



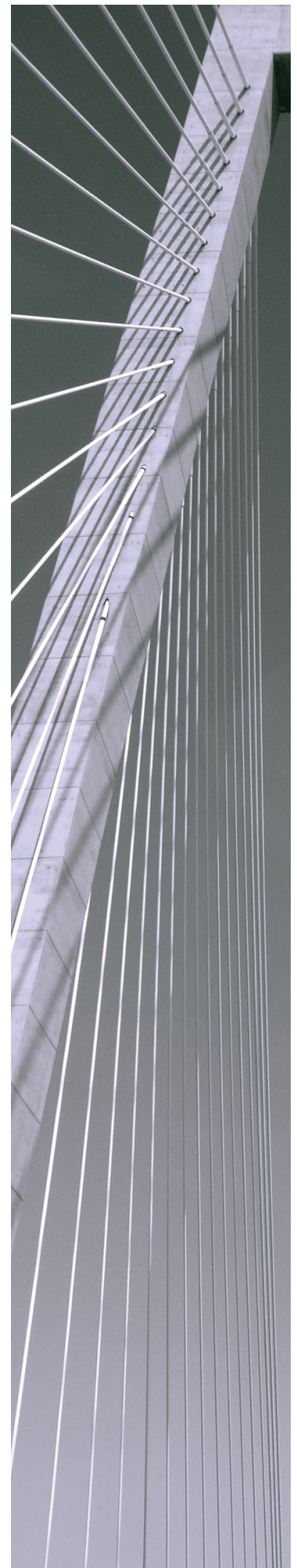
Simba Spark JDBC Driver with SQL Connector

Installation and Configuration Guide

Simba Technologies Inc.

Version 2.6.3

July 6, 2018



Copyright © 2018 Simba Technologies Inc. All Rights Reserved.

Information in this document is subject to change without notice. Companies, names and data used in examples herein are fictitious unless otherwise noted. No part of this publication, or the software it describes, may be reproduced, transmitted, transcribed, stored in a retrieval system, decompiled, disassembled, reverse-engineered, or translated into any language in any form by any means for any purpose without the express written permission of Simba Technologies Inc.

Trademarks

Simba, the Simba logo, SimbaEngine, and Simba Technologies are registered trademarks of Simba Technologies Inc. in Canada, United States and/or other countries. All other trademarks and/or servicemarks are the property of their respective owners.

Contact Us

Simba Technologies Inc.
938 West 8th Avenue
Vancouver, BC Canada
V5Z 1E5

Tel: +1 (604) 633-0008

Fax: +1 (604) 633-0004

www.simba.com

About This Guide

Purpose

The *Simba Spark JDBC Driver with SQL Connector Installation and Configuration Guide* explains how to install and configure the Simba Spark JDBC Driver with SQL Connector on all supported platforms. The guide also provides details related to features of the driver.

Audience

The guide is intended for end users of the Simba Spark JDBC Driver.

Knowledge Prerequisites

To use the Simba Spark JDBC Driver, the following knowledge is helpful:

- Familiarity with the platform on which you are using the Simba Spark JDBC Driver
- Ability to use the data store to which the Simba Spark JDBC Driver is connecting
- An understanding of the role of JDBC technologies in connecting to a data store
- Experience creating and configuring JDBC connections
- Exposure to SQL

Document Conventions

Italics are used when referring to book and document titles.

Bold is used in procedures for graphical user interface elements that a user clicks and text that a user types.

Monospace font indicates commands, source code or contents of text files.

Note:

A text box with a pencil icon indicates a short note appended to a paragraph.

! Important:

A text box with an exclamation mark indicates an important comment related to the preceding paragraph.

Table of Contents

About the Simba Spark JDBC Driver	6
System Requirements	7
Simba Spark JDBC Driver Files	8
Installing and Using the Simba Spark JDBC Driver	9
Referencing the JDBC Driver Libraries	9
Registering the Driver Class	10
Building the Connection URL	11
Configuring Authentication	13
Using No Authentication	13
Using Kerberos	13
Using User Name	14
Using User Name And Password (LDAP)	15
Authentication Mechanisms	16
Configuring Kerberos Authentication for Windows	18
Increasing the Connection Speed	24
Configuring SSL	25
Configuring Logging	27
Features	29
SQL Query versus HiveQL Query	29
Data Types	29
Catalog and Schema Support	30
Write-back	30
Security and Authentication	30
Driver Configuration Options	32
AllowSelfSignedCerts	32
AsyncExecPollInterval	33
AuthMech	33
CAIssuedCertsMismatch	34
CatalogSchemaSwitch	34
DecimalColumnScale	34
DefaultStringColumnLength	35

Installation and Configuration Guide

DelegationUID	35
FastConnection	35
httpPath	36
KrbAuthType	36
KrbHostFQDN	37
KrbRealm	38
KrbServiceName	38
LogLevel	38
LogPath	39
PreparedMetaLimitZero	40
PWD	40
RowsFetchedPerBlock	40
ServerVersion	41
SocketTimeout	41
SSL	42
SSLKeyStore	42
SSLKeyStorePwd	43
SSLTrustStore	43
SSLTrustStorePwd	44
StripCatalogName	44
transportMode	44
UID	45
UseNativeQuery	45
Third-Party Trademarks	47
Third-Party Licenses	48

About the Simba Spark JDBC Driver

The Simba Spark JDBC Driver is used for direct SQL and HiveQL access to Apache Hadoop / Spark, enabling Business Intelligence (BI), analytics, and reporting on Hadoop / Spark-based data. The driver efficiently transforms an application's SQL query into the equivalent form in HiveQL, which is a subset of SQL-92. If an application is Spark-aware, then the driver is configurable to pass the query through to the database for processing. The driver interrogates Spark to obtain schema information to present to a SQL-based application. Queries, including joins, are translated from SQL to HiveQL. For more information about the differences between HiveQL and SQL, see [Features](#) on page 29.

The Simba Spark JDBC Driver complies with the JDBC 4.0 and 4.1 data standards. JDBC is one of the most established and widely supported APIs for connecting to and working with databases. At the heart of the technology is the JDBC driver, which connects an application to the database. For more information about JDBC, see *Data Access Standards* on the Simba Technologies website: <https://www.simba.com/resources/data-access-standards-glossary>.

This guide is suitable for users who want to access data residing within Spark from their desktop environment. Application developers might also find the information helpful. Refer to your application for details on connecting via JDBC.

System Requirements

Each machine where you use the Simba Spark JDBC Driver must have Java Runtime Environment (JRE) installed. The version of JRE that must be installed depends on the version of the JDBC API you are using with the driver. The following table lists the required version of JRE for each provided version of the JDBC API.

JDBC API Version	JRE Version
4.0	6.0 or later
4.1	7.0

The driver supports Apache Spark versions 1.1.0 through 2.3.0.

! Important:

The driver only supports connections to Spark Thrift Server instances. It does not support connections to Shark Server instances.

Simba Spark JDBC Driver Files

The Simba Spark JDBC Driver is delivered in the following two ZIP archives, where *[Version]* is the version number of the driver:

- `SparkJDBC4_[Version].zip`
- `SparkJDBC41_[Version].zip`

Each archive contains the driver supporting the JDBC API version indicated in the archive name, as well as release notes and third-party license information. In addition, the required third-party libraries and dependencies are packaged and shared in the driver JAR file in the archive.

Installing and Using the Simba Spark JDBC Driver

To install the Simba Spark JDBC Driver on your machine, extract the files from the appropriate ZIP archive to the directory of your choice.

! Important:

If you received a license file through email, then you must copy the file into the same directory as the driver JAR file before you can use the Simba Spark JDBC Driver.

To access a Spark data store using the Simba Spark JDBC Driver, you need to configure the following:

- The list of driver library files (see [Referencing the JDBC Driver Libraries](#) on page 9)
- The `Driver` or `DataSource` class (see [Registering the Driver Class](#) on page 10)
- The connection URL for the driver (see [Building the Connection URL](#) on page 11)

! Important:

The Simba Spark JDBC Driver provides read-only access to Spark Thrift Server instances. It does not support connections to Shark Server instances.

Referencing the JDBC Driver Libraries

Before you use the Simba Spark JDBC Driver, the JDBC application or Java code that you are using to connect to your data must be able to access the driver JAR files. In the application or code, specify all the JAR files that you extracted from the ZIP archive.

Using the Driver in a JDBC Application

Most JDBC applications provide a set of configuration options for adding a list of driver library files. Use the provided options to include all the JAR files from the ZIP archive as part of the driver configuration in the application. For more information, see the documentation for your JDBC application.

Using the Driver in Java Code

You must include all the driver library files in the class path. This is the path that the Java Runtime Environment searches for classes and other resource files. For more

information, see "Setting the Class Path" in the appropriate Java SE Documentation:

For Java SE 6:

- For Windows:
<https://docs.oracle.com/javase/6/docs/technotes/tools/windows/classpath.html>
- For Linux and Solaris:
<https://docs.oracle.com/javase/6/docs/technotes/tools/solaris/classpath.html>
- For Windows:
<http://docs.oracle.com/javase/7/docs/technotes/tools/windows/classpath.html>
- For Linux and Solaris:
<http://docs.oracle.com/javase/7/docs/technotes/tools/solaris/classpath.html>

Registering the Driver Class

Before connecting to your data, you must register the appropriate class for your application.

The following is a list of the classes used to connect the Simba Spark JDBC Driver to Spark data stores. The `Driver` classes extend `java.sql.Driver`, and the `DataSource` classes extend `javax.sql.DataSource` and `javax.sql.ConnectionPoolDataSource`.

To support JDBC 4.0, classes with the following fully-qualified class names (FQCNs) are available:

- `com.simba.spark.jdbc4.Driver`
- `com.simba.spark.jdbc4.DataSource`

To support JDBC 4.1, classes with the following FQCNs are available:

- `com.simba.spark.jdbc41.Driver`
- `com.simba.spark.jdbc41.DataSource`

The following sample code shows how to use the `DriverManager` to establish a connection for JDBC 4.0:

Note:

In these examples, the line `Class.forName(DRIVER_CLASS);` is only required for JDBC 4.0.

```
private static Connection connectViaDM() throws Exception
{
    Connection connection = null;
```

```
Class.forName(DRIVER_CLASS);
connection = DriverManager.getConnection(CONNECTION_URL);
return connection;
}
```

The following sample code shows how to use the `DataSource` class to establish a connection:

```
private static Connection connectViaDS() throws Exception
{
    Connection connection = null;
    Class.forName(DRIVER_CLASS);
    DataSource ds = new com.simba.spark.jdbc41.DataSource();
    ds.setURL(CONNECTION_URL);
    connection = ds.getConnection();
    return connection;
}
```

Building the Connection URL

Use the connection URL to supply connection information to the data store that you are accessing. The following is the format of the connection URL for the Simba Spark JDBC Driver, where *[Host]* is the DNS or IP address of the Spark server and *[Port]* is the number of the TCP port that the server uses to listen for client requests:

```
jdbc:spark://[Host]:[Port]
```

Note:

By default, Spark uses port 10000.

By default, the driver uses the schema named **default** and authenticates the connection using the user name **spark**.

You can specify optional settings such as the schema to use or any of the connection properties supported by the driver. For a list of the properties available in the driver, see [Driver Configuration Options](#) on page 32. If you specify a property that is not supported by the driver, then the driver attempts to apply the property as a Spark server-side property for the client session.

The following is the format of a connection URL that specifies some optional settings:


```
jdbc:spark://[Host]:[Port]/[Schema];[Property1]=[Value];  
[Property2]=[Value];...
```

For example, to connect to port 11000 on an Spark server installed on the local machine, use a schema named default2, and authenticate the connection using a user name and password, you would use the following connection URL:

```
jdbc:spark://localhost:11000/default2;AuthMech=3;UID=simba;P  
WD=simba
```

! Important:

- Properties are case-sensitive.
- Do not duplicate properties in the connection URL.

 **Note:**

If you specify a schema in the connection URL, you can still issue queries on other schemas by explicitly specifying the schema in the query. To inspect your databases and determine the appropriate schema to use, type the `show databases` command at the Spark command prompt.

Configuring Authentication

The Simba Spark JDBC Driver supports the following authentication mechanisms:

- No Authentication
- Kerberos
- User Name
- User Name And Password

You configure the authentication mechanism that the driver uses to connect to Spark by specifying the relevant properties in the connection URL.

For information about selecting an appropriate authentication mechanism when using the Simba Spark JDBC Driver, see [Authentication Mechanisms](#) on page 16.

For information about the properties you can use in the connection URL, see [Driver Configuration Options](#) on page 32.

**Note:**

In addition to authentication, you can configure the driver to connect over SSL. For more information, see [Configuring SSL](#) on page 25.

Using No Authentication

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To configure a connection without authentication:

1. Set the `AuthMech` property to 0.
2. Set the `transportMode` property to `binary`.

For example:


```
jdbc:spark://localhost:10000;AuthMech=0;transportMode=binary;
```

Using Kerberos

Kerberos must be installed and configured before you can use this authentication mechanism. For information about configuring and operating Kerberos on Windows, see [Configuring Kerberos Authentication for Windows](#) on page 18. For other operating

systems, see the MIT Kerberos documentation: <http://web.mit.edu/kerberos/krb5-latest/doc/>.

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

 **Note:**

When you use this authentication mechanism, SASL is the only Thrift transport protocol that is supported. The driver uses SASL by default, so you do not need to set the `transportMode` property.

To configure default Kerberos authentication:

1. Set the `AuthMech` property to 1.
2. To use the default realm defined in your Kerberos setup, do not set the `KrbRealm` property.

If your Kerberos setup does not define a default realm or if the realm of your Spark server is not the default, then set the `KrbRealm` property to the realm of the Spark server.

3. Set the `KrbHostFQDN` property to the fully qualified domain name of the Spark server host.

For example, the following connection URL connects to a Spark server with Kerberos enabled, but without SSL enabled:

```
jdbc:spark://node1.example.com:10000;AuthMech=1;
KrbRealm=EXAMPLE.COM;KrbHostFQDN=node1.example.com;
KrbServiceName=spark
```

In this example, Kerberos is enabled for JDBC connections, the Kerberos service principal name is `spark/node1.example.com@EXAMPLE.COM`, the host name for the data source is `node1.example.com`, and the server is listening on port 10000 for JDBC connections.

Using User Name

This authentication mechanism requires a user name but does not require a password. The user name labels the session, facilitating database tracking.

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To configure User Name authentication:

1. Set the `AuthMech` property to 2.
2. Set the `transportMode` property to `sasl`.
3. Set the `UID` property to an appropriate user name for accessing the Spark server.

For example:

```
jdbc:spark://node1.example.com:10000;AuthMech=2;  
transportMode=sasl;UID=spark
```

Using User Name And Password (LDAP)

This authentication mechanism requires a user name and a password. It is most commonly used with LDAP authentication.

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To configure User Name And Password authentication:

1. Set the `AuthMech` property to 3.
2. Set the `transportMode` property to the transport protocol that you want to use in the Thrift layer.
3. If you set the `transportMode` property to `http`, then set the `httpPath` property to the partial URL corresponding to the Spark server. Otherwise, do not set the `httpPath` property.
4. Set the `UID` property to an appropriate user name for accessing the Spark server.
5. Set the `PWD` property to the password corresponding to the user name you provided.

For example, the following connection URL connects to a Spark server with LDAP authentication enabled, but without SSL or SASL enabled:

```
jdbc:spark://node1.example.com:10000;AuthMech=3;  
transportMode=http;httpPath=cliservice;UID=spark;PWD=simba;
```

In this example, user name and password (LDAP) authentication is enabled for JDBC connections, the LDAP user name is `spark`, the password is `simba`, and the server is listening on port 10000 for JDBC connections.

Authentication Mechanisms

To connect to a Spark server, you must configure the Simba Spark JDBC Driver to use the authentication mechanism that matches the access requirements of the server and provides the necessary credentials. To determine the authentication settings that your Spark server requires, check the server configuration and then refer to the corresponding section below.

Spark Thrift Server supports the following authentication mechanisms:


- No Authentication (see [Using No Authentication](#) on page 13)
- Kerberos (see [Using Kerberos](#) on page 13)
- User Name (see [Using User Name](#) on page 14)
- User Name And Password (see [Using User Name And Password \(LDAP\)](#) on page 15)

Most default configurations of Spark Thrift Server require User Name authentication. If you are unable to connect to your Spark server using User Name authentication, then verify the authentication mechanism configured for your Spark server by examining the `hive-site.xml` file. Examine the following properties to determine which authentication mechanism your server is set to use:

- `hive.server2.authentication`: This property sets the authentication mode for Spark Server 2. The following values are available:
 - `NONE` enables plain SASL transport. This is the default value.
 - `NOSASL` disables the Simple Authentication and Security Layer (SASL).
 - `KERBEROS` enables Kerberos authentication and delegation token authentication.
 - `PLAINASASL` enables user name and password authentication using a cleartext password mechanism.
 - `LDAP` enables user name and password authentication using the Lightweight Directory Access Protocol (LDAP).
- `hive.server2.enable.doAs`: If this property is set to the default value of `TRUE`, then Spark processes queries as the user who submitted the query. If this property is set to `FALSE`, then queries are run as the user that runs the `hiveserver2` process.

The following table lists the authentication mechanisms to configure for the driver based on the settings in the `hive-site.xml` file.

<code>hive.server2.authentication</code>	<code>hive.server2.enable.doAs</code>	Driver Authentication Mechanism
NOSASL	FALSE	No Authentication
KERBEROS	TRUE or FALSE	Kerberos
KERBEROS	TRUE	Delegation Token
NONE	TRUE or FALSE	User Name
PLAINASL or LDAP	TRUE or FALSE	User Name And Password

 **Note:**

It is an error to set `hive.server2.authentication` to `NOSASL` and `hive.server2.enable.doAs` to `true`. This configuration will not prevent the service from starting up, but results in an unusable service.

For more information about authentication mechanisms, refer to the documentation for your Hadoop / Spark distribution. See also "Running Hadoop in Secure Mode" in the Apache Hadoop documentation: http://hadoop.apache.org/docs/r0.23.7/hadoop-project-dist/hadoop-common/ClusterSetup.html#Running_Hadoop_in_Secure_Mode.

Using No Authentication

When `hive.server2.authentication` is set to `NOSASL`, you must configure your connection to use No Authentication.

Using Kerberos

When connecting to a Spark Thrift Server instance and `hive.server2.authentication` is set to `KERBEROS`, you must configure your connection to use Kerberos or Delegation Token authentication.

Using User Name

When connecting to a Spark Thrift Server instance and `hive.server2.authentication` is set to `NONE`, you must configure your connection to use User Name authentication. Validation of the credentials that you include depends on `hive.server2.enable.doAs`:

- If `hive.server2.enable.doAs` is set to `TRUE`, then the server attempts to map the user name provided by the driver from the driver configuration to an existing operating system user on the host running Spark Thrift Server. If this user name does not exist in the operating system, then the user group lookup fails and existing HDFS permissions are used. For example, if the current user group is allowed to read and write to the location in HDFS, then read and write queries are allowed.
- If `hive.server2.enable.doAs` is set to `FALSE`, then the user name in the driver configuration is ignored.

If no user name is specified in the driver configuration, then the driver defaults to using **spark** as the user name.

Using User Name And Password

When connecting to a Spark Thrift Server instance and the server is configured to use the SASL-PLAIN authentication mechanism with a user name and a password, you must configure your connection to use User Name And Password authentication.

Configuring Kerberos Authentication for Windows

You can configure your Kerberos setup so that you use the MIT Kerberos Ticket Manager to get the Ticket Granting Ticket (TGT), or configure the setup so that you can use the driver to get the ticket directly from the Key Distribution Center (KDC). Also, if a client application obtains a Subject with a TGT, it is possible to use that Subject to authenticate the connection.

Downloading and Installing MIT Kerberos for Windows

To download and install MIT Kerberos for Windows 4.0.1:

1. Download the appropriate Kerberos installer:
 - For a 64-bit machine, use the following download link from the MIT Kerberos website: <http://web.mit.edu/kerberos/dist/kfw/4.0/kfw-4.0.1-amd64.msi>.
 - For a 32-bit machine, use the following download link from the MIT Kerberos website: <http://web.mit.edu/kerberos/dist/kfw/4.0/kfw-4.0.1-i386.msi>.

 **Note:**

The 64-bit installer includes both 32-bit and 64-bit libraries. The 32-bit installer includes 32-bit libraries only.

2. To run the installer, double-click the `.msi` file that you downloaded.


3. Follow the instructions in the installer to complete the installation process.
4. When the installation completes, click **Finish**.

Using the MIT Kerberos Ticket Manager to Get Tickets

Setting the KRB5CCNAME Environment Variable


You must set the KRB5CCNAME environment variable to your credential cache file.

To set the KRB5CCNAME environment variable:

1. Click **Start** , then right-click **Computer**, and then click **Properties**.
2. Click **Advanced System Settings**.
3. In the System Properties dialog box, on the **Advanced** tab, click **Environment Variables**.
4. In the Environment Variables dialog box, under the System Variables list, click **New**.
5. In the **New System Variable** dialog box, in the Variable Name field, type **KRB5CCNAME**.
6. In the **Variable Value** field, type the path for your credential cache file. For example, type `C:\KerberosTickets.txt`.
7. Click **OK** to save the new variable.
8. Make sure that the variable appears in the System Variables list.
9. Click **OK** to close the Environment Variables dialog box, and then click **OK** to close the System Properties dialog box.
10. Restart your machine.

Getting a Kerberos Ticket

To get a Kerberos ticket:

1. Click **Start** , then click **All Programs**, and then click the **Kerberos for Windows (64-bit)** or **Kerberos for Windows (32-bit)** program group.
2. Click **MIT Kerberos Ticket Manager**.
3. In the MIT Kerberos Ticket Manager, click **Get Ticket**.
4. In the Get Ticket dialog box, type your principal name and password, and then click **OK**.

If the authentication succeeds, then your ticket information appears in the MIT Kerberos Ticket Manager.

Authenticating to the Spark Server

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To authenticate to the Spark server:

- Use a connection URL that has the following properties defined:
 - `AuthMech`
 - `KrbHostFQDN`
 - `KrbRealm`
 - `KrbServiceName`


For detailed information about these properties, see [Driver Configuration Options](#) on page 32

Using the Driver to Get Tickets

Deleting the KRB5CCNAME Environment Variable

To enable the driver to get Ticket Granting Tickets (TGTs) directly, make sure that the KRB5CCNAME environment variable has not been set.

To delete the KRB5CCNAME environment variable:

1. Click the **Start** button , then right-click **Computer**, and then click **Properties**.
2. Click **Advanced System Settings**.
3. In the System Properties dialog box, click the **Advanced** tab and then click **Environment Variables**.
4. In the Environment Variables dialog box, check if the KRB5CCNAME variable appears in the System variables list. If the variable appears in the list, then select the variable and click **Delete**.
5. Click **OK** to close the Environment Variables dialog box, and then click **OK** to close the System Properties dialog box.

Setting Up the Kerberos Configuration File

To set up the Kerberos configuration file:

1. Create a standard `krb5.ini` file and place it in the `C:\Windows` directory.
2. Make sure that the KDC and Admin server specified in the `krb5.ini` file can be resolved from your terminal. If necessary, modify `C:\Windows\System32\drivers\etc\hosts`.

Setting Up the JAAS Login Configuration File

To set up the JAAS login configuration file:

1. Create a JAAS login configuration file that specifies a keytab file and `doNotPrompt=true`.

For example:

```
Client {  
  com.sun.security.auth.module.Krb5LoginModule required  
  useKeyTab=true  
  keyTab="PathToTheKeyTab"  
  principal="simba@SIMBA"  
  doNotPrompt=true;  
};
```

2. Set the `java.security.auth.login.config` environment variable to the location of the JAAS file.

For example: `C:\KerberosLoginConfig.ini`.

Authenticating to the Spark Server

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To authenticate to the Spark server:

- Use a connection URL that has the following properties defined:
 - `AuthMech`
 - `KrbHostFQDN`
 - `KrbRealm`
 - `KrbServiceName`

For detailed information about these properties, see [Driver Configuration Options](#) on page 32.

Using an Existing Subject to Authenticate the Connection

If the client application obtains a Subject with a TGT, then that Subject can be used to authenticate the connection to the server.

To use an existing Subject to authenticate the connection:

1. Create a PrivilegedAction for establishing the connection to the database.

For example:

```
// Contains logic to be executed as a privileged action
public class AuthenticateDriverAction
implements PrivilegedAction<Void>
{
// The connection, which is established as a
PrivilegedAction
Connection con;

// Define a string as the connection URL
static String ConnectionURL =
"jdbc:spark://192.168.1.1:10000";

/**
 * Logic executed in this method will have access to the
 * Subject that is used to "doAs". The driver will get
 * the Subject and use it for establishing a connection
 * with the server.
 */
@Override
public Void run()
{
try
{
// Establish a connection using the connection URL
con = DriverManager.getConnection(ConnectionURL);
}
catch (SQLException e)
{
// Handle errors that are encountered during
// interaction with the data store
e.printStackTrace();
}
catch (Exception e)
{
// Handle other errors
e.printStackTrace();
}
}
```

```
return null;
}
}
```

2. Run the PrivilegedAction using the existing Subject, and then use the connection.

For example:

```
// Create the action
AuthenticateDriverAction authenticateAction = new
AuthenticateDriverAction();
// Establish the connection using the Subject for
// authentication.
Subject.doAs(loginConfig.getSubject(),
authenticateAction);
// Use the established connection.
authenticateAction.con;
```

Increasing the Connection Speed

If you want to speed up the process of connecting to the data store, you can disable several of the connection checks that the driver performs.

! Important:

Enabling these options can speed up the connection process, but may result in errors. In particular, the `ServerVersion` must match the version number of the server, otherwise errors may occur.

To increase the driver's connection speed:

1. To bypass the connection testing process, set the `FastConnection` property to 1.
2. To bypass the server version check, set the `ServerVersion` property to the version number of the Spark server that you are connecting to.

For example, to connect to Spark Server 2.2.0, set the `ServerVersion` property to `2.2.0`.

Configuring SSL

Note:

In this documentation, "SSL" indicates both TLS (Transport Layer Security) and SSL (Secure Sockets Layer). The driver supports industry-standard versions of TLS/SSL.

If you are connecting to a Spark server that has Secure Sockets Layer (SSL) enabled, you can configure the driver to connect to an SSL-enabled socket. When connecting to a server over SSL, the driver uses one-way authentication to verify the identity of the server.

One-way authentication requires a signed, trusted SSL certificate for verifying the identity of the server. You can configure the driver to access a specific TrustStore or KeyStore that contains the appropriate certificate. If you do not specify TrustStore or KeyStore, then the driver uses the default Java TrustStore named `jssecacerts`. If `jssecacerts` is not available, then the driver uses `cacerts` instead.

You provide this information to the driver in the connection URL. For more information about the syntax of the connection URL, see [Building the Connection URL](#) on page 11.

To configure SSL:

1. If you are not using one of the default Java TrustStores, then do one of the following:
 - Create a TrustStore and configure the driver to use it:
 - a. Create a TrustStore containing your signed, trusted server certificate.
 - b. Set the `SSLTrustStore` property to the full path of the TrustStore.
 - c. Set the `SSLTrustStorePwd` property to the password for accessing the TrustStore.
 - Or, create a KeyStore and configure the driver to use it:
 - a. Create a KeyStore containing your signed, trusted server certificate.
 - b. Set the `SSLKeyStore` property to the full path of the KeyStore.
 - c. Set the `SSLKeyStorePwd` property to the password for accessing the KeyStore.
2. Set the `SSL` property to 1.
3. Optionally, to allow the SSL certificate used by the server to be self-signed, set the `AllowSelfSignedCerts` property to 1.


! Important:

When the `AllowSelfSignedCerts` property is set to 1, SSL verification is disabled. The driver does not verify the server certificate against the trust store, and does not verify if the server's host name matches the CN or Subject Alternative Names in the server certificate.

4. Optionally, to allow the common name of a CA-issued certificate to not match the host name of the Spark server, set the `CAIssuedCertNamesMismatch` property to 1.

For example, the following connection URL connects to a data source using username and password (LDAP) authentication, with SSL enabled:

```
jdbc:spark://localhost:10000;AuthMech=3;SSL=1;
SSLKeyStore=C:\\Users\\bsmith\\Desktop\\keystore.jks;
SSLKeyStorePwd=simbaSSL123;UID=spark;PWD=simba123
```

 Note:

For more information about the connection properties used in SSL connections, see [Driver Configuration Options](#) on page 32

Configuring Logging

To help troubleshoot issues, you can enable logging in the driver.

! Important:

Only enable logging long enough to capture an issue. Logging decreases performance and can consume a large quantity of disk space.

In the connection URL, set the `LogLevel` key to enable logging at the desired level of detail. The following table lists the logging levels provided by the Simba Spark JDBC Driver, in order from least verbose to most verbose.

LogLevel Value	Description
0	Disable all logging.
1	Log severe error events that lead the driver to abort.
2	Log error events that might allow the driver to continue running.
3	Log events that might result in an error if action is not taken.
4	Log general information that describes the progress of the driver.
5	Log detailed information that is useful for debugging the driver.
6	Log all driver activity.

To enable logging:

1. Set the `LogLevel` property to the desired level of information to include in log files.
2. Set the `LogPath` property to the full path to the folder where you want to save log files. To make sure that the connection URL is compatible with all JDBC applications, escape the backslashes (`\`) in your file path by typing another backslash.

For example, the following connection URL enables logging level 3 and saves the log files in the `C:\temp` folder:

```
jdbc:spark://localhost:11000;LogLevel=3;LogPath=C:\\temp
```

3. To make sure that the new settings take effect, restart your JDBC application and reconnect to the server.

The Simba Spark JDBC Driver produces the following log files in the location specified in the `LogPath` property:

- A `SparkJDBC_driver.log` file that logs driver activity that is not specific to a connection.
- A `SparkJDBC_connection_[Number].log` file for each connection made to the database, where *[Number]* is a number that identifies each log file. This file logs driver activity that is specific to the connection.

If the `LogPath` value is invalid, then the driver sends the logged information to the standard output stream (`System.out`).

To disable logging:

1. Set the `LogLevel` property to 0.
2. To make sure that the new setting takes effect, restart your JDBC application and reconnect to the server.

Features

More information is provided on the following features of the Simba Spark JDBC Driver:

- [SQL Query versus HiveQL Query](#) on page 29
- [Data Types](#) on page 29
- [Catalog and Schema Support](#) on page 30
- [Write-back](#) on page 30
- [Security and Authentication](#) on page 30

SQL Query versus HiveQL Query

The native query language supported by Spark is HiveQL. HiveQL is a subset of SQL-92. However, the syntax is different enough that most applications do not work with native HiveQL.

Data Types

The Simba Spark JDBC Driver supports many common data formats, converting between Spark, SQL, and Java data types.

The following table lists the supported data type mappings.

Spark Type	SQL Type	Java Type
BIGINT	BIGINT	java.math.BigInteger
BINARY	VARBINARY	byte[]
BOOLEAN	BOOLEAN	Boolean
DATE	DATE	java.sql.Date
DECIMAL	DECIMAL	java.math.BigDecimal
DOUBLE	DOUBLE	Double
FLOAT	REAL	Float

Spark Type	SQL Type	Java Type
INT	INTEGER	Long
SMALLINT	SMALLINT	Integer
TIMESTAMP	TIMESTAMP	java.sql.Timestamp
TINYINT	TINYINT	Short
VARCHAR	VARCHAR	String

Catalog and Schema Support

The Simba Spark JDBC Driver supports both catalogs and schemas to make it easy for the driver to work with various JDBC applications. Since Spark only organizes tables into schemas/databases, the driver provides a synthetic catalog named SPARK under which all of the schemas/databases are organized. The driver also maps the JDBC schema to the Spark schema/database.

Note:

Setting the `CatalogSchemaSwitch` connection property to 1 will cause Spark catalogs to be treated as schemas in the driver as a restriction for filtering.

Write-back

The Simba Spark JDBC Driver supports translation for the following syntax when connecting to a Spark Thrift Server instance that is running Spark 1.3 or later:

- INSERT
- CREATE
- DROP

Spark does not support UPDATE or DELETE syntax.

If the statement contains non-standard SQL-92 syntax, then the driver is unable to translate the statement to SQL and instead falls back to using HiveQL.

Security and Authentication

To protect data from unauthorized access, some Spark data stores require connections to be authenticated with user credentials or the SSL protocol. The Simba Spark JDBC

Driver provides full support for these authentication protocols.

 **Note:**


In this documentation, "SSL" indicates both TLS (Transport Layer Security) and SSL (Secure Sockets Layer). The driver supports industry-standard versions of TLS/SSL.

The driver provides mechanisms that allow you to authenticate your connection using the Kerberos protocol, your Spark user name only, or your Spark user name and password. You must use the authentication mechanism that matches the security requirements of the Spark server. For information about determining the appropriate authentication mechanism to use based on the Spark server configuration, see [Authentication Mechanisms](#) on page 16. For detailed driver configuration instructions, see [Configuring Authentication](#) on page 13.

Additionally, the driver supports SSL connections with one-way authentication. If the server has an SSL-enabled socket, then you can configure the driver to connect to it.

It is recommended that you enable SSL whenever you connect to a server that is configured to support it. SSL encryption protects data and credentials when they are transferred over the network, and provides stronger security than authentication alone. For detailed configuration instructions, see [Configuring SSL](#) on page 25.

The SSL version that the driver supports depends on the JVM version that you are using. For information about the SSL versions that are supported by each version of Java, see "Diagnosing TLS, SSL, and HTTPS" on the Java Platform Group Product Management Blog: https://blogs.oracle.com/java-platform-group/entry/diagnosing_tls_ssl_and_https.

 **Note:**

The SSL version used for the connection is the highest version that is supported by both the driver and the server, which is determined at connection time.

Driver Configuration Options

Driver Configuration Options lists and describes the properties that you can use to configure the behavior of the Simba Spark JDBC Driver.

You can set configuration properties using the connection URL. For more information, see [Building the Connection URL](#) on page 11.

 **Note:**

Property names and values are case-sensitive.

AllowSelfSignedCerts

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver allows the server to use self-signed SSL certificates.

- 1: The driver allows self-signed certificates.

! Important:

When this property is set to 1, SSL verification is disabled. The driver does not verify the server certificate against the trust store, and does not verify if the server's host name matches the CN or Subject Alternative Names in the server certificate.

- 0: The driver does not allow self-signed certificates.

 **Note:**

This property is applicable only when SSL connections are enabled.

AsyncExecPollInterval

Default Value	Data Type	Required
10	Integer	No

Description

The time in milliseconds between each poll for the asynchronous query execution status.

"Asynchronous" refers to the fact that the RPC call used to execute a query against Spark is asynchronous. It does not mean that JDBC asynchronous operations are supported.

 **Note:**

This option is applicable only to HDInsight clusters.

AuthMech

Default Value	Data Type	Required
Depends on the <code>transportMode</code> setting. For more information, see transportMode on page 44.	Integer	No

Description

The authentication mechanism to use. Set the property to one of the following values:

- 0 for No Authentication.
- 1 for Kerberos.
- 2 for User Name.
- 3 for User Name And Password.

CAIssuedCertsMismatch

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver requires the name of the CA-issued SSL certificate to match the host name of the Spark server.

- 0: The driver requires the names to match.
- 1: The driver allows the names to mismatch.



Note:

This property is applicable only when SSL connections are enabled.

CatalogSchemaSwitch

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver treats Spark catalogs as schemas or as catalogs.

- 1: The driver treats Spark catalogs as schemas as a restriction for filtering.
- 0: Spark catalogs are treated as catalogs, and Spark schemas are treated as schemas.

DecimalColumnScale

Default Value	Data Type	Required
10	Integer	No

Description

The maximum number of digits to the right of the decimal point for numeric data types.

DefaultStringLength

Default Value	Data Type	Required
255	Integer	No

Description

The maximum number of characters that can be contained in STRING columns. The range of `DefaultStringLength` is 0 to 32767.

By default, the columns metadata for Spark does not specify a maximum data length for STRING columns.

DelegationUID

Default Value	Data Type	Required
None	String	No

Description

Use this option to delegate all operations against Spark to a user that is different than the authenticated user for the connection.



Note:

This option is applicable only when connecting to a Spark Thrift Server instance that supports this feature.

FastConnection

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver bypasses the connection testing process. Enabling this option can speed up the connection process, but may result in errors.

- 1: The driver connects to the data source without first testing the connection.
- 0: The driver tests the connection before connecting to the data source.

httpPath

Default Value	Data Type	Required
None	String	Yes, if <code>transportMode=http</code> .

Description

The partial URL corresponding to the Spark server.

The driver forms the HTTP address to connect to by appending the `httpPath` value to the host and port specified in the connection URL. For example, to connect to the HTTP address `http://localhost:10002/cliservice`, you would use the following connection URL:

```
jdbc:hive2://localhost:10002;AuthMech=3;transportMode=http;httpPath=cliservice;UID=hs2;PWD=simba;
```

Note:

By default, Spark servers use `cliservice` as the partial URL.

KrbAuthType

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies how the driver obtains the Subject for Kerberos authentication.

- 0: The driver automatically detects which method to use for obtaining the Subject:
 1. First, the driver tries to obtain the Subject from the current thread's inherited `AccessControlContext`. If the `AccessControlContext` contains multiple Subjects, the driver uses the most recent Subject.
 2. If the first method does not work, then the driver checks the `java.security.auth.login.config` system property for a JAAS configuration. If a JAAS configuration is specified, the driver uses that information to create a `LoginContext` and then uses the Subject associated with it.
 3. If the second method does not work, then the driver checks the `KRB5_CONFIG` and `KRB5CCNAME` system environment variables for a Kerberos ticket cache. The driver uses the information from the cache to create a `LoginContext` and then uses the Subject associated with it.
- 1: The driver checks the `java.security.auth.login.config` system property for a JAAS configuration. If a JAAS configuration is specified, the driver uses that information to create a `LoginContext` and then uses the Subject associated with it.
- 2: The driver checks the `KRB5_CONFIG` and `KRB5CCNAME` system environment variables for a Kerberos ticket cache. The driver uses the information from the cache to create a `LoginContext` and then uses the Subject associated with it.

KrbHostFQDN

Default Value	Data Type	Required
None	String	Yes, if <code>AuthMech=1</code> .

Description

The fully qualified domain name of the Spark Thrift Server host.

KrbRealm

Default Value	Data Type	Required
Depends on your Kerberos configuration	String	No

Description

The realm of the Spark Thrift Server host.

If your Kerberos configuration already defines the realm of the Spark Thrift Server host as the default realm, then you do not need to configure this property.

KrbServiceName

Default Value	Data Type	Required
None	String	Yes, if <code>AuthMech=1</code> .

Description

The Kerberos service principal name of the Spark server.

LogLevel

Default Value	Data Type	Required
0	Integer	No

Description

Use this property to enable or disable logging in the driver and to specify the amount of detail included in log files.

! Important:

Only enable logging long enough to capture an issue. Logging decreases performance and can consume a large quantity of disk space.

Set the property to one of the following numbers:

- 0: Disable all logging.
- 1: Enable logging on the FATAL level, which logs very severe error events that will lead the driver to abort.
- 2: Enable logging on the ERROR level, which logs error events that might still allow the driver to continue running.
- 3: Enable logging on the WARNING level, which logs events that might result in an error if action is not taken.
- 4: Enable logging on the INFO level, which logs general information that describes the progress of the driver.
- 5: Enable logging on the DEBUG level, which logs detailed information that is useful for debugging the driver.
- 6: Enable logging on the TRACE level, which logs all driver activity.

When logging is enabled, the driver produces the following log files in the location specified in the `LogPath` property:

- A `SparkJDBC_driver.log` file that logs driver activity that is not specific to a connection.
- A `SparkJDBC_connection_[Number].log` file for each connection made to the database, where `[Number]` is a number that distinguishes each log file from the others. This file logs driver activity that is specific to the connection.

If the `LogPath` value is invalid, then the driver sends the logged information to the standard output stream (`System.out`).

LogPath

Default Value	Data Type	Required
The current working directory.	String	No

Description

The full path to the folder where the driver saves log files when logging is enabled.

PreparedMetaLimitZero

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the `PreparedStatement.getMetadata()` call will request metadata from the server with `LIMIT 0`.

- 1: The `PreparedStatement.getMetadata()` call uses `LIMIT 0`.
- 0: The `PreparedStatement.getMetadata()` call does not use `LIMIT 0`.

PWD

Default Value	Data Type	Required
None	String	Yes, if <code>AuthMech=3</code> .

Description

The password corresponding to the user name that you provided using the property [UID](#) on page 45.

RowsFetchedPerBlock

Default Value	Data Type	Required
10000	Integer	No

Description

The maximum number of rows that a query returns at a time.

Any positive 32-bit integer is a valid value, but testing has shown that performance gains are marginal beyond the default value of 10000 rows.

ServerVersion

Default Value	Data Type	Required
AUTO	String	No

Description

The version number of the data server. This option is used to bypass the driver's server version check. This can speed up the connection process, but may result in errors.

If this option is not set or is set to `AUTO`, the driver checks the version of the server when a connection is made.

Otherwise, this option should be set to the version number of the server, in the format:

```
<MajorVersion>.<MinorVersion>.<PatchNumber>
```

For example, `ServerVersion=2.2.0` indicates that the driver is connecting to Spark Server 2.2.0.

! Important:

If this option is set, it must match the version of the server, otherwise errors may occur.

SocketTimeout

Default Value	Data Type	Required
0	Integer	No

Description

The number of seconds that the TCP socket waits for a response from the server before raising an error on the request.

When this property is set to `0`, the connection does not time out.

SSL

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver communicates with the Spark server through an SSL-enabled socket.

- 1: The driver connects to SSL-enabled sockets.
- 0: The driver does not connect to SSL-enabled sockets.

 **Note:**

SSL is configured independently of authentication. When authentication and SSL are both enabled, the driver performs the specified authentication method over an SSL connection.


SSLKeyStore

Default Value	Data Type	Required
None	String	No

Description

The full path of the Java KeyStore containing the server certificate for one-way SSL authentication.

See also the property [SSLKeyStorePwd](#) on page 43.

 **Note:**

The Simba Spark JDBC Driver accepts TrustStores and KeyStores for one-way SSL authentication. See also the property [SSLTrustStore](#) on page 43.

SSLKeyStorePwd

Default Value	Data Type	Required
None	Integer	Yes, if you are using a KeyStore for connecting over SSL.

Description

The password for accessing the Java KeyStore that you specified using the property [SSLKeyStore](#) on page 42.

SSLTrustStore

Default Value	Data Type	Required
<p><code>jssecacerts</code>, if it exists.</p> <p>If <code>jssecacerts</code> does not exist, then <code>cacerts</code> is used. The default location of <code>cacerts</code> is <code>jre\lib\security\.</code></p>	String	No

Description

The full path of the Java TrustStore containing the server certificate for one-way SSL authentication.

See also the property [SSLTrustStorePwd](#) on page 44.



Note:

The Simba Spark JDBC Driver accepts TrustStores and KeyStores for one-way SSL authentication. See also the property [SSLKeyStore](#) on page 42.

SSLTrustStorePwd

Default Value	Data Type	Required
None	String	Yes, if using a TrustStore

Description

The password for accessing the Java TrustStore that you specified using the property [SSLTrustStore](#) on page 43.

StripCatalogName

Default Value	Data Type	Required
1	Integer	No

Description

This property specifies whether the driver removes catalog names from query statements if translation fails or if the `UseNativeQuery` property is set to 1.

- 1: If query translation fails or if the `UseNativeQuery` property is set to 1, then the driver removes catalog names from the query statement.
- 0: The driver does not remove catalog names from query statements.

transportMode

Default Value	Data Type	Required
sasl	String	No

Description

The transport protocol to use in the Thrift layer.

- `binary`: The driver uses the Binary transport protocol.

If you use this setting but do not specify the `AuthMech` property, then the driver uses `AuthMech=0` by default. This setting is valid only when the `AuthMech` property is set to 0 or 3.

- `sasl`: The driver uses the SASL transport protocol.

If you use this setting but do not specify the `AuthMech` property, then the driver uses `AuthMech=2` by default. This setting is valid only when the `AuthMech` property is set to 1, 2, or 3.

- `http`: The driver uses the HTTP transport protocol.

If you use this setting but do not specify the `AuthMech` property, then the driver uses `AuthMech=3` by default. This setting is valid only when the `AuthMech` property is set to 3.

If you set this property to `http`, then the port number in the connection URL corresponds to the HTTP port rather than the TCP port, and you must specify the `httpPath` property. For more information, see [httpPath](#) on page 36.

UID

Default Value	Data Type	Required
<code>spark</code>	String	Yes, if <code>AuthMech=3</code> .

Description

The user name that you use to access the Spark server.

UseNativeQuery

Default Value	Data Type	Required
0	Integer	No

Description

This property specifies whether the driver transforms the queries emitted by applications.

- 1: The driver does not transform the queries emitted by applications, so the native query is used.

- 0: The driver transforms the queries emitted by applications and converts them into an equivalent form in HiveQL.

**Note:**

If the application is Spark-aware and already emits HiveQL, then enable this option to avoid the extra overhead of query transformation.

Third-Party Trademarks

Oracle and Java are registered trademarks of Oracle and/or its affiliates. Other names may be trademarks of their respective owners.

Apache Spark, Apache, and Spark are trademarks or registered trademarks of The Apache Software Foundation or its subsidiaries in Canada, United States and/or other countries.

All other trademarks are trademarks of their respective owners.

Third-Party Licenses

The licenses for the third-party libraries that are included in this product are listed below.

Simple Logging Façade for Java (SLF4J) License

Copyright © 2004-2015 QOS.ch

All rights reserved.

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Apache License, Version 2.0

The following notice is included in compliance with the Apache License, Version 2.0 and is applicable to all software licensed under the Apache License, Version 2.0.

Apache License

Version 2.0, January 2004

<http://www.apache.org/licenses/>

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions for use, reproduction, and distribution as defined by Sections 1 through 9 of this document.

"Licensor" shall mean the copyright owner or entity authorized by the copyright owner that is granting the License.

"Legal Entity" shall mean the union of the acting entity and all other entities that control, are controlled by, or are under common control with that entity. For the purposes of this definition, "control" means (i) the power, direct or indirect, to cause the direction or management of such entity, whether by contract or otherwise, or (ii) ownership of fifty percent (50%) or more of the outstanding shares, or (iii) beneficial ownership of such entity.

"You" (or "Your") shall mean an individual or Legal Entity exercising permissions granted by this License.

"Source" form shall mean the preferred form for making modifications, including but not limited to software source code, documentation source, and configuration files.

"Object" form shall mean any form resulting from mechanical transformation or translation of a Source form, including but not limited to compiled object code, generated documentation, and conversions to other media types.

"Work" shall mean the work of authorship, whether in Source or Object form, made available under the License, as indicated by a copyright notice that is included in or attached to the work (an example is provided in the Appendix below).

"Derivative Works" shall mean any work, whether in Source or Object form, that is based on (or derived from) the Work and for which the editorial revisions, annotations, elaborations, or other modifications represent, as a whole, an original work of authorship. For the purposes of this License, Derivative Works shall not include works that remain separable from, or merely link (or bind by name) to the interfaces of, the Work and Derivative Works thereof.

"Contribution" shall mean any work of authorship, including the original version of the Work and any modifications or additions to that Work or Derivative Works thereof, that is intentionally submitted to Licensor for inclusion in the Work by the copyright owner or by an individual or Legal Entity authorized to submit on behalf of the copyright owner. For the purposes of this definition, "submitted" means any form of electronic, verbal, or written communication sent to the Licensor or its representatives, including but not limited to communication on electronic mailing lists, source code control systems, and issue tracking systems that are managed by, or on behalf of, the Licensor for the purpose of discussing and improving the Work, but excluding communication that is conspicuously marked or otherwise designated in writing by the copyright owner as "Not a Contribution."

"Contributor" shall mean Licensor and any individual or Legal Entity on behalf of whom a Contribution has been received by Licensor and subsequently incorporated within the Work.

2. **Grant of Copyright License.** Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable copyright license to reproduce, prepare Derivative Works of, publicly display, publicly perform, sublicense, and distribute the Work and such Derivative Works in Source or Object form.
3. **Grant of Patent License.** Subject to the terms and conditions of this License, each Contributor hereby grants to You a perpetual, worldwide, non-exclusive, no-charge, royalty-free, irrevocable (except as stated in this section) patent license to make, have made, use, offer to sell, sell, import, and otherwise transfer the Work, where such license applies only to those patent claims licensable by such Contributor that are necessarily infringed by their Contribution(s) alone or by combination of their Contribution(s) with the Work to which such Contribution(s) was submitted. If You institute patent litigation against any entity (including a cross-claim or counterclaim in a lawsuit) alleging that the Work or a Contribution incorporated within the Work constitutes direct or contributory patent infringement, then any patent licenses granted to You under this License for that Work shall terminate as of the date such litigation is filed.
4. **Redistribution.** You may reproduce and distribute copies of the Work or Derivative Works thereof in any medium, with or without modifications, and in Source or Object form, provided that You meet the following conditions:
 - (a) You must give any other recipients of the Work or Derivative Works a copy of this License; and
 - (b) You must cause any modified files to carry prominent notices stating that You changed the files; and
 - (c) You must retain, in the Source form of any Derivative Works that You distribute, all copyright, patent, trademark, and attribution notices from the Source form of the Work, excluding those notices that do not pertain to any part of the Derivative Works; and
 - (d) If the Work includes a "NOTICE" text file as part of its distribution, then any Derivative Works that You distribute must include a readable copy of the attribution notices contained within such NOTICE file, excluding those notices that do not pertain to any part of the Derivative Works, in at least one of the following places: within a NOTICE text file distributed as part of the Derivative Works; within the Source form or documentation, if provided along with the Derivative Works; or, within a display generated by the Derivative Works, if and wherever such third-party notices normally appear. The contents of the NOTICE file are for informational purposes

only and do not modify the License. You may add Your own attribution notices within Derivative Works that You distribute, alongside or as an addendum to the NOTICE text from the Work, provided that such additional attribution notices cannot be construed as modifying the License.

You may add Your own copyright statement to Your modifications and may provide additional or different license terms and conditions for use, reproduction, or distribution of Your modifications, or for any such Derivative Works as a whole, provided Your use, reproduction, and distribution of the Work otherwise complies with the conditions stated in this License.

5. **Submission of Contributions.** Unless You explicitly state otherwise, any Contribution intentionally submitted for inclusion in the Work by You to the Licensor shall be under the terms and conditions of this License, without any additional terms or conditions. Notwithstanding the above, nothing herein shall supersede or modify the terms of any separate license agreement you may have executed with Licensor regarding such Contributions.
6. **Trademarks.** This License does not grant permission to use the trade names, trademarks, service marks, or product names of the Licensor, except as required for reasonable and customary use in describing the origin of the Work and reproducing the content of the NOTICE file.
7. **Disclaimer of Warranty.** Unless required by applicable law or agreed to in writing, Licensor provides the Work (and each Contributor provides its Contributions) on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied, including, without limitation, any warranties or conditions of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A PARTICULAR PURPOSE. You are solely responsible for determining the appropriateness of using or redistributing the Work and assume any risks associated with Your exercise of permissions under this License.
8. **Limitation of Liability.** In no event and under no legal theory, whether in tort (including negligence), contract, or otherwise, unless required by applicable law (such as deliberate and grossly negligent acts) or agreed to in writing, shall any Contributor be liable to You for damages, including any direct, indirect, special, incidental, or consequential damages of any character arising as a result of this License or out of the use or inability to use the Work (including but not limited to damages for loss of goodwill, work stoppage, computer failure or malfunction, or any and all other commercial damages or losses), even if such Contributor has been advised of the possibility of such damages.
9. **Accepting Warranty or Additional Liability.** While redistributing the Work or Derivative Works thereof, You may choose to offer, and charge a fee for, acceptance of support, warranty, indemnity, or other liability obligations and/or rights consistent with this License. However, in accepting such obligations, You may act only on Your own behalf and on Your sole responsibility, not on behalf of

any other Contributor, and only if You agree to indemnify, defend, and hold each Contributor harmless for any liability incurred by, or claims asserted against, such Contributor by reason of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work.

To apply the Apache License to your work, attach the following boilerplate notice, with the fields enclosed by brackets "[]" replaced with your own identifying information. (Don't include the brackets!) The text should be enclosed in the appropriate comment syntax for the file format. We also recommend that a file or class name and description of purpose be included on the same "printed page" as the copyright notice for easier identification within third-party archives.

Copyright [yyyy] [name of copyright owner]

Licensed under the Apache License, Version 2.0 (the "License"); you may not use this file except in compliance with the License. You may obtain a copy of the License at

<http://www.apache.org/licenses/LICENSE-2.0>

Unless required by applicable law or agreed to in writing, software distributed under the License is distributed on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the License for the specific language governing permissions and limitations under the License.

This product includes software that is licensed under the Apache License, Version 2.0 (listed below):

Apache Commons

Copyright © 2001-2015 The Apache Software Foundation

Apache Commons Codec

Copyright © 2002-2014 The Apache Software Foundation

Apache Hadoop Common

Copyright © 2014 The Apache Software Foundation

Apache Hive

Copyright © 2008-2015 The Apache Software Foundation

Apache HttpComponents Client

Copyright © 1999-2012 The Apache Software Foundation

Apache HttpComponents Core

Copyright © 1999-2012 The Apache Software Foundation

Apache Logging Services

Copyright © 1999-2012 The Apache Software Foundation

Apache Spark

Copyright © 2014 The Apache Software Foundation

Apache Thrift

Copyright © 2006-2010 The Apache Software Foundation

Apache ZooKeeper

Copyright © 2010 The Apache Software Foundation

Licensed under the Apache License, Version 2.0 (the "License"); you may not use this file except in compliance with the License. You may obtain a copy of the License at

<http://www.apache.org/licenses/LICENSE-2.0>

Unless required by applicable law or agreed to in writing, software distributed under the License is distributed on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied. See the License for the specific language governing permissions and limitations under the License.