from a previous version with more than two streams using the Volt 9.0 Community Edition, the restore will fail. If this happens when upgrading, you can initialize a new database root, load the schema without the additional streams, then manually restore the data.

- **Support for CentOS and RHEL 6 removed**

The officially supported platforms for Volt have been updated. CentOS and RHEL version 6 are no longer officially supported. The current list of supported platforms include CentOS and RHEL version 7.0 or later, Ubuntu versions 14.04, 16.04, and 18.04, and Macintosh OS X 10.9 or later.

- **Support for export and import to Kafka 0.8.2 removed**

The Kafka import and export connectors now require Kafka version 0.10.2 or later.

- **Logging name change from JOIN to ELASTIC**

The log4J logger reporting on elastic changes to Volt clusters has been renamed from JOIN to ELASTIC.

Chapter 5. Upgrading to Volt Active Data V10

This chapter describes what new features are introduced in V10.0. V10.0 does *not* require any changes to client applications or databases prior to upgrading.

5.1. What's New in Volt V10.0

Volt 10.0 is a major release incorporating features from recent updates plus new capabilities. The major new features in V10.0 include:

- **New Volt Operator for Kubernetes** — Volt now offers a complete solution for running Volt databases in a Kubernetes cloud environment. Volt V10.0 provides managed control of the database startup process, a new Volt Operator for coordinating cluster activities, and Helm charts for managing the relationship between Kubernetes, Volt and the Operator. The Volt Kubernetes solution is available to Enterprise customers and includes support for all Volt functionality, including cross data center replication (XDCR). See the *Volt Kubernetes Administrator's Guide* for more information.
- **New Prometheus agent for Volt** — For customers who use Prometheus to monitor their systems, Volt now provides a Prometheus agent that can collect statistics from a running cluster and make them available to the Prometheus engine. The Prometheus agent is available as a Kubernetes container or as a separate process that can either run on one of the Volt servers or remotely and makes itself available through port 1234 by default. See the README file in the `/tools/monitoring/prometheus` folder in the directory where you install Volt for details.
- **Enhancements to Export** — Recent updates to export provide significant improvements to reliability and performance. The key advantages of the new export subsystem are:
 - **Better throughput** — Initial performance tests demonstrate significantly better throughput on export queues using the new subsystem over previous versions of Volt.
 - **Adjustable thread pools** — The new subsystem lets you set the thread pool size for export as a whole or to define thread pools for individual connectors.
 - **Fewer duplicate rows** — When cluster nodes fail and rejoin the cluster, the export subsystem resubmits certain rows to ensure they are delivered. The new subsystem keeps better track of the acknowledged rows and does not need to send as many duplicates to maintain the same level of durability.
- **Improved license management** — Starting with Volt V10.0, specifying the product license has moved from the **voltdb start** command to the **voltdb init** command. In other words, you only have to specify the license once, when you initialize the database root directory, rather than every time you start the database. When you do specify the license on the **init** command, it is stored in the root directory the same way the configuration is.

The same rules apply about the default location of the license as before. So if you store your license in your current working directory, your home directory, or the `/voltdb` subfolder where Volt is installed, you do not need to include the **--license** argument when initializing the database. Also note that the **--license** argument on the **voltdb start** command is now deprecated but still operational. So if you have scripts to start Volt that include **--license** on the **start** command, they will continue to work. However, we recommend you change to the new syntax whenever convenient because support for **voltdb start --license** may be removed in some future major release.

- **Support for RHEL and CentOS V8** — After internal testing and validation, RHEL and CentOS V8 are now supported platforms for production use of Volt.

5.2. Special Considerations for Existing Customers

Volt 10.0 contains no incompatible changes with Volt V9. All existing Volt V9.x databases and client applications can be upgraded to V10.0 as is.

Chapter 6. Upgrading to Volt Active Data V11

This chapter describes what new features are introduced in V11.0 and what upgrade tasks may be required of existing customers.

6.1. What's New in Volt V11.0

Volt 11 is a major release incorporating features from recent updates plus new capabilities. The major new features in V11 include:

- **Volt Topics** — Volt Topics provide the intelligent streaming of Volt's existing import and export capabilities, but with the flexibility of Kafka-like streams. Topics allow for both inbound and outbound streaming to multiple client producers and consumers. They also use the existing Kafka interface to simplify integration into existing infrastructure. But most importantly, they allow for intelligent processing and manipulation of the data as it passes through the pipeline.

Volt topics, which were released as a beta feature in V10.2, are now ready for production use. See the chapter on Streaming Data in the *Using VoltDB* manual for more information.

- **Support for Python 3.6** — The Volt command line tools have been upgraded to use Python version 3. Python 3 is commonly available on modern operating systems and so simplifies the process of configuring platforms for Volt.
- **New Kubernetes capabilities** — Upgrades to the Volt Operator for Kubernetes provide two important new features:
 - **Multi-cluster XDCR** — It is now possible to create a cross datacenter replication (XDCR) network with three or more clusters. Additional Helm properties help simplify the management and maintenance of the XDCR clusters. See the chapter on Database Replication in the *Volt Kubernetes Administrator's Guide* for details.
 - **Volt Topic Support** — The Operator now provides the properties necessary to configure and start Volt topics in clusters running in Kubernetes.
- **Volt Java Client improvements** — The Volt Java client interface has been updated with the following improvements:
 - **Topology Awareness** — Previously, there were two options for handling topology changes on the server, `setReconnectOnConnectionLoss()` and `setTopologyChangeAware()`, which were mutually exclusive. This limitation has been removed and `setTopologyChangeAware()` has been enhanced to include reconnection when the last connection is lost, further improving connectivity and resilience.
 - **Non-Blocking Asynchronous Calls** — Normally, the asynchronous `callProcedure` method returns an error if the client cannot queue the call because of backpressure. However, it is still possible for the call to block in certain cases. It is now possible to avoid blocking entirely by setting the `setNonblockingAsync()` configuration option on the client. See the Javadoc for details.
 - **Connection timeouts** — Handling of connection timeouts by the client has been improved. Now, if the client is able to detect a timeout before it is sent to the server, the client aborts the transaction and returns the procedure status `GRACEFUL_FAILURE`, with a status string of "Procedure call not queued: timed out waiting for host connection."

- **Security updates** — The Volt Management Center (VMC) web-based console for Volt has been updated to the latest versions of the jQuery libraries to address security vulnerabilities. The current library versions for VMC are JQuery v3.5.1 and jQuery-UI v1.12.1.

6.2. Special Considerations for Existing Customers

Most of the new features and capabilities in Volt V11.0 do not impact existing applications. However, there are a few changes that require action for users upgrading from earlier versions. Also several deprecated features have now been removed. Existing customers should take note of the following changes:

- **Supported platforms**

Ubuntu 16.04 is no longer a supported production platform for Volt. The currently supported operating systems for running production Volt databases are:

- CentOS and Red Hat (RHEL) V7.0 and later or V8.0 and later
- Ubuntu 18.04 and 20.04

- **Python 3.6 is now required**

The system requirements for Volt have been changed from Python 2.7 to Python 3.6.

- **Support for LIMIT PARTITION ROWS has been removed**

The LIMIT PARTITION ROWS clause of the CREATE TABLE statement has been removed. The USING TTL clause and scheduled tasks are the recommended replacements for this feature.

- **The deprecated @SnapshotStatus system procedure has been removed**

The @SnapshotStatus system procedure has been deleted. The @Statistics system procedure with the SNAPSHOTSUMMARY selector is the recommended replacement.

Chapter 7. Upgrading to Volt Active Data V12

This chapter describes what new features are introduced in V12.0 and what upgrade tasks may be required of existing customers.

7.1. What's New in Volt V12.0

Volt 12 is a major release that includes several key features. First and foremost, the memory management for the database table data has been rewritten and optimized to reduce certain impediments in the previous implementation. Although this change is primarily internal and transparent to you as a customer, it does have two direct benefits in terms of eliminating development and operational roadblocks:

- **No Large Compaction Events** — As tuples are inserted and deleted, small gaps of unused memory are created within the larger allocated blocks. Previously, if the total amount of allocated but unused memory hit a specific high watermark, the database would compact all of the table memory before continuing. As effective as this mechanism was, it could result in unpredictable latency spikes in the ongoing workload.

Now, defragmentation of data storage is performed incrementally on a per table and per partition basis. Since the compaction transactions are much smaller, and also partitioned, they have little or no impact on the ongoing business workload. In addition, you as the database administrator have control over how large those periodic compaction events are and how often they occur. See the chapter on memory management in the *Volt Performance and Customization Guide* for more information about the new memory management algorithm.

- **No Hash Mismatches Due to Row Order** — In the past, developers had to be careful not to introduce non-deterministic behavior into their stored procedures by performing unordered queries. The issue was that, when using K-Safety, different copies of a partition could return results in a different order if you did not include the appropriate ORDER BY clause.

A key aspect of the memory management scheme introduced in V12.0 is that all copies of a partition now always return a query's results in one, deterministic order, even if the query itself is not sorted. This means that queries without an appropriate ORDER BY clause will not cause a hash mismatch.

Mind you, including an ORDER BY clause is still recommended so you can depend on the order in which the results are returned. Although VoltDB now returns results in a deterministic order, you do not know what that order will be. Also, although the new deterministic row order helps, there are other practices (such as calling system-specific time functions) that still cause hash mismatches and must be avoided. See the section on stored procedures and determinism in the *Using VoltDB* manual for a reminder of what to watch out for.

Other new features introduced in V12.0 and recent releases include:

- **Support for Ubuntu 22.04 and the Rocky OS** — Volt Active Data has added Ubuntu 22.04 and Rocky OS as supported platforms for VoltDB.
- **Support for storing TLS/SSL credentials in Kubernetes secrets** — When enabling TLS/SSL in Kubernetes, you can now store your TLS/SSL credentials (including the keystore, truststore, and passwords) in a Kubernetes secret. This avoids having to specify passwords on the Helm command line and simplifies the commands needed to start and update database instances. See the section on configuring TLS/SSL in the *Volt Kubernetes Administrator's Guide* for details.

- **Expiration dates for user accounts** — You can now specify an expiration date for user accounts in the database configuration file. Once the specified date is past, the associated account can no longer access the database, until the configuration for the user account is updated. The expiration date is optional. See the section on defining users and roles in the *Using VoltDB* manual for details.
- **New LAG() windowing function** — The LAG() function accesses previous rows from the window results using an offset. See the section on windowing functions in the SELECT reference page for more information.
- **Dedicated pod for VMC and HTTP API in Kubernetes** — By default, Volt in Kubernetes now creates a separate pod for the Volt Management Center (VMC) and HTTP API. This provides a single service name for accessing these resources, as well as a single instance for the entire cluster (rather than separate instances for each host). The new pod is available from the service name `{release-name}-voltdb-vmc` where `{release-name}` is the name of the Helm release for the database cluster.

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Chapter 8. Upgrading to Volt Active Data V13

This chapter describes what new features are introduced in V12.0 and what upgrade tasks may be required of existing customers.

8.1. What's New in Volt V13

Volt Active Data V13 is a major release that includes a number of structural enhancements as well as the general availability for production use of features previewed in earlier releases. New features and enhancements in V13.0 include:

- **New Prometheus metrics system** — Volt V13 announces the general production release of a new metrics system, where every server in the cluster reports its own data through a Prometheus-compliant endpoint. You enable Prometheus metrics in the configuration file when initializing the database by adding the `<metrics>` element to the Volt configuration file:

```
<deployment>
  <cluster kfactor="1"/>
  <metrics enabled="true"/>
</deployment>
```

Once enabled, each Volt server reports server-specific information through the metrics port, which defaults to 11781. The new metrics system replaces the standalone Prometheus agent, which has now been deprecated. See the sections on integrating with Prometheus in the *Volt Administrator's Guide* and *Volt Kubernetes Administrator's Guide*.

- **New Grafana dashboards** — To match the new metrics system, Volt provides sample Grafana dashboards to help visualize your database's performance and status. There are matching dashboards designed for use with Kubernetes and bare metal:
 - Kubernetes dashboards: <https://github.com/VoltDB/volt-monitoring/tree/main/dashboards/Volt-K8s-13.x/new-metrics>
 - Bare metal dashboards: <https://github.com/VoltDB/volt-monitoring/tree/main/dashboards/Volt-V13.x/new-metrics>
- **Support for alternate character sets** — Volt provides full support for international characters through its use of UTF-8 for storing and displaying textual data. However, there are other character encodings that may be in use by customers, including both older, established encodings such as Shift_JIS and newer encodings like the Chinese GB18030-2022 standard. For customers using alternate character encodings as the default in their client environment, Volt now provides automatic conversion of character encodings both interactively and for file input. The **sqlcmd** utility automatically converts to and from the terminal session's localized character set for input and display. When reading and writing files, you can use the `--charset` qualifier to specify the character encoding of the file, both with the **sqlcmd** and **csvloader** utilities.
- **Improved command line interface for the sqlcmd utility** — In addition to full character set support, the **sqlcmd** utility has a more complete and consistent set of command line qualifiers. The new `--output-file` qualifier captures the output of SQL statements; it does not echo the commands or informational messages. When used with the `--output-format=csv` qualifier, `--output-file` now generates valid CSV files without extraneous lines. Similarly, the `--file` qualifier lets you process a

file containing any valid **sqlcmd** statements or directives. And if the file contains only data definition language (DDL) statements, you can use the `--batch` qualifier to process all of the statement as a single batch significantly reducing the time required to update the schema. See the **sqlcmd** reference page for these and other improvements to the **sqlcmd** utility.

- **Beta support for ARM architecture** — Beta software kits for running the VoltDB server software natively on ARM64 architecture are now available. If you are interested in participating in the ARM64 beta program, please contact your Volt Customer Success Manager.
- **Support for Kubernetes 1.27** — Volt Active Data now supports version 1.27 of the Kubernetes platform. See the *Kubernetes Compatibility Chart* for details on what versions of Kubernetes are supported by each version of VoltDB.

8.2. Special Considerations for Existing Customers

The new features and capabilities in VoltDB V13.0 do not impact existing applications. However, there are a few changes that require action for users upgrading from earlier versions. Existing customers should take note of the following changes:

- **Ubuntu 18.04 and CentOS/RHEL V7 are no longer supported**

Starting with V13, Ubuntu 18.04, which has reached end of life, and CentOS and Red Hat V7 are no longer supported as production platforms for Volt Active Data. Although the VoltDB software may continue to run, we strongly recommend upgrading to either Ubuntu 22.04 or Rocky Linux or RHEL V8.6 or later for production use.

- **The standalone Prometheus agent is deprecated**

Support for Prometheus data scraping was originally provided by a separate Prometheus agent (run in a separate pod on Kubernetes). That original cluster-wide agent has been replaced with a new metrics system that provides Prometheus endpoints on all of the cluster nodes, each reporting its own data. As a result, the standalone Prometheus agent has been deprecated and will be removed in a future release.