Hadoop Foreign Data Wrapper Guide

Version 2.0.7

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1	Hadoop Foreign Data Wrapper Guide	3
2	What's New	3
3	Requirements Overview	3
4	Architecture Overview	4
5	Supported Authentication Methods	4
6	Installing the Hadoop Foreign Data Wrapper	5
7	Updating the Hadoop Foreign Data Wrapper	12
8	Features of the Hadoop Foreign Data Wrapper	12
9	Configuring the Hadoop Foreign Data Wrapper	13
10	Using the Hadoop Foreign Data Wrapper	23
11	Identifying the Hadoop Foreign Data Wrapper Version	29
12	Uninstalling the Hadoop Foreign Data Wrapper	29

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1 Hadoop Foreign Data Wrapper Guide

The Hadoop Foreign Data Wrapper (`hdfs_fdw`) is a Postgres extension that allows you to access data that resides on a Hadoop file system from EDB Postgres Advanced Server. The foreign data wrapper makes the Hadoop file system a read-only data source that you can use with Postgres functions and utilities, or in conjunction with other data that resides on a Postgres host.

The Hadoop Foreign Data Wrapper can be installed with an RPM package. You can download an installer from the EDB website.

This guide uses the term `Postgres` to refer to an instance of EDB Postgres Advanced Server.

2 What's New

The following features are added to create Hadoop Foreign Data Wrapper `2.0.7`:

- Support for EDB Postgres Advanced Server 13.
- Support for Ubuntu 20.04 LTS platform.

3 Requirements Overview

Supported Versions

The Hadoop Foreign Data Wrapper is certified with EDB Postgres Advanced Server 9.6 and above.

Supported Platforms

The Hadoop Foreign Data Wrapper is supported on the following platforms:

Linux x86-64

- RHEL 8.x and 7.x
- CentOS 8.x and 7.x
- OL 8.x and 7.x
- Ubuntu 20.04 and 18.04 LTS
- Debian 10.x and 9.x

Linux on IBM Power8/9 (LE)

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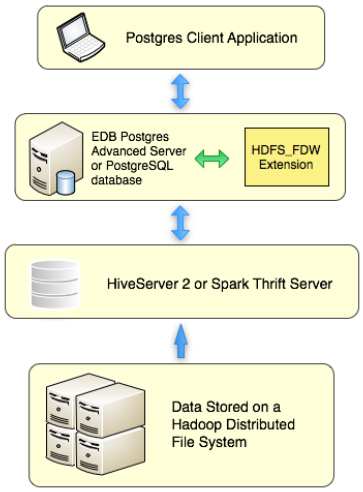
- RHEL 7.x

The Hadoop Foreign Data Wrapper supports use of the Hadoop file system using a HiveServer2 interface or Apache Spark using the Spark Thrift Server.

4 Architecture Overview

Hadoop is a framework that allows you to store a large data set in a distributed file system.

The Hadoop data wrapper provides an interface between a Hadoop file system and a Postgres database. The Hadoop data wrapper transforms a Postgres `SELECT` statement into a query that is understood by the HiveQL or Spark SQL interface.



When possible, the Foreign Data Wrapper asks the Hive or Spark server to perform the actions associated with the `WHERE` clause of a `SELECT` statement. Pushing down the `WHERE` clause improves performance by decreasing the amount of data moving across the network.

5 Supported Authentication Methods

The Hadoop Foreign Data Wrapper supports `NOSASL` and `LDAP` authentication modes. To use `NOSASL`, do not specify any `OPTIONS` while creating user mapping. For `LDAP` authentication mode, specify `username` and `password` in `OPTIONS` while creating user mapping.

Using LDAP Authentication

When using the Hadoop Foreign Data Wrapper with `LDAP` authentication, you must first configure the `Hive Server` or `Spark Server` to use LDAP authentication. The configured server must provide a `hive-site.xml`

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file that includes the connection details for the LDAP server. For example:

```
<property>
  <name>hive.server2.authentication</name>
  <value>LDAP</value>
  <description>
    Expects one of [nosasl, none, ldap, kerberos, pam, custom].
    Client authentication types.
      NONE: no authentication check
      LDAP: LDAP/AD based authentication
      KERBEROS: Kerberos/GSSAPI authentication
      CUSTOM: Custom authentication provider
              (Use with property hive.server2.custom.authentication.class)
      PAM: Pluggable authentication module
      NOSASL:  Raw transport
  </description>
</property>
<property>
  <name>hive.server2.authentication.ldap.url</name>
  <value>ldap://localhost</value>
  <description>LDAP connection URL</description>
</property>
<property>
  <name>hive.server2.authentication.ldap.baseDN</name>
  <value>ou=People,dc=itzgeek,dc=local</value>
  <description>LDAP base DN</description>
</property>
```

Then, when starting the hive server, include the path to the `hive-site.xml` file in the command. For example:

```
./hive --config path_to_hive-site.xml_file --service hiveServer2
```

Where *path_to_hive-site.xml_file* specifies the complete path to the `hive-site.xml` file.

When creating the user mapping, you must provide the name of a registered LDAP user and the corresponding password as options. For details, see Create User Mapping.

Using NOSASL Authentication

When using `NOSASL` authentication with the Hadoop Foreign Data Wrapper, set the authorization to `None`, and the authentication method to `NOSASL` on the `Hive Server` or `Spark Server`. For example, if you start the `Hive Server` at the command line, include the `hive.server2.authentication` configuration parameter in the command:

```
hive --service hiveserver2 --hiveconf hive.server2.authentication=NOSASL
```

6 Installing the Hadoop Foreign Data Wrapper

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The Hadoop Foreign Data Wrapper can be installed with an RPM package. During the installation process, the installer will satisfy software prerequisites.

Installing the Hadoop Foreign Data Wrapper using an RPM Package

You can install the Hadoop Foreign Data Wrapper using an RPM package on the following platforms:

- RHEL 7
- RHEL 8
- CentOS 7
- CentOS 8

On RHEL 7

Before installing the Hadoop Foreign Data Wrapper, you must install the following prerequisite packages, and request credentials from EDB:

Install the `epel-release` package:

```
yum -y install https://dl.fedoraproject.org/pub/epel/epel-release-latest-7.noarch.rpm
```

Enable the optional, extras, and HA repositories:

```
subscription-manager repos --enable "rhel-*-optional-rpms" --enable "rhel-*-extras-rpms"  --enable "rhel-ha-for-rhel-*-server-rpms"
```

You must also have credentials that allow access to the EDB repository. For information about requesting credentials, visit:

https://info.enterprisedb.com/rs/069-ALB-339/images/Repository%20Access%2004-09-2019.pdf

After receiving your repository credentials you can:

1. Create the repository configuration file.
2. Modify the file, providing your user name and password.
3. Install `edb-as<xx>-hdfs_fdw`.

Creating a Repository Configuration File

To create the repository configuration file, assume superuser privileges, and invoke the following command:

```
yum -y install https://yum.enterprisedb.com/edbrepos/edb-repo-latest.noarch.rpm
```

The repository configuration file is named `edb.repo`. The file resides in `/etc/yum.repos.d`.

Modifying the file, providing your user name and password

After creating the `edb.repo` file, use your choice of editor to ensure that the value of the `enabled` parameter is `1`, and replace the `username` and `password` placeholders in the `baseurl` specification with the name and password of a registered EDB user.

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```
[edb]
name=EnterpriseDB RPMs $releasever - $basearch
baseurl=https://<username>:<password>@yum.enterprisedb.com/edb/redhat/rhel-
$releasever-$basearch
enabled=1
gpgcheck=1
repo_gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/ENTERPRISEDB-GPG-KEY
```

Installing Hadoop Foreign Data Wrapper

After saving your changes to the configuration file, use the following commands to install the Hadoop Foreign Data Wrapper:

```
yum install edb-as<xx>-hdfs_fdw
```

where `xx` is the server version number.

When you install an RPM package that is signed by a source that is not recognized by your system, yum may ask for your permission to import the key to your local server. If prompted, and you are satisfied that the packages come from a trustworthy source, enter `y`, and press `Return` to continue.

During the installation, yum may encounter a dependency that it cannot resolve. If it does, it will provide a list of the required dependencies that you must manually resolve.

On RHEL 8

Before installing the Hadoop Foreign Data Wrapper, you must install the following prerequisite packages, and request credentials from EDB:

Install the `epel-release` package:

```
dnf -y install https://dl.fedoraproject.org/pub/epel/epel-release-latest-
8.noarch.rpm
```

Enable the `codeready-builder-for-rhel-8-\*-rpms` repository:

```
ARCH=$( /bin/arch )
subscription-manager repos --enable "codeready-builder-for-rhel-8-${ARCH}-rpms"
```

You must also have credentials that allow access to the EDB repository. For information about requesting credentials, visit:

https://info.enterprisedb.com/rs/069-ALB-339/images/Repository%20Access%2004-09-2019.pdf

After receiving your repository credentials you can:

1. Create the repository configuration file.
2. Modify the file, providing your user name and password.
3. Install `edb-as<xx>-hdfs_fdw`.

Creating a Repository Configuration File

To create the repository configuration file, assume superuser privileges, and invoke the following command:

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```
dnf -y https://yum.enterprisedb.com/edbrepos/edb-repo-latest.noarch.rpm
```

The repository configuration file is named `edb.repo`. The file resides in `/etc/yum.repos.d`.

Modifying the file, providing your user name and password

After creating the `edb.repo` file, use your choice of editor to ensure that the value of the `enabled` parameter is `1`, and replace the `username` and `password` placeholders in the `baseurl` specification with the name and password of a registered EDB user.

```
[edb]
name=EnterpriseDB RPMs $releasever - $basearch
baseurl=https://<username>:<password>@yum.enterprisedb.com/edb/redhat/rhel-
$releasever-$basearch
enabled=1
gpgcheck=1
repo_gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/ENTERPRISEDB-GPG-KEY
```

Installing Hadoop Foreign Data Wrapper

After saving your changes to the configuration file, use the below command to install the Hadoop Foreign Data Wrapper:

```
dnf install edb-as<xx>-hdfs_fdw
```

When you install an RPM package that is signed by a source that is not recognized by your system, yum may ask for your permission to import the key to your local server. If prompted, and you are satisfied that the packages come from a trustworthy source, enter `y`, and press `Return` to continue.

During the installation, yum may encounter a dependency that it cannot resolve. If it does, it will provide a list of the required dependencies that you must manually resolve.

On CentOS 7

Before installing the Hadoop Foreign Data Wrapper, you must install the following prerequisite packages, and request credentials from EDB:

Install the `epel-release` package:

```
yum -y install https://dl.fedoraproject.org/pub/epel/epel-release-latest-
7.noarch.rpm
```

!!! Note You may need to enable the `[extras]` repository definition in the `CentOS-Base.repo` file (located in `/etc/yum.repos.d`).

You must also have credentials that allow access to the EDB repository. For information about requesting credentials, visit:

https://www.enterprisedb.com/user/login

After receiving your repository credentials you can:

1. Create the repository configuration file.

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2. Modify the file, providing your user name and password.
3. Install `edb-as<xx>-hdfs_fdw`.

Creating a Repository Configuration File

To create the repository configuration file, assume superuser privileges, and invoke the following command:

```
yum -y install https://yum.enterprisedb.com/edbrepos/edb-repo-latest.noarch.rpm
```

The repository configuration file is named `edb.repo`. The file resides in `/etc/yum.repos.d`.

Modifying the file, providing your user name and password

After creating the `edb.repo` file, use your choice of editor to ensure that the value of the `enabled` parameter is `1`, and replace the `username` and `password` placeholders in the `baseurl` specification with the name and password of a registered EDB user.

```
[edb]
name=EnterpriseDB RPMs $releasever - $basearch
baseurl=https://<username>:<password>@yum.enterprisedb.com/edb/redhat/rhel-
$releasever-$basearch
enabled=1
gpgcheck=1
repo_gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/ENTERPRISEDB-GPG-KEY
```

Installing Hadoop Foreign Data Wrapper

After saving your changes to the configuration file, use the following command to install the Hadoop Foreign Data Wrapper:

```
yum install edb-as<xx>-hdfs_fdw
```

where `xx` is the server version number.

When you install an RPM package that is signed by a source that is not recognized by your system, yum may ask for your permission to import the key to your local server. If prompted, and you are satisfied that the packages come from a trustworthy source, enter `y`, and press `Return` to continue.

During the installation, yum may encounter a dependency that it cannot resolve. If it does, it will provide a list of the required dependencies that you must manually resolve.

On CentOS 8

Before installing the Hadoop Foreign Data Wrapper, you must install the following prerequisite packages, and request credentials from EDB:

Install the `epel-release` package:

```
dnf -y install https://dl.fedoraproject.org/pub/epel/epel-release-latest-
8.noarch.rpm
```

Enable the `PowerTools` repository:

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```
dnf config-manager --set-enabled PowerTools
```

You must also have credentials that allow access to the EDB repository. For information about requesting credentials, visit:

https://info.enterprisedb.com/rs/069-ALB-339/images/Repository%20Access%2004-09-2019.pdf

After receiving your repository credentials you can:

1. Create the repository configuration file.
2. Modify the file, providing your user name and password.
3. Install `edb-as<xx>-hdfs_fdw`.

Creating a Repository Configuration File

To create the repository configuration file, assume superuser privileges, and invoke the following command:

```
dnf -y install https://yum.enterprisedb.com/edbrepos/edb-repo-latest.noarch.rpm
```

The repository configuration file is named `edb.repo`. The file resides in `/etc/yum.repos.d`.

Modifying the file, providing your user name and password

After creating the `edb.repo` file, use your choice of editor to ensure that the value of the `enabled` parameter is `1`, and replace the `username` and `password` placeholders in the `baseurl` specification with the name and password of a registered EDB user.

```
[edb]
name=EnterpriseDB RPMs $releasever - $basearch
baseurl=https://<username>:<password>@yum.enterprisedb.com/edb/redhat/rhel-
$releasever-$basearch
enabled=1
gpgcheck=1
repo_gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/ENTERPRISEDB-GPG-KEY
```

Installing Hadoop Foreign Data Wrapper

After saving your changes to the configuration file, use the following command to install the Hadoop Foreign Data Wrapper:

```
dnf install edb-as<xx>-hdfs_fdw
```

where `xx` is the server version number.

When you install an RPM package that is signed by a source that is not recognized by your system, yum may ask for your permission to import the key to your local server. If prompted, and you are satisfied that the packages come from a trustworthy source, enter `y`, and press `Return` to continue.

During the installation, yum may encounter a dependency that it cannot resolve. If it does, it will provide a list of the required dependencies that you must manually resolve.

Installing the Hadoop Foreign Data Wrapper on a Debian or Ubuntu Host

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To install the Hadoop Foreign Data Wrapper on a Debian or Ubuntu host, you must have credentials that allow access to the EDB repository. To request credentials for the repository, visit the EDB website.

The following steps will walk you through on using the EDB apt repository to install a Debian package. When using the commands, replace the `username` and `password` with the credentials provided by EDB.

1. Assume superuser privileges:

```
sudo su -
```

2. Configure the EnterpriseDB repository:

   On Debian 9 and Ubuntu:

```
sh -c 'echo "deb https://username:password@apt.enterprisedb.com/$(lsb_release
-cs)-edb/ $(lsb_release -cs) main" > /etc/apt/sources.list.d/edb-$(lsb_release
-cs).list'
```

   On Debian 10:

   1. Set up the EDB repository:

```
sh -c 'echo "deb [arch=amd64] https://apt.enterprisedb.com/$(lsb_release -cs)-
edb/ $(lsb_release -cs) main" > /etc/apt/sources.list.d/edb-$(lsb_release -
cs).list'
```

   1. Substitute your EDB credentials for the `username` and `password` in the following command:

```
sh -c 'echo "machine apt.enterprisedb.com login <username> password
<password>" > /etc/apt/auth.conf.d/edb.conf'
```

3. Add support to your system for secure APT repositories:

```
apt-get install apt-transport-https
```

4. Add the EDB signing key:

```
wget -q -O - https://username:password
@apt.enterprisedb.com/edb-deb.gpg.key | apt-key add -
```

5. Update the repository metadata:

```
apt-get update
```

6. Install the package:

```
apt-get install edb-as<xx>-hdfs-fdw
```

where `xx` is the server version number.

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7 Updating the Hadoop Foreign Data Wrapper

Updating an RPM Installation

If you have an existing RPM installation of Hadoop Foreign Data Wrapper, you can use yum or dnf to upgrade your repository configuration file and update to a more recent product version. To update the `edb.repo` file, assume superuser privileges and enter:

- On RHEL or CentOS 7:

  ```
  yum upgrade edb-repo
  ```

- On RHEL or CentOS 8:

  ```
  dnf upgrade edb-repo
  ```

yum or dnf will update the `edb.repo` file to enable access to the current EDB repository, configured to connect with the credentials specified in your `edb.repo` file. Then, you can use yum or dnf to upgrade any installed packages:

- On RHEL or CentOS 7:

  ```
  yum upgrade edb-as<xx>-hdfs_fdw
  ```

  where `xx` is the server version number.

- On RHEL or CentOS 8:

  ```
  dnf upgrade edb-as<xx>-hdfs_fdw
  ```

  where `xx` is the server version number.

Updating MongoDB Foreign Data Wrapper on a Debian or Ubuntu Host

To update MongoDB Foreign Data Wrapper on a Debian or Ubuntu Host, use the following command:

```
apt-get --only-upgrade install edb-as<xx>-hdfs-fdw
```

where `xx` is the server version number.

8 Features of the Hadoop Foreign Data Wrapper

The key features of the Hadoop Foreign Data Wrapper are listed below:

Where Clause Push-down

Hadoop Foreign Data Wrappper allows the push-down of `WHERE` clause to the foreign server for execution. This

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feature optimizes remote queries to reduce the number of rows transferred from foreign servers.

Column Push-down

Hadoop Foreign Data Wrapper supports column push-down. As a result, the query brings back only those columns that are a part of the select target list.

Automated Cleanup

Hadoop Foreign Data Wrappper allows the cleanup of foreign tables in a single operation using `DROP EXTENSION` command. This feature is specifically useful when a foreign table is set for a temporary purpose. The syntax is:

```
DROP EXTENSION hdfs_fdw CASCADE;
```

For more information, see DROP EXTENSION.

---

9 Configuring the Hadoop Foreign Data Wrapper

Before creating the extension and the database objects that use the extension, you must modify the Postgres host, providing the location of the supporting libraries.

After installing Postgres, modify the `postgresql.conf` located in:

```
/var/lib/edb/as_version/data
```

Modify the configuration file with your editor of choice, adding the `hdfs_fdw.jvmpath` parameter to the end of the configuration file, and setting the value to specify the location of the Java virtual machine (`libjvm.so`). Set the value of `hdfs_fdw.classpath` to indicate the location of the java class files used by the adapter; use a colon (:) as a delimiter between each path. For example:

```
hdfs_fdw.classpath=
'/usr/edb/as12/lib/HiveJdbcClient-
1.0.jar:/home/edb/Projects/hadoop_fdw/hadoop/share/hadoop/common/hadoop-
common-2.6.4.jar:/home/edb/Projects/hadoop_fdw/apache-hive-1.0.1-
bin/lib/hive-jdbc-1.0.1-standalone.jar'
```

!!! Note The jar files (hive-jdbc-1.0.1-standalone.jar and hadoop-common-2.6.4.jar) mentioned in the above example should be copied from respective Hive and Hadoop sources or website to PostgreSQL instance where Hadoop Foreign Data Wrapper is installed.

```
If you are using EDB Advanced Server and have a `DATE` column in your
database, you must set `edb_redwood_date = OFF` in the `postgresql.conf`
file.
```

After setting the parameter values, restart the Postgres server. For detailed information about controlling the service on an Advanced Server host, see the EDB Postgres Advanced Server Installation Guide, available at:

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> https://www.enterprisedb.com/resources/product-documentation

Before using the Hadoop Foreign Data Wrapper, you must:

1. Use the CREATE EXTENSION command to create the extension on the Postgres host.
2. Use the CREATE SERVER command to define a connection to the Hadoop file system.
3. Use the CREATE USER MAPPING command to define a mapping that associates a Postgres role with the server.
4. Use the CREATE FOREIGN TABLE command to define a table in the Advanced Server database that corresponds to a database that resides on the Hadoop cluster.

CREATE EXTENSION

Use the `CREATE EXTENSION` command to create the `hdfs_fdw` extension. To invoke the command, use your client of choice (for example, psql) to connect to the Postgres database from which you will be querying the Hive or Spark server, and invoke the command:

```
CREATE EXTENSION [IF NOT EXISTS] hdfs_fdw [WITH] [SCHEMA schema_name];
```

Parameters

`IF NOT EXISTS`

> Include the `IF NOT EXISTS` clause to instruct the server to issue a notice instead of throwing an error if an extension with the same name already exists.

`schema_name`

> Optionally specify the name of the schema in which to install the extension's objects.

Example

The following command installs the `hdfs_fdw` hadoop foreign data wrapper:

```
CREATE EXTENSION hdfs_fdw;
```

For more information about using the foreign data wrapper `CREATE EXTENSION` command, see:

> https://www.postgresql.org/docs/current/static/sql-createextension.html.

CREATE SERVER

Use the `CREATE SERVER` command to define a connection to a foreign server. The syntax is:

```
CREATE SERVER server_name FOREIGN DATA WRAPPER hdfs_fdw
    [OPTIONS (option 'value' [, ...])]
```

The role that defines the server is the owner of the server; use the `ALTER SERVER` command to reassign ownership of a foreign server. To create a foreign server, you must have `USAGE` privilege on the foreign-data wrapper specified in the `CREATE SERVER` command.

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Parameters

`server_name`

> Use `server_name` to specify a name for the foreign server. The server name must be unique within the database.

`FOREIGN_DATA_WRAPPER`

> Include the `FOREIGN_DATA_WRAPPER` clause to specify that the server should use the `hdfs_fdw` foreign data wrapper when connecting to the cluster.

`OPTIONS`

> Use the `OPTIONS` clause of the `CREATE SERVER` command to specify connection information for the foreign server. You can include:

Option	Description
host	The address or hostname of the Hadoop cluster. The default value is `localhost`.
port	The port number of the Hive Thrift Server or Spark Thrift Server. The default is `10000`.
client_type	Specify hiveserver2 or spark as the client type. To use the ANALYZE statement on Spark, you must specify a value of spark; if you do not specify a value for client_type, the default value is hiveserver2.
auth_type	The authentication type of the client; specify LDAP or NOSASL. If you do not specify an auth_type, the data wrapper will decide the auth_type value on the basis of the user mapping:- If the user mapping includes a user name and password, the data wrapper will use LDAP authentication. - If the user mapping does not include a user name and password, the data wrapper will use NOSASL authentication.
connect_timeout	The length of time before a connection attempt times out. The default value is `300` seconds.
fetch_size	A user-specified value that is provided as a parameter to the JDBC API setFetchSize. The default value is `10,000`.
log_remote_sql	If true, logging will include SQL commands executed on the remote hive server and the number of times that a scan is repeated. The default is `false`.
query_timeout	Use query_timeout to provide the number of seconds after which a request will timeout if it is not satisfied by the Hive server. Query timeout is not supported by the Hive JDBC driver.
use_remote_estimate	Include the use_remote_estimate to instruct the server to use EXPLAIN commands on the remote server when estimating processing costs. By default, use_remote_estimate is false, and remote tables are assumed to have `1000` rows.

Example

The following command creates a foreign server named `hdfs_server` that uses the `hdfs_fdw` foreign data wrapper to connect to a host with an IP address of `170.11.2.148`:

```
CREATE SERVER hdfs_server FOREIGN DATA WRAPPER hdfs_fdw OPTIONS (host
'170.11.2.148', port '10000', client_type 'hiveserver2', auth_type 'LDAP',
connect_timeout '10000', query_timeout '10000');
```

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The foreign server uses the default port (`10000`) for the connection to the client on the Hadoop cluster; the connection uses an LDAP server.

For more information about using the `CREATE SERVER` command, see:

> https://www.postgresql.org/docs/current/static/sql-createserver.html

CREATE USER MAPPING

Use the `CREATE USER MAPPING` command to define a mapping that associates a Postgres role with a foreign server:

```
CREATE USER MAPPING FOR role_name SERVER server_name
       [OPTIONS (option 'value' [, ...])];
```

You must be the owner of the foreign server to create a user mapping for that server.

Please note: the Hadoop Foreign Data Wrapper supports NOSASL and LDAP authentication. If you are creating a user mapping for a server that uses LDAP authentication, use the `OPTIONS` clause to provide the connection credentials (the username and password) for an existing LDAP user. If the server uses NOSASL authentication, omit the OPTIONS clause when creating the user mapping.

Parameters

`role_name`

> Use `role_name` to specify the role that will be associated with the foreign server.

`server_name`

> Use `server_name` to specify the name of the server that defines a connection to the Hadoop cluster.

`OPTIONS`

> Use the `OPTIONS` clause to specify connection information for the foreign server. If you are using LDAP authentication, provide a:
>
> `username`: the name of the user on the LDAP server.
>
> `password`: the password associated with the username.
>
> If you do not provide a user name and password, the data wrapper will use NOSASL authentication.

Example

The following command creates a user mapping for a role named `enterprisedb`; the mapping is associated with a server named `hdfs_server`:

> `CREATE USER MAPPING FOR enterprisedb SERVER hdfs_server;`

If the database host uses LDAP authentication, provide connection credentials when creating the user mapping:

```
CREATE USER MAPPING FOR enterprisedb SERVER hdfs_server OPTIONS (username
```

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```
'alice', password '1safepwd');
```

The command creates a user mapping for a role named `enterprisedb` that is associated with a server named `hdfs_server`. When connecting to the LDAP server, the Hive or Spark server will authenticate as `alice`, and provide a password of `1safepwd`.

For detailed information about the `CREATE USER MAPPING` command, see:

> https://www.postgresql.org/docs/current/static/sql-createusermapping.html

CREATE FOREIGN TABLE

A foreign table is a pointer to a table that resides on the Hadoop host. Before creating a foreign table definition on the Postgres server, connect to the Hive or Spark server and create a table; the columns in the table will map to to columns in a table on the Postgres server. Then, use the `CREATE FOREIGN TABLE` command to define a table on the Postgres server with columns that correspond to the table that resides on the Hadoop host. The syntax is:

```
CREATE FOREIGN TABLE [ IF NOT EXISTS ] table_name ( [
  { column_name data_type [ OPTIONS ( option 'value' [, ... ] ) ] [ COLLATE
collation ] [ column_constraint [ ... ] ]
    | table_constraint }
    [, ... ]
] )
[ INHERITS ( parent_table [, ... ] ) ]
  SERVER server_name [ OPTIONS ( option 'value' [, ... ] ) ]
```

where `column_constraint` is:

```
[ CONSTRAINT constraint_name ]
{ NOT NULL | NULL | CHECK (expr) [ NO INHERIT ] | DEFAULT default_expr }
```

and `table_constraint` is:

```
[ CONSTRAINT constraint_name ] CHECK (expr) [ NO INHERIT ]
```

Parameters

`table_name`

> Specifies the name of the foreign table; include a schema name to specify the schema in which the foreign table should reside.

`IF NOT EXISTS`

> Include the `IF NOT EXISTS` clause to instruct the server to not throw an error if a table with the same name already exists; if a table with the same name exists, the server will issue a notice.

`column_name`

> Specifies the name of a column in the new table; each column should correspond to a column described on the Hive or Spark server.

`data_type`

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> Specifies the data type of the column; when possible, specify the same data type for each column on the Postgres server and the Hive or Spark server. If a data type with the same name is not available, the Postgres server will attempt to cast the data type to a type compatible with the Hive or Spark server. If the server cannot identify a compatible data type, it will return an error.

`COLLATE collation`

> Include the `COLLATE` clause to assign a collation to the column; if not specified, the column data type's default collation is used.

`INHERITS (parent_table [, ... ])`

> Include the `INHERITS` clause to specify a list of tables from which the new foreign table automatically inherits all columns. Parent tables can be plain tables or foreign tables.

`CONSTRAINT constraint_name`

> Specify an optional name for a column or table constraint; if not specified, the server will generate a constraint name.

`NOT NULL`

> Include the `NOT NULL` keywords to indicate that the column is not allowed to contain null values.

`NULL`

> Include the `NULL` keywords to indicate that the column is allowed to contain null values. This is the default.

`CHECK (expr) [NO INHERIT]`

> Use the `CHECK` clause to specify an expression that produces a Boolean result that each row in the table must satisfy. A check constraint specified as a column constraint should reference that column's value only, while an expression appearing in a table constraint can reference multiple columns.
>
> A `CHECK` expression cannot contain subqueries or refer to variables other than columns of the current row.
>
> Include the `NO INHERIT` keywords to specify that a constraint should not propagate to child tables.

`DEFAULT default_expr`

> Include the `DEFAULT` clause to specify a default data value for the column whose column definition it appears within. The data type of the default expression must match the data type of the column.

`SERVER server_name [OPTIONS (option 'value' [, ... ] ) ]`

> To create a foreign table that will allow you to query a table that resides on a Hadoop file system, include the `SERVER` clause and specify the `server_name` of the foreign server that uses the Hadoop data adapter.
>
> Use the `OPTIONS` clause to specify the following `options` and their corresponding values:

option	value
dbname	The name of the database on the Hive server; the database name is required.
table_name	The name of the table on the Hive server; the default is the name of the foreign table.

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Example

To use data that is stored on a distributed file system, you must create a table on the Postgres host that maps the columns of a Hadoop table to the columns of a Postgres table. For example, for a Hadoop table with the following definition:

```
CREATE TABLE weblogs (
 client_ip           STRING,
 full_request_date   STRING,
 day                 STRING,
 month               STRING,
 month_num           INT,
 year                STRING,
 hour                STRING,
 minute              STRING,
 second              STRING,
 timezone            STRING,
 http_verb           STRING,
 uri                 STRING,
 http_status_code    STRING,
 bytes_returned      STRING,
 referrer            STRING,
 user_agent          STRING)
row format delimited
fields terminated by '\t';
```

You should execute a command on the Postgres server that creates a comparable table on the Postgres server:

```
CREATE FOREIGN TABLE weblogs
(
 client_ip               TEXT,
 full_request_date       TEXT,
 day                     TEXT,
 Month                   TEXT,
 month_num               INTEGER,
 year                    TEXT,
 hour                    TEXT,
 minute                  TEXT,
 second                  TEXT,
 timezone                TEXT,
 http_verb               TEXT,
 uri                     TEXT,
 http_status_code        TEXT,
 bytes_returned          TEXT,
 referrer                TEXT,
 user_agent              TEXT
)
SERVER hdfs_server
        OPTIONS (dbname 'webdata', table_name 'weblogs');
```

Include the `SERVER` clause to specify the name of the database stored on the Hadoop file system (`webdata`) and the name of the table (`weblogs`) that corresponds to the table on the Postgres server.

For more information about using the `CREATE FOREIGN TABLE` command, see:

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> https://www.postgresql.org/docs/current/static/sql-createforeigntable.html

Data Type Mappings

When using the foreign data wrapper, you must create a table on the Postgres server that mirrors the table that resides on the Hive server. The Hadoop data wrapper will automatically convert the following Hive data types to the target Postgres type:

Hive	Postgres
BIGINT	BIGINT/INT8
BOOLEAN	BOOL/BOOLEAN
BINARY	BYTEA
CHAR	CHAR
DATE	DATE
DOUBLE	FLOAT8
FLOAT	FLOAT/FLOAT4
INT/INTEGER	INT/INTEGER/INT4
SMALLINT	SMALLINT/INT2
STRING	TEXT
TIMESTAMP	TIMESTAMP
TINYINT	INT2
VARCHAR	VARCHAR

DROP EXTENSION

Use the `DROP EXTENSION` command to remove an extension. To invoke the command, use your client of choice (for example, psql) to connect to the Postgres database from which you will be dropping the Hadoop server, and run the command:

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

Parameters

`IF EXISTS`

> Include the `IF EXISTS` clause to instruct the server to issue a notice instead of throwing an error if an extension with the specified name doesn't exists.

`name`

> Specify the name of the installed extension. It is optional.
>
> `CASCADE`
>
> Automatically drop objects that depend on the extension. It drops all the other dependent objects too.
>
> `RESTRICT`

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> Do not allow to drop extension if any objects, other than its member objects and extensions listed in the same DROP command are dependent on it.

Example

The following command removes the extension from the existing database:

```
DROP EXTENSION hdfs_fdw;
```

For more information about using the foreign data wrapper `DROP EXTENSION` command, see:

> https://www.postgresql.org/docs/current/sql-dropextension.html.

DROP SERVER

Use the `DROP SERVER` command to remove a connection to a foreign server. The syntax is:

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

The role that drops the server is the owner of the server; use the `ALTER SERVER` command to reassign ownership of a foreign server. To drop a foreign server, you must have `USAGE` privilege on the foreign-data wrapper specified in the `DROP SERVER` command.

Parameters

`IF EXISTS`

> Include the `IF EXISTS` clause to instruct the server to issue a notice instead of throwing an error if a server with the specified name doesn't exists.

`name`

> Specify the name of the installed server. It is optional.
>
> `CASCADE`
>
> Automatically drop objects that depend on the server. It should drop all the other dependent objects too.
>
> `RESTRICT`
>
> Do not allow to drop the server if any objects are dependent on it.

Example

The following command removes a foreign server named `hdfs_server`:

```
DROP SERVER hdfs_server;
```

For more information about using the `DROP SERVER` command, see:

> https://www.postgresql.org/docs/current/sql-dropserver.html

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DROP USER MAPPING

Use the `DROP USER MAPPING` command to remove a mapping that associates a Postgres role with a foreign server. You must be the owner of the foreign server to remove a user mapping for that server.

```
DROP USER MAPPING [ IF EXISTS ] FOR { user_name | USER | CURRENT_USER | PUBLIC }
SERVER server_name;
```

Parameters

`IF EXISTS`

> Include the `IF EXISTS` clause to instruct the server to issue a notice instead of throwing an error if the user mapping doesn't exist.

`user_name`

> Specify the user name of the mapping.

`server_name`

> Specify the name of the server that defines a connection to the Hadoop cluster.

Example

The following command drops a user mapping for a role named `enterprisedb`; the mapping is associated with a server named `hdfs_server`:

```
DROP USER MAPPING FOR enterprisedb SERVER hdfs_server;
```

For detailed information about the `DROP USER MAPPING` command, see:

> https://www.postgresql.org/docs/current/static/sql-dropusermapping.html

DROP FOREIGN TABLE

A foreign table is a pointer to a table that resides on the Hadoop host. Use the `DROP FOREIGN TABLE` command to remove a foreign table. Only the owner of the foreign table can drop it.

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

Parameters

`IF EXISTS`

> Include the `IF EXISTS` clause to instruct the server to issue a notice instead of throwing an error if the foreign table with the specified name doesn't exists.

`name`

> Specify the name of the foreign table.

`CASCADE`

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> Automatically drop objects that depend on the foreign table. It should drop all the other dependent objects too.

`RESTRICT`

> Do not allow to drop foreign table if any objects are dependent on it.

Example

```
DROP FOREIGN TABLE warehouse;
```

For more information about using the `DROP FOREIGN TABLE` command, see:

> https://www.postgresql.org/docs/current/sql-dropforeigntable.html

---

10 Using the Hadoop Foreign Data Wrapper

You can use the Hadoop Foreign Data Wrapper either through the Apache Hive or the Apache Spark. Both Hive and Spark store metadata in the configured metastore, where databases and tables are created using HiveQL.

Using HDFS FDW with Apache Hive on Top of Hadoop

`Apache Hive` data warehouse software facilitates querying and managing large datasets residing in distributed storage. Hive provides a mechanism to project structure onto this data and query the data using a SQL-like language called `HiveQL`. At the same time, this language allows traditional map/reduce programmers to plug in their custom mappers and reducers when it is inconvenient or inefficient to express this logic in `HiveQL`.

There are two versions of Hive - `HiveServer1` and `HiveServer2` which can be downloaded from the Apache Hive website.

!!! Note The Hadoop Foreign Data Wrapper supports only `HiveServer2`.

To use HDFS FDW with Apache Hive on top of Hadoop:

Step 1: Download weblogs_parse and follow the instructions at the Wiki Pentaho website.

Step 2: Upload `weblog_parse.txt` file using these commands:

```
hadoop fs -mkdir /weblogs
hadoop fs -mkdir /weblogs/parse
hadoop fs -put weblogs_parse.txt /weblogs/parse/part-00000
```

Step 3: Start `HiveServer`, if not already running, using following command:

```
$HIVE_HOME/bin/hiveserver2
```

or

```
$HIVE_HOME/bin/hive --service hiveserver2
```

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Step 4: Connect to `HiveServer2` using the hive `beeline` client. For example:

```
$ beeline
Beeline version 1.0.1 by Apache Hive
beeline> !connect jdbc:hive2://localhost:10000/default;auth=noSasl
```

Step 5: Create a table in Hive. The example creates a table named `weblogs`"

```
CREATE TABLE weblogs (
    client_ip           STRING,
    full_request_date   STRING,
    day                 STRING,
    month               STRING,
    month_num           INT,
    year                STRING,
    hour                STRING,
    minute              STRING,
    second              STRING,
    timezone            STRING,
    http_verb           STRING,
    uri                 STRING,
    http_status_code    STRING,
    bytes_returned      STRING,
    referrer            STRING,
    user_agent          STRING)
row format delimited
fields terminated by '\t';
```

Step 6: Load data into the table.

```
hadoop fs -cp /weblogs/parse/part-00000 /user/hive/warehouse/weblogs/
```

Step 7: Access your data from Postgres; you can now use the `weblog` table. Once you are connected using psql, follow the below steps:

```
-- set the GUC variables appropriately, e.g. :
hdfs_fdw.jvmpath='/home/edb/Projects/hadoop_fdw/jdk1.8.0_111/jre/lib/amd64/server/
'
hdfs_fdw.classpath='/usr/local/edbas/lib/postgresql/HiveJdbcClient-
1.0.jar:/home/edb/Projects/hadoop_fdw/hadoop/share/hadoop/common/hadoop-common-
2.6.4.jar:/home/edb/Projects/hadoop_fdw/apache-hive-1.0.1-bin/lib/hive-jdbc-
1.0.1-standalone.jar'

-- load extension first time after install
CREATE EXTENSION hdfs_fdw;

-- create server object
CREATE SERVER hdfs_server
         FOREIGN DATA WRAPPER hdfs_fdw
         OPTIONS (host '127.0.0.1');

-- create user mapping
CREATE USER MAPPING FOR postgres
```

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```
    SERVER hdfs_server OPTIONS (username 'hive_username', password
'hive_password');

-- create foreign table
CREATE FOREIGN TABLE weblogs
(
 client_ip               TEXT,
 full_request_date       TEXT,
 day                     TEXT,
 Month                   TEXT,
 month_num               INTEGER,
 year                    TEXT,
 hour                    TEXT,
 minute                  TEXT,
 second                  TEXT,
 timezone                TEXT,
 http_verb               TEXT,
 uri                     TEXT,
 http_status_code        TEXT,
 bytes_returned          TEXT,
 referrer                TEXT,
 user_agent              TEXT
)
SERVER hdfs_server
         OPTIONS (dbname 'default', table_name 'weblogs');


-- select from table
postgres=# SELECT DISTINCT client_ip IP, count(*)
           FROM weblogs GROUP BY IP HAVING count(*) > 5000 ORDER BY 1;
       ip        | count
-----------------+-------
 13.53.52.13     |  5494
 14.323.74.653   | 16194
 322.6.648.325   | 13242
 325.87.75.336   |  6500
 325.87.75.36    |  6498
 361.631.17.30   | 64979
 363.652.18.65   | 10561
 683.615.622.618 | 13505
(8 rows)

-- EXPLAIN output showing WHERE clause being pushed down to remote server.
EXPLAIN (VERBOSE, COSTS OFF) SELECT client_ip, full_request_date, uri FROM
weblogs WHERE http_status_code = 200;
                                                        QUERY PLAN
-------------------------------------------------------------------------------
--------------------------------
 Foreign Scan on public.weblogs
   Output: client_ip, full_request_date, uri
   Remote SQL: SELECT client_ip, full_request_date, uri FROM default.weblogs
WHERE ((http_status_code = '200'))
(3 rows)
```

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Using HDFS FDW with Apache Spark on Top of Hadoop

Apache Spark is a general purpose distributed computing framework which supports a wide variety of use cases. It provides real time streaming as well as batch processing with speed, ease of use, and sophisticated analytics. Spark does not provide a storage layer as it relies on third party storage providers like Hadoop, HBASE, Cassandra, S3 etc. Spark integrates seamlessly with Hadoop and can process existing data. Spark SQL is 100% compatible with `HiveQL` and can be used as a replacement of `Hiveserver2`, using `Spark Thrift Server`.

To use HDFS FDW with Apache Spark on top of Hadoop:

Step 1: Download and install Apache Spark in local mode.

Step 2: In the folder `$SPARK_HOME/conf` create a file `spark-defaults.conf` containing the following line:

```
spark.sql.warehouse.dir hdfs://localhost:9000/user/hive/warehouse
```

By default, Spark uses `derby` for both the meta data and the data itself (called a warehouse in Spark). To have Spark use Hadoop as a warehouse, you should add this property.

Step 3: Start the Spark Thrift Server.

```
./start-thriftserver.sh
```

Step 4: Make sure the Spark Thrift server is running and writing to a log file.

Step 5: Create a local file (`names.txt`) that contains the following entries:

```
$ cat /tmp/names.txt
1,abcd
2,pqrs
3,wxyz
4,a_b_c
5,p_q_r
,
```

Step 6: Connect to Spark Thrift Server2 using the Spark `beeline` client. For example:

```
$ beeline
Beeline version 1.2.1.spark2 by Apache Hive
beeline> !connect jdbc:hive2://localhost:10000/default;auth=noSasl
org.apache.hive.jdbc.HiveDriver
```

Step 7: Prepare the sample data on Spark. Run the following commands in the `beeline` command line tool:

```
./beeline
Beeline version 1.2.1.spark2 by Apache Hive
beeline> !connect jdbc:hive2://localhost:10000/default;auth=noSasl
org.apache.hive.jdbc.HiveDriver
Connecting to jdbc:hive2://localhost:10000/default;auth=noSasl
Enter password for jdbc:hive2://localhost:10000/default;auth=noSasl:
Connected to: Spark SQL (version 2.1.1)
Driver: Hive JDBC (version 1.2.1.spark2)
Transaction isolation: TRANSACTION_REPEATABLE_READ
0: jdbc:hive2://localhost:10000> create database my_test_db;
```

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```
+---------+--+
| Result  |
+---------+--+
+---------+--+
No rows selected (0.379 seconds)
0: jdbc:hive2://localhost:10000> use my_test_db;
+---------+--+
| Result  |
+---------+--+
+---------+--+
No rows selected (0.03 seconds)
0: jdbc:hive2://localhost:10000> create table my_names_tab(a int, name string)
                                 row format delimited fields terminated by ' ';
+---------+--+
| Result  |
+---------+--+
+---------+--+
No rows selected (0.11 seconds)
0: jdbc:hive2://localhost:10000>

0: jdbc:hive2://localhost:10000> load data local inpath '/tmp/names.txt'
                                 into table my_names_tab;
+---------+--+
| Result  |
+---------+--+
+---------+--+
No rows selected (0.33 seconds)
0: jdbc:hive2://localhost:10000> select * from my_names_tab;
+-------+---------+--+
|   a   |  name   |
+-------+---------+--+
| 1     | abcd    |
| 2     | pqrs    |
| 3     | wxyz    |
| 4     | a_b_c   |
| 5     | p_q_r   |
| NULL  | NULL    |
+-------+---------+--+
```

The following commands list the corresponding files in Hadoop:

```
$ hadoop fs -ls /user/hive/warehouse/
Found 1 items
drwxrwxrwx   - org.apache.hive.jdbc.HiveDriver supergroup 0 2020-06-12 17:03
/user/hive/warehouse/my_test_db.db

$ hadoop fs -ls /user/hive/warehouse/my_test_db.db/
Found 1 items
drwxrwxrwx   - org.apache.hive.jdbc.HiveDriver supergroup 0 2020-06-12 17:03
/user/hive/warehouse/my_test_db.db/my_names_tab
```

Step 8: Access your data from Postgres using psql:

```
-- set the GUC variables appropriately, e.g. :
```

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```
hdfs_fdw.jvmpath='/home/edb/Projects/hadoop_fdw/jdk1.8.0_111/jre/lib/amd64/server/
'
hdfs_fdw.classpath='/usr/local/edbas/lib/postgresql/HiveJdbcClient-
1.0.jar:/home/edb/Projects/hadoop_fdw/hadoop/share/hadoop/common/hadoop-common-
2.6.4.jar:/home/edb/Projects/hadoop_fdw/apache-hive-1.0.1-bin/lib/hive-jdbc-
1.0.1-standalone.jar'

-- load extension first time after install
CREATE EXTENSION hdfs_fdw;

-- create server object
CREATE SERVER hdfs_server
  FOREIGN DATA WRAPPER hdfs_fdw
  OPTIONS (host '127.0.0.1', port '10000', client_type 'spark', auth_type
'NOSASL');

-- create user mapping
CREATE USER MAPPING FOR postgres
  SERVER hdfs_server OPTIONS (username 'spark_username', password
'spark_password');

-- create foreign table
CREATE FOREIGN TABLE f_names_tab( a int, name varchar(255)) SERVER hdfs_svr
  OPTIONS (dbname 'testdb', table_name 'my_names_tab');

-- select the data from foreign server
select * from f_names_tab;
 a |  name
---+--------
 1 | abcd
 2 | pqrs
 3 | wxyz
 4 | a_b_c
 5 | p_q_r
 0 |
(6 rows)

-- EXPLAIN output showing WHERE clause being pushed down to remote server.
EXPLAIN (verbose, costs off) SELECT name FROM f_names_tab WHERE a > 3;
                                QUERY PLAN
-------------------------------------------------------------------------
 Foreign Scan on public.f_names_tab
   Output: name
   Remote SQL: SELECT name FROM my_test_db.my_names_tab WHERE ((a > '3'))
(3 rows)
```

!!! Note The same port was being used while creating foreign server because the Spark Thrift Server is compatible with the Hive Thrift Server. Applications using Hiveserver2 would work with Spark except for the behaviour of the `ANALYZE` command and the connection string in the case of `NOSASL`. We recommend using `ALTER SERVER` and changing the `client_type` option if Hive is to be replaced with Spark.

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11 Identifying the Hadoop Foreign Data Wrapper Version

The Hadoop Foreign Data Wrapper includes a function that you can use to identify the currently installed version of the `.so` file for the data wrapper. To use the function, connect to the Postgres server, and enter:

```
SELECT hdfs_fdw_version();
```

The function returns the version number:

```
hdfs_fdw_version
-----------------
<xxxxx>
```

12 Uninstalling the Hadoop Foreign Data Wrapper

Uninstalling an RPM Package

You can use the `yum remove` or `dnf remove` command to remove a package installed by `yum` or `dnf`. To remove a package, open a terminal window, assume superuser privileges, and enter the command:

- On RHEL or CentOS 7:

  ```
  yum remove edb-as<xx>-hdfs_fdw
  ```

  where `xx` is the server version number.

- On RHEL or CentOS 8:

  ```
  dnf remove edb-as<xx>-hdfs_fdw
  ```

  where `xx` is the server version number.

Uninstalling Hadoop Foreign Data Wrapper on a Debian or Ubuntu Host

- To uninstall Hadoop Foreign Data Wrapper on a Debian or Ubuntu host, invoke the following command.

  ```
  apt-get remove edb-as<xx>-hdfs-fdw
  ```

  where `xx` is the server version number.

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