RTI Security Plugins

Getting Started Guide

Version 6.0.0

Technical Support

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Chapter 1 Introduction

RTI® Security Plugins is a robust set of security capabilities, including authentication, encryption, access control and logging. Secure multicast support enables efficient and scalable distribution of data to many subscribers. Performance is also optimized by fine-grain control over the level of security applied to each data flow, such as whether encryption or just data integrity is required.

This release of *Security Plugins* includes partial support for the DDS Security specification from the Object Management Group (OMG)[1]. This support allows *DomainParticipants* to authenticate and authorize each other before initializing communication, and then encode and decode the communication traffic to achieve confidentiality, message authentication, and data integrity.

Specifically, these features are supported:

- Authentication can now be done as part of the *RTI Connext® DDS* discovery process to ensure that DomainParticipants validate each other's identity.
- Access Control permissions checking can now be done as part of the *Connext DDS* discovery process to ensure that *DomainParticipants*, *DataWriters*, and *DataReaders* have the appropriate permissions to exist and match with each other. Domain governance can now be done during entity creation to ensure the right security attributes are applied to the right *DomainParticipants*, *DataWriters*, and *DataReaders*.
- Cryptographic operations can now be done as part of *Connext DDS* steady-state communication to ensure confidentiality, message authentication, and data integrity.
- Logging operations can now be done using the Logging Plugin. There are options to print the log messages to standard output or a file, distribute log messages over a DDS topic, and control the verbosity level of the log messages.
- Data tagging can now be done using the DataTagQosPolicy, and data tags can now be allowed or denied using the Permissions Document.

[1]http://www.omg.org/spec/DDS-SECURITY/1.1/

The above features are supported in the RTI core middleware in the C, C++, Java, and .NET programming languages.

The following DDS Security features are *not* supported:

- Revocation of identities and permissions
- Instance-level permissions checking

For descriptions and examples of the security configuration in this release, please consult the **hello_security** examples under the **rti_workspace/*version*/examples/connext_dds/[c, cpp, java, csharp]** directory.

To use *Security Plugins*, you will need to create private keys, identity certificates, governance, and permission files, as well as signed versions for use in secure authenticated, authorized, and/or encrypted communications.

If you are new to the world of internet security, see this link:

- https://en.wikipedia.org/wiki/Public-key_cryptography

Fundamentally, if you want to deploy a secure system, your organization will need to have an in-house security expert. Just using *Security Plugins* is not sufficient. It is a tool that can build secure systems, but you do have to use it (configure it) to meet your requirements. If used incorrectly, systems deployed with *Security Plugins* may not meet the security requirements of a project.

The *Security Plugins* bundle includes a set of builtin plugins that implement those defined by the DDS Security specification. It is also possible to implement new custom plugins by using the *Security Plugins SDK* bundle (for more information, please contact **support@rti.com**).

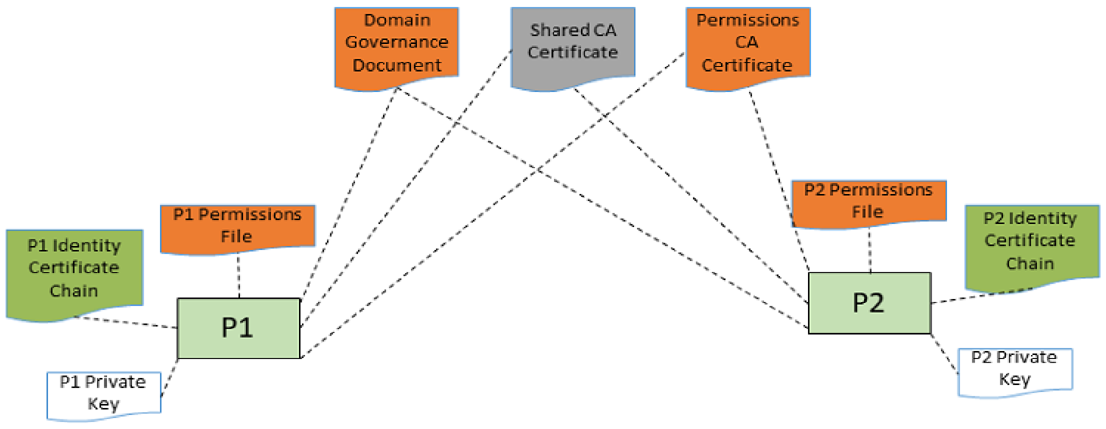
You should know that *Security Plugins* use the same technology as most of the world's eCommerce, so if you have ever purchased something on the internet, the same technology protecting your purchase is used by *Security Plugins* to protect data exchange.

As an end user, you need to have the following files that an application using *Security Plugins* needs to communicate in a secure DDS domain:

- **Keys.** Each participant has a Private Key and Identity Certificate pair that is used in the authentication process.
- **Shared CA** has signed participant public keys. Participants must also have a copy of the CA certificate (also known as Identity Certificate Authority Certificate).
- **Permissions File** specifies what domains/partitions the *DomainParticipant* can join, what topics it can read/write, and what tags are associate with the readers/writers.
- **Domain Governance** specifies which domains should be secured and how.

Permissions CA has a signed participant permission file, as well as the domain governance document. Participants must have a copy of the permissions CA certificate (also known as Permissions Authority Certificate).

Figure 1.1: Configuring & Deploying DDS Security


Domain Governance Document
Shared CA Certificate
Permissions CA Certificate
P1 Permissions File
P1 Identity Certificate Chain
P1
P1 Private Key
P2 Permissions File
P2 Identity Certificate Chain
P2
P2 Private Key

Chapter 2 Paths Mentioned in Documentation

The documentation refers to:

- **<NDDSHOME>**

  This refers to the installation directory for *RTI® Connext® DDS*. The default installation paths are:

  - Mac® OS X® systems:
    /Applications/rti_connext_dds-6.0.0
  - UNIX-based systems, non-*root* user:
    /home/<your user name>/rti_connext_dds-6.0.0
  - UNIX-based systems, *root* user:
    /opt/rti_connext_dds-6.0.0
  - Windows® systems, user without Administrator privileges:
    <your home directory>\rti_connext_dds-6.0.0
  - Windows systems, user with Administrator privileges:
    C:\Program Files\rti_connext_dds-6.0.0

  You may also see $NDDSHOME or %NDDSHOME%, which refers to an environment variable set to the installation path.

  Wherever you see <NDDSHOME> used in a path, replace it with your installation path.

Note for Windows Users: When using a command prompt to enter a command that includes the path **C:\Program Files** (or any directory name that has a space), enclose the path in quotation marks. For example:

```
"C:\Program Files\rti_connext_dds-6.0.0\bin\rtiddsgen"
```

Or if you have defined the NDDSHOME environment variable:

```
"%NDDSHOME%\bin\rtiddsgen"
```

- **<path to examples>**

  By default, examples are copied into your home directory the first time you run *RTI Launcher* or any script in **<NDDSHOME>/bin**. This document refers to the location of the copied examples as <path to examples>.

  Wherever you see <path to examples>, replace it with the appropriate path.

  Default path to the examples:

  - Mac OS X systems: **/Users/<*your user name*>/rti_workspace/6.0.0/examples**
  - UNIX-based systems: **/home/<*your user name*>/rti_workspace/6.0.0/examples**
  - Windows systems: ***<your Windows documents folder>*\rti_workspace\6.0.0\examples**

    Where 'your Windows documents folder' depends on your version of Windows. For example, on Windows 10, the folder is **C:\Users\<your user name>\Documents**.

  Note: You can specify a different location for **rti_workspace**. You can also specify that you do not want the examples copied to the workspace. For details, see *Controlling Location for RTI Workspace and Copying of Examples* in the *RTI Connext DDS Core Libraries Getting Started Guide*.

Chapter 3 Download Instructions

Download *Security Plugins* from the RTI Support Portal, accessible from https://support.rti.com/.

Security Plugins also requires OpenSSL®, which is available from RTI's Support Portal, or you may obtain it from another source.

You will need your username and password to log into the portal; these are included in the letter confirming your purchase or evaluation copy. If you do not have this letter, please contact **license@rti.com**.

Once you have logged into the portal, select the **Downloads** link, then select the appropriate version of *Security Plugins* and OpenSSL for your platform.

If you need help with the download process, contact **support@rti.com**.

- *Security Plugins* can be downloaded in the following packages:

  Non-Evaluation:

  - **rti_security_plugins-**<*version*>**-host-**<*host platform*>**.rtipkg**,
    which includes the compiler-independent Security Plugins dependencies (documentation, headers, and the libraries used by RTI tools and services) for the host platform.
  - **rti_security_plugins-**<*version*>**-target-**<*target architecture*>**.rtipkg**,
    which contains the Security Plugins libraries you will link against.

  Evaluation:

  - **rti_security_plugins-**<*version*>**-eval-**<*target architecture*>**.rtipkg**,
    which includes the compiler-independent Security Plugins dependencies (documentation, headers, and the libraries used by RTI tools and services) for the host platform and the Security Plugins evaluation libraries you will link against for your target platform.

- OpenSSL:
    - OpenSSL distribution files for RTI tools and services follow the naming convention: **openssl-<***version***>-host-<***host platform***>.rtipkg**.
    - OpenSSL distribution files to link against your application follow the naming convention: **openssl-<***version***>-target-<***target architecture***>.tar.gz** (or **.zip** on Windows systems).

  For the currently supported OpenSSL version number, see the *RTI Security Plugins Release Notes*. Architecture names are described in the *RTI Connext DDS Core Libraries Platform Notes*. For example:

    - Bundle with distribution files for RTI tools and services: **openssl-1.0.2o-host-x64Win64.rtipkg.**
    - Bundle with distribution files to link against your application: **openssl-1.0.2o-target-x64Win64VS2013.zip.**

Chapter 4 Installation Instructions

You do not need administrator privileges. All directory locations are meant as examples only; adjust them to suit your site.

These instructions assume you are installing *Security Plugins* 6.0.0 and OpenSSL 1.0.2o. See the *RTI Security Plugins Release Notes* for the currently supported versions.

4.1 Installing an Evaluation Version

4.1.1 UNIX-Based Systems

1. Install the *Connext DDS* host and target bundles, as described the *RTI Connext DDS Core Libraries Getting Started Guide.*
2. Install the *Security Plugins* package. Use the package installer, just as you did for the *Connext DDS* target bundles in step 1.
    - **rti_security_plugins-6.0.0-eval-<*target architecture*>.rtipkg**

   (Where <*target architecture*> is one of the supported platforms, see the *RTI Connext DDS Core Libraries Platform Notes*).

   After installation, the security header files and libraries will be under **include/ndds/security** and **lib/<*target architecture*>**, respectively.
3. Install an OpenSSL host package from RTI: **openssl-1.0.2o-host-<*host platform*>.rtipkg**.
4. Install an OpenSSL target package from RTI: **openssl-1.0.2o-target-<*target architecture*>.tar.gz**.
    a. Make sure you have GNU's version of the tar utility, **gtar** (which handles long file names), and GNU's version of the unzip utility, **gunzip**.
    b. Move the downloaded OpenSSL distribution file to a directory of your choice, such as **/local/rti**, and change to that directory:

```
> cd /local/rti
```

c. Use **gunzip** to uncompress the OpenSSL file. (This is not the same as the OpenSSL host package in the previous step.) For example (your filename may be different):

```
> gunzip openssl-1.0.2o-target-armv7aQNX6.6.0qcc_cpp4.7.3.tar.gz
```

d. Use **gtar** to extract the distribution from the uncompressed file. For example:

```
> gtar xvf openssl-1.0.2o-target-armv7aQNX6.6.0qcc_cpp4.7.3.tar
```

This will extract files into **/local/rti/openssl-1.0.2o**.

e. Include the resulting **/bin** directory in your PATH. For example, assuming you want to use the "release" version of the OpenSSL libraries (enter the command all on one line):

```
> setenv PATH
  /local/rti/openssl-1.0.2o/armv7aQNX6.6.0qcc_cpp4.7.3/release/bin:${PATH}
```

f. If linking dynamically, include the resulting **/lib** directory in your LD_LIBRARY_PATH. For example, assuming you want to use the "release" version of the OpenSSL libraries (enter the command all on one line):

```
> setenv LD_LIBRARY_PATH
  /local/rti/openssl-1.0.2o/armv7aQNX6.6.0qcc_cpp4.7.3/release/lib:$PATH
```

g. To verify your installation, enter:

```
> openssl version
```

You should see a response similar to:

```
OpenSSL 1.0.2o
```

5. Your *Security Plugins* distribution may require a license. See Chapter 6 License Management on page 16.

4.1.2 Windows Systems

1. Install *Connext DDS* host and target bundles on top of each other, as described the *RTI Connext DDS Core Libraries Getting Started Guide.*

2. Install the *Security Plugins* package. Use the package installer, just as you did for the *Connext DDS* target bundles in step 1.

   - **rti_security_plugins-6.0.0-eval-<*target architecture*>.rtipkg**

   (Where <*target architecture*> is one of the supported platforms, see the *RTI Connext DDS Core Libraries Platform Notes*).

   After installation, the security header files and libraries will be under **include/ndds/security** and **lib/<target architecture>**, respectively.

3. Install an OpenSSL host package from RTI: o**penssl-1.0.2o-host-<*host platform*>.rtipkg**.

4. Install an OpenSSL target package from RTI: **openssl-1.0.2o-target-<*target architecture*>.zip**.
   a. Right-click the distribution file and extract the contents in a directory of your choice.
   b. Add the resulting **bin** directory to your **Path** environment variable:

      c:\rti\openssl-1.0.2o\<*target architecture*>\release\bin

      (If you need help with this process, please see the *RTI Connext DDS Core Libraries Getting Started Guide*.)
   c. To verify your installation, open a command prompt and enter:

      ```
      > openssl version
      ```

      You should see a response similar to:

      ```
      OpenSSL 1.0.2o
      ```
5. Your *Security Plugins* distribution may require a license. See Chapter 6 License Management on page 16.

4.2 Installing a Non-Evaluation Version

4.2.1 UNIX-Based Systems

1. Install the *Connext DDS* host and target bundles on top of each other, as described the *RTI Connext DDS Core Libraries Getting Started Guide*.
2. Install the *Security Plugins* host and target packages to enable security for your applications. The security header files and libraries will be under **include/ndds/security** and **lib/<*target architecture*>**, respectively:
   - **rti_security_plugins-6.0.0-host-<*host platform*>.rtipkg**
   - **rti_security_plugins-6.0.0-target-<*target architecture*>.rtipkg**

   (Where <*host platform*> is **i86Linux**, **x64Linux**, or **darwin** and <*target architecture*> is one of the supported platforms, see the *RTI Security Plugins Release Notes*).
3. If you want to enable security for RTI tools and services, install an OpenSSL host package from RTI:
   - **openssl-1.0.2o-host-<*host platform*>.rtipkg**
4. Install a supported version of OpenSSL:
   a. Make sure you have GNU's version of the tar utility, **gtar** (which handles long file names), and GNU's version of the unzip utility, **gunzip**.
   b. Move the downloaded OpenSSL distribution file to a directory of your choice, such as **/local/rti**, and change to that directory:

```
> cd /local/rti
```

c. Use **gunzip** to uncompress the OpenSSL file. (This is not the same as the OpenSSL host package in the previous step.) For example (your filename may be different):

```
> gunzip openssl-1.0.2o-target-armv7aQNX6.6.0qcc_cpp4.7.3.tar.gz
```

d. Use **gtar** to extract the distribution from the uncompressed file. For example:

```
> gtar xvf openssl-1.0.2o-target-armv7aQNX6.6.0qcc_cpp4.7.3.tar
```

This will extract files into **/local/rti/openssl-1.0.2o**.

e. Include the resulting **/bin** directory in your PATH. For example, assuming you want to use the "release" version of the OpenSSL libraries (enter the command all on one line):

```
> setenv PATH
  /local/rti/openssl-1.0.2o/armv7aQNX6.6.0qcc_cpp4.7.3/release/bin:${PATH}
```

f. If linking dynamically, include the resulting **/lib** directory in your LD_LIBRARY_PATH. For example, assuming you want to use the "release" version of the OpenSSL libraries (enter the command all on one line):

```
> setenv LD_LIBRARY_PATH
  /local/rti/openssl-1.0.2o/armv7aQNX6.6.0qcc_cpp4.7.3/release/lib:$PATH
```

g. To verify your installation, enter:

```
> openssl version
```

You should see a response similar to:

```
OpenSSL 1.0.2o
```

This completes the installation process.

4.2.2 Windows Systems

1. Install the *Connext DDS* host and target bundles on top of each other, as described the *RTI Connext DDS Core Libraries Getting Started Guide.*

2. Install the *Security Plugins* host and target packages to enable security for your applications. The security header files and libraries will be under **include/ndds/security** and **lib/<*target architecture*>**, respectively:

   - **rti_security_plugins-6.0.0-host-<*host platform*>.rtipkg**
   - **rti_security_plugins-6.0.0-target-<*target architecture*>.rtipkg**

   (Where <*host platform*> is **i86Win32** or **x64Win64**, and <*target architecture*> is one of the supported platforms, see the *RTI Security PluginsRelease Notes*).

3. If you want to enable security for RTI tools and services, install OpenSSL host packages from RTI:

   - **openssl-1.0.2o-host-<*host platform*>.rtipkg**

4. Install a supported version of OpenSSL:
    a. Right-click the distribution file and extract the contents in a directory of your choice.
    b. Add the resulting **bin** directory to your **Path** environment variable:
        - **c:\rti\openssl-1.0.2o\<*target architecture*>\release\bin**

        (If you need help with this process, please see the *RTI Connext DDS Core Libraries Getting Started Guide*.)
    c. To verify your installation, open a command prompt and enter:

        ```
        > openssl version
        ```

        You should see a response similar to:

        ```
        OpenSSL 1.0.2o
        ```

This completes the installation process.

Chapter 5 Libraries Required for Using RTI Security Plugins

To use the *RTI Security Plugins*, link against the additional libraries in one of the following tables, depending on your platform. Select the files appropriate for your chosen library format.

Table 5.1 Additional Libraries for Using RTI Security Plugins on Android Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Dynamic Release	libnddssecurity.so	librtisslsupport.so
Dynamic Debug	libnddssecurityd.so	librtisslsupport.so
Static Release	libnddssecurityz.a	librtisslsupportz.a
Static Debug	libnddssecurityzd.a	librtisslsupportz.a

[a] These libraries are in <NDDSHOME>/lib/<architecture>.

[b] These libraries are in <openssl install dir>/<architecture>/<debug or release dir>/lib.

Table 5.2 Additional Libraries for Using RTI Security Plugins on iOS Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Static Release	libnddssecurityz.a	libsslz.a libcryptoz.a
Static Debug	libnddssecurityzd.a	libsslz.a libcryptoz.a

[a] These libraries are in <NDDSHOME>/lib/<architecture>.

[b] These libraries are in <openssl install dir>/<architecture>/<debug or release dir>/lib.

Table 5.3 Additional Libraries for Using RTI Security Plugins on Unix-Based Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Dynamic Release	libnddssecurity.so	libssl.so libcrypto.so
Dynamic Debug	libnddssecurityd.so	libssl.so libcrypto.so
Static Release	libnddssecurityz.a	libsslz.a libcryptoz.a
Static Debug	libnddssecurityzd.a	libsslz.a libcryptoz.a

[a] These libraries are in <NDDSHOME>/lib/<architecture>.
[b] These libraries are in <openssl install dir>/<architecture>/<debug or release dir>/lib.

Table 5.4 Additional Libraries for Using RTI Security Plugins on OS X Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Dynamic Release	libnddssecurity.dylib	libssl.dylib libcrypto.dylib
Dynamic Debug	libnddssecurityd.dylib	libssl.dylib libcrypto.dylib
Static Release	libnddssecurityz.a	libsslz.a libcryptoz.a
Static Debug	libnddssecurityzd.a	libsslz.a libcryptoz.a

[a]These libraries are in <NDDSHOME>/lib/<architecture>.
[b]These libraries are in <openssl install dir>/<architecture>/<debug or release dir>/lib.

Table 5.5 Additional Libraries for Using RTI Security Plugins on QNX Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Dynamic Release	libnddssecurity.so	libssl.so libcrypto.so
Dynamic Debug	libnddssecurityd.so	libssl.so libcrypto.so
Static Release	libnddssecurityz.a	libsslz.a libcryptoz.a
Static Debug	libnddssecurityzd.a	libsslz.a libcryptoz.a

[a]These libraries are in <NDDSHOME>/lib/<architecture>.
[b]These libraries are in <openssl install dir>/<architecture>/<debug or release dir>/lib.

Table 5.6 Additional Libraries for Using RTI Security Plugins on Windows Systems

Library Format	RTI Security Plugins Libraries [a]	OpenSSL Libraries [b]
Dynamic Release	nddssecurity.lib	ssleay32.lib libeay32.lib
Dynamic Debug	nddssecurityd.lib	ssleay32.lib libeay32.lib
Static Release	nddssecurityz.lib	ssleay32z.lib libeay32z.lib
Static Debug	nddssecurityzd.lib	ssleay32z.lib libeay32z.lib

[a]These libraries are in <NDDSHOME>/lib/<architecture>.
[b]These libraries are in <openssl install dir>\<architecture>\<debug, release, static_debug, or static_release dir>\lib.

Chapter 6 License Management

Most package types (Professional, Basic, and Evaluation) require a license file in order to run.

If your distribution requires a license file, you will receive one from RTI via email.

If you have more than one license file from RTI, you can concatenate them into one file.

A single license file can be used to run on any architecture and is not node-locked. You are not required to run a license server.

6.1 Installing the License File

Save the license file in any location of your choice; the locations checked by the plugin are listed below. You can also specify the location of your license file in *RTI Launcher*'s **Configuration** tab. Then *Launcher* can copy the license file to the installation directory or to the user workspace.

Each time your application starts, it will look for the license file in the following locations until it finds a valid license. (The properties are in the PropertyQosPolicy of the *DomainParticipant*.)

1. A property called **com.rti.serv.secure.license_string**. The value for this property can be set to the content of a license file. (This may be necessary if a file system is not supported on your platform.)
2. A property called **dds.license.license_string**. (Only if you have an evaluation version of *Connext DDS Professional*.)

   The above two **license_string** properties can be set to the content of a license file. (This may be necessary if a file system is not supported on your platform.) You can set the property either in source code or in an XML file.

   If the content of the license file is in XML, special characters for XML need to be escaped in the license string. Special characters include: quotation marks (") (replace with &quot;), apostrophes (') (replace with &apos;), greater-than (>) (replace with &gt;), less-than (<) (replace with &lt;), and ampersands (&) (replace with &amp;).

Example XML file:

```
<participant_qos>
    <property>
        <value>
            <element>
                <name>dds.license.license_string</name>
                <value>contents of license file</value>
            </element>
        </value>
    </property>
</participant_qos>
```

3. A property called **com.rti.serv.secure.license_file**.
4. A property called **dds.license.license_file**. (Only if you have an evaluation version of *Connext DDS Professional*.)

   The above two **license_file** properties can be set to the location (full path and filename) of a license file. (This may be necessary if a default license location is not feasible and environment variables are not supported.) You can set the property either in source code or in an XML file.

   Example XML to set **dds.license.license_file**:

```
<participant_qos>
    <property>
        <value>
            <element>
                <name>dds.license.license_file</name>
                <value>path to license file</value>
            </element>
        </value>
    </property>
</participant_qos>
```

5. In the location specified in the environment variable RTI_LICENSE_FILE, which you may set to point to the full path of the license file, including the filename.

   Note: When you run any of the scripts in the **<NDDSHOME>/bin** directory, this automatically sets the RTI_LICENSE_FILE environment variable (if it isn't already set) prior to calling the executable. It looks for the license file in two places: your **rti_workspace** directory and the installation directory (NDDSHOME). (See Chapter 2 Paths Mentioned in Documentation on page 4.)
6. If you are running any of the tools/services as executables via **NDDSHOME/bin/<e***xecutable script*> or through *Launcher*:
   a. In your **rti_workspace/<***version*> directory, in a file called **rti_license.dat**.
   b. In your **rti_workspace** directory, in a file called **rti_license.dat**.
   c. In <NDDSHOME> (the *Connext DDS* installation directory), in a file called **rti_license.dat**.

7. If you are running your own application linked with *Connext DDS* libraries:
    a. In your current working directory, in a file called **rti_license.dat**.
    b. In <NDDSHOME> (the *Connext DDS* installation directory), in a file called **rti_license.dat**.

As *Connext DDS* attempts to locate and read your license file, you may (depending on the terms of the license) see a message with details about your license.

If the license file cannot be found or the license has expired, your application may be unable to initialize, depending on the terms of the license. If that is the case, your application's call to **DomainParticipantFactory.create_participant()** will return null, preventing communication.

If you have any problems with your license file, please email **support@rti.com**.

6.2 Adding or Removing License Management

If your license file changes—for example, you receive a new license for a longer term than your original license—you do not need to reinstall.

However, if you switch from a license-managed distribution of *Connext DDS* to one of the same version that does not require license management, or vice versa, RTI recommends that you first uninstall your original distribution before installing your new distribution. Doing so will prevent you from inadvertently using a mixture of libraries from multiple installations.

Chapter 7 Restrictions when Using RTI Security Plugins

7.1 When to Set Security Parameters

In *Connext DDS*, you must set the security-related participant properties *before* you create a participant (see the tables at the beginning of Chapter 8 Authentication on page 20). You cannot create a participant without security and then call **DomainParticipant::set_qos()** with security properties, even if the participant has not yet been enabled.

7.2 Mixing Libraries Not Supported

Mixing static and dynamic RTI libraries (e.g., using RTI static core libraries and dynamic Security Plugins libraries) is not supported for user applications.

Chapter 8 Authentication

Authentication is the process of making sure a *DomainParticipant* is who it claims to be. Loading any security plugins will configure the *DomainParticipant* to authenticate a newly discovered remote participant before initiating endpoint discovery with that participant. Authentication is done via a series of inter-participant challenge and response messages. These messages perform mutual authentication, so the end result is that this participant authenticates the remote participant and vice-versa. If this participant fails to authenticate the remote participant, the remote participant is ignored. Otherwise, this participant initiates endpoint discovery with the remote participant and communication resumes as normal.

Table 8.1 Properties for Enabling Security below, Table 8.2 DDS Security Properties for Configuring Authentication on page 22, and Table 8.3 RTI Security Plugins Properties for Configuring Authentication on page 25 list the properties that you can set for Authentication and enabling security in general. These properties are configured through the *DomainParticipant*'s PropertyQosPolicy.

Table 8.1 Properties for Enabling Security

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
com.rti.serv.load_plugin (Note: this does not take a prefix)	***Required*** The prefix name of the security plugin suite that will be loaded by *Connext DDS*. For example: **com.rti.serv.secure**. You will use this string as the prefix to some of the property names. Setting this value to non-NULL will also configure the *DomainParticipant* to attempt authentication with newly discovered remote participants. Note: you can load only one security plugin suite. Default: NULL unless using the **Generic.Security** builtin profile

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 8.1 Properties for Enabling Security

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
library	***Only required if linking dynamically*** Must be set to the dynamic library that implements the security plugin suite. If using *Connext DDS*'s provided security plugin suite, you must set this value to **nddssecurity**. This library and the dependent OpenSSL libraries must be in your library search path (pointed to by the environment variable **LD_LIBRARY_PATH** on UNIX/Solaris systems, **Path** on Windows systems, **LIBPATH** on AIX systems, **DYLD_LIBRARY_PATH** on Mac OS systems). Default: NULL unless using **Generic.Security** builtin profile
create_function	***Only required if linking dynamically*** Must be set to the security plugin suite creation function that is implemented by the library. If using *Connext DDS*'s provided security plugin suite, you must set this value to **RTI_Security_PluginSuite_create**. Default: NULL unless using **Generic.Security** builtin profile
create_function_ptr	***Only required if linking statically*** Must be set to the security plugin suite creation function implemented by the library. If using *Connext DDS*'s provided security plugin suite, you must set this value to the stringified pointer value of **RTI_Security_PluginSuite_create**, as demonstrated in the **hello_security** examples. Note: you cannot set this value in an XML profile. You must set it in code. Default: NULL

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 8.2 DDS Security Properties for Configuring Authentication

Property Name	Property Value Description

dds.sec.au-th.identity_ca	***Required***
	This Identity Certificate Authority is used for signing authentication certificate files.
	OpenSSL should generate this file using commands such as the following. For an example **openssl.cnf** file, refer to the example **cert** folder: **rti_workspace/version/examples/dds_security/cert**. Note: You will need to modify this file to match your certificate folder structure and Identity Certificate Authority desired configuration.
	RSA:
	`% openssl genrsa -out cakey.pem 2048`
	`% openssl req -new -key cakey.pem -out ca.csr -config  openssl.cnf`
	`% openssl x509 -req -days 3650 -in ca.csr -signkey cakey.pem -out cacert.pem`
	DSA:
	`% openssl dsaparam 2048 > dsaparam`
	`% openssl gendsa -out cakeydsa.pem dsaparam`
	`% openssl req -new -key cakeydsa.pem -out dsaca.csr -config openssldsa.cnf`
	`% openssl x509 -req -days 3650 -in dsaca.csr -signkey cakeydsa.pem -out cacertdsa.pem`
	ECDSA:
	`% openssl ecparam -name prime256v1 > ecdsaparam`
	`% openssl req -nodes -x509 -days 3650 -newkey ec:ecdsaparam`
	`-keyout cakeyECdsa.pem -out cacertECdsa.pem -config opensslECdsa.cnf`
	If specifying the file name as the property value, this property value should be set to "file:" (no space after the colon), followed by the file name that appears after the "-out" parameter.
	Note: When running the above commands, you may run into these OpenSSL warnings:
	`WARNING: can't open config file: [default openssl built-inpath]/openssl.cnf`
	Or:
	`unable to write 'random state'`
	To resolve the first issue, set the environmental variable OPENSSL_CONF with the path to the **openssl.cnf** file you are using. To resolve the above issue, set the environmental variable RANDFILE with the path to a writable file.
	Two participants that want to securely communicate with each other must use the same Identity Certificate Authority.
	The document should be in PEM format. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example:
	`"data:,-----BEGIN CERTIFICATE-----\nabcdef\n-----END CERTIFICATE-----"`
	Note that the two "\n" characters are required.
	Default: NULL

Table 8.2 DDS Security Properties for Configuring Authentication

Property Name	Property Value Description

dds.sec.auth.private_key	***Required***
	The private key associated with the first certificate that appears in identity_certificate. After generating the **ca_file**, OpenSSL should generate this file using commands such as the following:
	RSA:
	`% openssl genrsa -out peer1key.pem 2048`
	DSA:
	`% openssl dsaparam 2048 > dsaparam`
	`% openssl gendsa -out peer1keydsa.pem dsaparam`
	ECDSA:
	`% openssl ecparam -name prime256v1 > ecdsaparam1`
	`% openssl req -nodes -new -newkey ec:ecdsaparam1 -config example1ECdsa.cnf -keyout peer1keyECdsa.pem -out peer1reqECdsa.pem`
	peer1reqECdsa.pem will be used to generate the certificate file. This property value should be set to **peer1keyECdsa.pem**.
	The document should be in PEM format. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example:
	`"data:,-----BEGIN PRIVATE KEY-----\nabcdef\n-----END PRIVATE KEY-----"`
	Note that the two "\n" characters are required.
	Default: NULL

Table 8.2 DDS Security Properties for Configuring Authentication

Property Name	Property Value Description

dds.sec.au-th.identity_cer-tificate	***Required***
	An Identity Certificate is required for secure communication.
	To generate this file, first generate the **ca_file** and **private_key_file**. Then create a **serial** file whose contents are **01** and a blank **index.txt** file. The names of these files will depend on the contents of the **openssl*.cnf** file. Then use OpenSSL to generate the certificate file using commands such as the following. For example **.cnf** files, refer to the example **cert** folder: **rti_work-space/version/examples/dds_security/cert**. Note: You will need to modify this file to match your certificate folder structure and Identity Certificate desired configuration:
	RSA:
	`% openssl req -config example1.cnf -new -key peer1key.pem`
	`-out user.csr`
	`% openssl ca -config openssl.cnf -days 365 -in user.csr`
	`-out peer1.pem`
	DSA:
	`% openssl req -config example1dsa.cnf -new -key peer1keydsa.pem -out dsauser.csr`
	`% openssl ca -config openssldsa.cnf -days 365`
	`-in dsauser.csr -out peer1dsa.pem`
	ECDSA:
	Generate **peer1reqECdsa.pem** using the instructions for private_key_file.
	`% openssl ca -batch -create_serial -config opensslECdsa.cnf`
	`-days 365 -in peer1reqECdsa.pem -out peer1ECdsa.pem`
	If specifying the file name as the property value, this property value should be set to "file:" (no space after the colon), followed by the file name that appears after the "-out" parameter.
	Notes:
	openssl((EC)dsa).cnf must have the same **countryName**, **stateOrProvinceName**, and **localityName** as the example **.cnf** files.
	Example **.cnf** files of different participants must have different commonNames.
	The document should be in PEM format. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example:
	`"data:,-----BEGIN CERTIFICATE-----\nabcdef\n-----END CERTIFICATE-----"`
	Note that the two "\n" characters are required.
	You may put a chain of certificates in the Identity Certificate by concatenating individual certificates and specifying the con-catenated result as a single file or string. See 8.1 Identity Certificate Chaining on page 26.
	Default: NULL

dds.sec.au-th.password	***Only required if private_key is encrypted***
	The password used to decrypt the private_key. The value of the password property is interpreted as the Base64 encoding of the symmetric key that will be used to decrypt the private_key. For example, if the private_key was encrypted using this command:
	`% openssl req -new -newkey ec:ecdsaparam2 -config example2ECdsa.cnf -keyout peer2keyECdsa.pem -`
	`passout pass:MyPassword -out peer2reqECdsa.pem`
	you can obtain the Base64 encoding of MyPassword using these commands:
	`% echo MyPassword > foo`
	`% openssl base64 -e -in foo`
	`TXlQYXNzd29yZAo=`
	The value of the password property should be "TXlQYXNzd29yZAo=". If the private_key was not encrypted, then the password must be NULL.
	Default: NULL

Table 8.3 RTI Security Plugins Properties for Configuring Authentication

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
authentication. shared_ secret_algorithm	***Optional*** The algorithm used to establish a shared secret during authentication. The options are **dh** and **ecdh** for (Elliptic Curve) Diffie-Hellman. If two participants discover each other and they specify different values for this algorithm, the algorithm that is used is the one that belongs to the participant with the lower-valued participant_key. **Note: ecdh** does not work with static OpenSSL libraries when using Certicom Security Builder Engine. Default: **ecdh**
authentication.alternative_ ca_files	***Optional*** A comma-separated list of alternative Identity CA certificates. If the verification of a file fails with the main certificate (identity_ca/ca_file), verification will be retried with all of the corresponding alternative certificates. If none of the alternative certificates can be used to verify the file, the verification process will fail. Default: NULL

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 8.3 RTI Security Plugins Properties for Configuring Authentication

Property Name (prefix with 'com.rti.serv.secure.') [1]	Property Value Description

authentication.crl_file	***Optional***
	 This Certificate Revocation List keeps track of untrusted X.509 certificates.
	 OpenSSL should generate this file using commands such as the following. For an example **opensslECdsa.cnf** file, refer to the example **cert** folder: **rti_workspace/version/examples/dds_security/cert**. Note: You will need to modify this file to match your certificate folder structure and Certificate Revocation List desired configuration:
	 `% touch indexECdsa.txt`
	 `% echo 01 > crlnumberECdsa`
	 `% openssl ca -config opensslECdsa.cnf -batch -revoke peerRevokedECdsa.pem`
	 `% openssl ca -config opensslECdsa.cnf -batch -gencrl -out democaECdsa.crl`
	 In this example:
	 crlnumberECdsa is the database of revoked certificates. This file should match the **crlnumber** value in **opensslECdsa.cnf**.
	 peerRevokedECdsa.pem is the **certificate_file** of a revoked *DomainParticipant*.
	 democaECdsa.crl should be the value of the **crl_file** property.
	 If **crl_file** is set to NULL, no CRL is checked, and all valid certificates will be considered trusted.
	 If **crl_file** is set to an invalid CRL file, the *DomainParticipant* creation will fail.
	 If **crl_file** is set to a valid CRL file, the CRL will be checked upon *DomainParticipant* creation and upon discovering other *DomainParticipants*. Creating a *DomainParticipant* with a revoked certificate will fail. If ParticipantA uses a certificate that does not appear in ParticipantA's CRL but does appear in ParticipantB's CRL, then ParticipantB will reject and ignore ParticipantA. Changes in the CRL will not be enforced until the *DomainParticipant* using the CRL is deleted and recreated.
	 Default: NULL

8.1 Identity Certificate Chaining

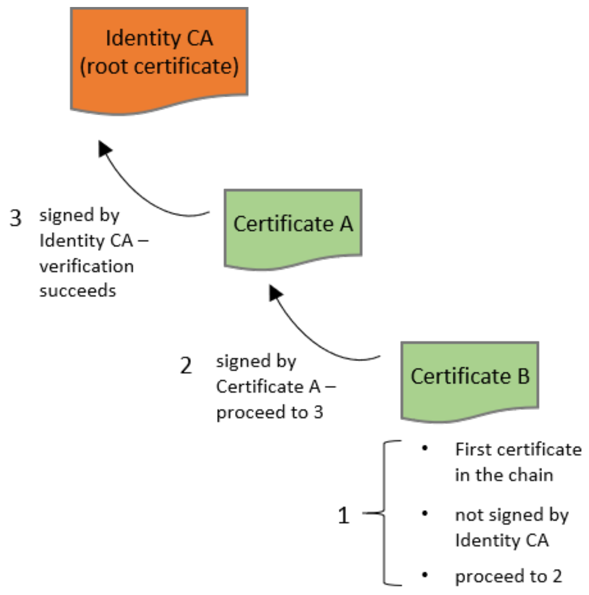
In the **dds.sec.auth.identity_certificate** property (see Table 8.2 DDS Security Properties for Configuring Authentication on page 22), you may put a chain of certificates in the Identity Certificate by concatenating individual certificates and specifying the concatenated result as a single file or string. The Identity Certificate will be verified against the Identity CA using the following procedure; see Figure 8.1: Identity Certificate Chaining on the next page:

- The current certificate is the first certificate in the Identity Certificate chain.
- Perform the following steps up to and including the case when the current certificate is the last certificate in the Identity Certificate chain:

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

- If the current certificate is signed by the Identity CA or any of the CAs in the list of **authentication.alternative_ca_files**, then the verification succeeds immediately.
- Otherwise:
    - If a next certificate exists in the chain and the current certificate is signed by that next certificate, then the next certificate becomes the current certificate.
    - Otherwise, verification fails immediately.

Figure 8.1: Identity Certificate Chaining


Identity CA
(root certificate)
3 signed by Identity CA – verification succeeds
Certificate A
2 signed by Certificate A – proceed to 3
Certificate B
1
First certificate in the chain
not signed by Identity CA
proceed to 2

8.2 Related Governance Attributes

This section describes the Authentication attributes that appear in the Governance Document.

8.2.1 domain_rule

The attribute **allow_unauthenticated_participants** belongs inside a <domain_rule>.

This attribute may be TRUE or FALSE. It controls whether or not a remote DomainParticipant that either doesn't support security or fails the authentication handshake is allowed to proceed in trying to communicate with the local DomainParticipant. Communication with such a DomainParticipant will happen only on the topics for which all of the topic rules are set to FALSE or NONE.

If **allow_unauthenticated_participants** is set to TRUE, **rtps_protection_kind** must be set to NONE.

8.3 Fragmentation Support for the Authentication Topic

Security Plugins supports fragmenting Authentication (ParticipantStatelessMessage) built-in topic samples. This is useful in scenarios with a hard limit on the transport maximum message size.

This feature is enabled by default: fragmentation of Authentication built-in topic samples will be triggered when sending samples that exceed the **message_size_max** configured in the transports used by *Connext DDS*.

8.4 Configuration Properties Common to All Authentication Plugins

Table 8.4 Properties for Configuring Authentication Common to Any Authentication Plugin below lists a set of properties that are not exclusive to the shipped *Security Plugins*, but that will affect any Authentication Plugin.

Table 8.4 Properties for Configuring Authentication Common to Any Authentication Plugin

Property Name (prefix with 'dds.participant.trust_ plugins.')	Property Value Description
authentication_timeout.sec	***Optional*** Controls the maximum time in seconds that an ongoing authentication can remain without completing. After this timeout expires, the authentication process is cancelled, and associated resources are released. Default: 60
authentication_request_delay.sec	***Optional*** Controls the delay in seconds before sending an authentication_request to the remote participant. For more information, please see 8.5 Re-Authentication below. Default: 5

8.5 Re-Authentication

The *Security Plugins* support securely re-authenticating remote Participants as described in the DDS Security specification. This is needed in scenarios where there is an asymmetric liveliness loss.

Asymmetric liveliness loss occurs between two Participants A and B when Participant A loses liveliness with B, and therefore cleans up all the associated state, while B still keeps the authenticated state. As B keeps an authenticated state from A, it will not accept new authentication messages from A. Without the ability to re-authenticate, asymmetric liveliness loss will lead to communication not recovering. The *Security Plugins* address this problem by including re-authentication capability as described in the DDS Security specification.

In *Security Plugins*, if Participant A has not completed an ongoing authentication with a Participant B after a specific period, it will send a "*dds.sec.auth_request*" message (or "*com.rti.sec.auth.request*" message if the remote Participant is 5.3.x or older) that includes a nonce[1] to Participant B. This message will give a hint to Participant B that Participant A is pending Authentication with Participant B. This specific period is configured by the property **dds.participant.trust_plugins.authentication_request_delay.sec**, see Table 8.4 Properties for Configuring Authentication Common to Any Authentication Plugin on the previous page.

When Participant B receives a "*dds.sec.auth_request*" (or "*com.rti.sec.auth.request*") message, it will check if it already has a valid completed authentication with Participant A. If that is the case, that could mean that an asymmetric liveliness loss has occurred. In order to verify that the authentication request is legitimate, the two Participants will now conduct a whole Authentication process that includes the nonce received as part of the triggering "*dds.sec.auth_request*" (or "*com.rti.sec.auth.request*"). Only if this secondary authentication succeeds, the old state will be removed in Participant B and replaced with the new one, allowing for discovery to complete again and communication to recover. If this secondary authentication fails, no change will be made in Participant B and the old authenticated session will be kept.

Because the old authenticated state is kept until the new authentication has successfully completed, the *Security Plugins* re-authentication is robust against attackers trying to bring down an existing authentication.

8.6 Protecting Participant Discovery

Participant discovery is sent through an unsecure channel. Consequently, additional mechanisms need to be put in place to make sure the received information comes from a legitimate participant. In *Security Plugins*, the mechanism for protecting the participant discovery information is known as TrustedState.

Security Plugins TrustedState is an RTI extension to the DDS Security Authentication specification that covers two limitations in the DDS Security specification:

- Vulnerability in the protocol: The lack of a standardized mechanism for validating that the Participant Discovery information received by DDS actually matches the one authenticated.
- Participant Discovery Data is immutable after authentication. This prevents functionality such as updating IP addresses.

Security Plugins TrustedState is a digest of the participant discovery data, plus information that unambiguously identifies the current local participant state, plus information that unambiguously identifies the current authentication session. TrustedState is exchanged as part of the authentication process as a vendor extension. Once the authentication completes, involved participants will validate received participant discovery information against the received TrustedState. This way, participants can be sure that the received participant discovery comes from the authenticated participant.

[1]Nonce: an arbitrary number used only once in a cryptographic communication, used to avoid replay attacks.

In order to securely propagate participant discovery changes after authenticating the remote participant, the *Security Plugins* use the participant's identity private key to sign the participant discovery data plus some additional information identifying the local participant state (and which is consistent with the one serialized in the TrustedState). This signature is then serialized as a property in the participant discovery data. This way, other participants can validate that the update is legitimate by verifying the received participant discovery against the participant's public key.

8.6.1 Supporting TrustedState in Custom Plugins

To secure participant discovery updates through the TrustedState mechanism in plugins other than the *Security Plugins*, the following APIs must be implemented by the custom plugin:

- **set_local_participant_trusted_state()**
- **verify_remote_participant_trusted_state()**
- **get_max_signature_size()**
- **private_sign()**
- **verify_private_signature()**

For more information, please see the **RTI_SecurityPlugins_BuildableSourceCode_Instructions** file included in the *Security Plugins* SDK.

Chapter 9 Access Control

Access Control consists of two components: governance and permissions checking. Governance is the process of configuring locally created *DomainParticipants, Topics, DataWriters,* and *DataReaders* to perform the right amount of security for the right use case. Permissions checking is the process of making sure locally created and remotely discovered entities are allowed to do what they want to do. Both governance and permissions checking are enforced by XML documents that are signed by a permissions certificate authority that may or may not be the same as the identity certificate authority that signs identity certificates. The XSD definitions of these documents are in **$(NDDSHOME)/resource/schema/dds_security_governance.xsd** and **dds_security_permissions.xsd**.

Examples of these documents are in **rti_workspace/version/examples/dds_security/xml/**, see **Governance.xml** and **PermissionsA.xml**. Use these files just as a reference, you will need to update their content/create new files to match your system configuration (domains, topics, and used identity certificates) before signing them. To specify that you want to use these XML files, add the properties in Table 9.1 DDS Security Properties for Configuring Access Control on the next page and Table 9.2 RTI Security Plugins Properties for Configuring Access Control on page 33 to the DDS_DomainParticipantQos property.

Table 9.1 DDS Security Properties for Configuring Access Control

Property Name	Property Value Description
dds.sec.access.permissions_ca	***Required*** This Permissions Certificate Authority is used for signing access control governance and permissions XML files and verifying the signatures of those files. The Permissions Certificate Authority file may or may not be the same as the Identity Certificate Authority file, but both files are generated in the same way. See the tables at the beginning of Chapter 8 Authentication on page 20 for the steps to generate this file. Two participants that want to securely communicate with each other must use the same Permissions Certificate Authority. The document should be in PEM format. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example: `"data:,-----BEGIN CERTIFICATE-----\nabcdef\n-----END CERTIFICATE-----"` Note that the two "\n" characters are required. Default: NULL
dds.sec.access.governance	***Required*** The signed document that specifies the level of security required per domain and per topic. To sign an XML document with a Permissions Certificate Authority, run the following OpenSSL command (enter this all on one line): openssl smime -sign -in Governance.xml -text -out signed_Governance.p7s -signer cacert.pem -inkey cakey.pem Then set this property value to **signed_Governance.p7s**. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example: `"data:,MIME-Version: 1.0\nContent-Type:...boundary=\"---7236\"\n\n"` Note that for signed XML files, all whitespace characters (' ', '\r', '\n') are significant, and all quotes must be escaped by a backslash. The safest way to get the correct property value is to call the fread() function on the file and use the resulting buffer as the property value. Default: NULL

Table 9.1 DDS Security Properties for Configuring Access Control

Property Name	Property Value Description
dds.sec.access.permissions	***Required*** The signed document that specifies the access control permissions per domain and per topic. The <subject_name> element identifies the *DomainParticipant* to which the permissions apply. Each subject name can only appear in a single <permissions> section within the XML Permissions document. The contents of the <subject_name> element should be the X.509 subject name for the *DomainParticipant*, as given in the "Subject" field of its Identity Certificate. A <permissions> section with a subject name that does not match the subject name given in the corresponding Identity Certificate will be ignored. To sign an XML document with a Permissions Certificate Authority, run the following OpenSSL command (enter this all on one line): openssl smime -sign -in PermissionsA.xml -text -out signed_PermissionsA.p7s -signer cacert.pem -inkey cakey.pem Then set this property value to **signed_PermissionsA.p7s**. The signed permissions document only supports validity dates between 1970010100 and 2038011903. Any dates before 1970010100 will result in an error, and any dates after 2038011903 will be treated as 2038011903. Currently, Connext DDS will not work if the system time is after January 19th, 2038. You may specify either the file name or the document contents. If specifying the file name, the property value must have the prefix "file:" (no space after the colon), followed by the fully-qualified path and name of the file. If specifying the contents of the document, the property value must have the prefix "data:," (no space after the comma), followed by the contents inside the document. For example: `"data:,MIME-Version: 1.0\nContent-Type:...boundary=\”---7236\”\n\n"` Note that for signed XML files, all whitespace characters (‘ ‘, ‘\r’, ‘\n’) are significant, and all quotes must be escaped by a backslash. The safest way to get the correct property value is to call the fread() function on the file and use the resulting buffer as the property value. Default: NULL

Table 9.2 RTI Security Plugins Properties for Configuring Access Control

Property Name (prefix with ‘com.rti.serv.secure.’)[1]	Property Value Description
access_control.alternative_permissions_authority_files	***Optional*** A comma-separated list of alternative Permissions CA certificates. If the verification of a file fails with the main certificate (permissions_ca/permissions_authority_file), verification will be retried with all of the corresponding alternative certificates. If none of the alternative certificates can be used to verify the file, the verification process will fail. Default: NULL

1 Assuming you used ‘com.rti.serv.secure’ as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 9.2 RTI Security Plugins Properties for Configuring Access Control

Property Name (prefix with 'com.rti.serv.secure.') [1]	Property Value Description
access_control.use_530_permissions_rules_precedence	***Optional*** How to deal with conflicting allow/deny rules in a Permissions Document. If TRUE, then the last rule will take precedence, which is consistent with Connext DDS 5.3.0 behavior. If FALSE, then the first rule will take precedence, which is consistent with the intended behavior of the DDS Security specification. Default: FALSE
access_control.use_530_logging_protection	***Optional*** How to set the value of <metadata_protection_kind> for the Builtin Logging Topic. If TRUE, then the value will be NONE, which is consistent with Connext 5.3.0 behavior. If FALSE, then the value will be SIGN, which is consistent with the behavior of the DDS Security specification. Default: FALSE
access_control.use_530_partitions	***Optional*** How to determine a match between a *DataWriter* or *DataReader's* partitions and an "allowed partitions" condition in a Permissions Document. If TRUE, then an entity is matched if it has at least one partition in the condition; this is consistent with Connext 5.3.0 behavior. If FALSE, then an entity is matched only if all of its partitions are in the condition; this is consistent with the behavior of the DDS Security specification. For example, if a *DataWriter* has partitions [A, B], and a Permissions Document allows partitions [B, C], then when use_530_partitions = TRUE, the *DataWriter* is allowed because B is allowed. When use_530_partitions = FALSE, the *DataWriter* is not allowed because A is not allowed. Default: FALSE

9.1 Related Governance Attributes

This section describes the Access Control attributes that appear in the Governance Document.

9.1.1 domain_rule

The following attributes belong inside a <domain_rule>:

- **enable_join_access_control** may be TRUE or FALSE. It controls whether or not remote DomainParticipant permissions are checked when a remote DomainParticipant is discovered. Local DomainParticipant permissions are always checked using the local DomainParticipant's Permissions Document. There is no way to configure whether or not local DomainParticipant permissions are checked when a DomainParticipant is created.
- **topic_access_rules** contains one or more **topic_rule** attributes.

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

9.1.2 topic_rule

The following attributes belong inside a <topic_rule>:

- **enable_read_access_control**
- **enable_write_access_control**

These attributes may be TRUE or FALSE. They control whether or not *DataReader* or *DataWriter* permissions are checked. If **enable_read_access_control** is TRUE for a given topic, the local permissions are enforced on locally created *DataReaders* of that topic, and the remote permissions are enforced on remotely discovered *DataReaders* of that topic. Similar logic applies to **enable_write_access_control** and *DataWriters*.

9.1.3 No Matching Rule

If no matching domain or topic rule is found, the Entity creation will fail.

9.2 Permissions Document

The Permissions Document is an XML document containing the permissions of the DomainParticipant and binding them to the subject name of the DomainParticipant as defined in the Identity Certificate. The Permissions CA must sign the Permissions Document. This document contains a set of <grant> sections, each of which contains a <subject_name> section, a <validity> section, zero or more <allow_rule> sections, and zero or more <deny_rule> sections. This document is exchanged during authentication handshaking, so to conserve bandwidth, it is best to have this document contain exactly one <grant> section, which contains the subject name and rules for the DomainParticipant that is sending the document.

The following sections describe the elements within the <publish> and <subscribe> sections, which are inside <allow_rule> and <deny_rule> sections.

9.2.1 Topics

The <topics> element defines the DDS Topic names that must be matched for the rule to apply. Topic names may be given explicitly or by means of Topic name expressions. Each topic name or topic-name expression appears separately in a <topic> sub-element within the <topics> element. The Topic name expression syntax and matching shall use the syntax and rules of the POSIX fnmatch() function as specified in POSIX 1003.2-1992, Section B.6.

Example (appearing within an <allow_rule> and within a publish or subscribe action):

```
<topics>
    <topic>Square</topic>
    <topic>B*</topic>
</topics>
```

The above topic condition would match Topic “Square” and any topic that starts with a “B”.

9.2.2 Partitions

The *RTI Connext DDS Core Libraries User's Manual* describes the PartitionQosPolicy as a sequence of strings that belong to a Publisher or Subscriber. The Security Plugins Access Control plugin uses these partitions to determine whether or not a DataWriter or DataReader is allowed to exist according to the Permissions Document. Inside the Permissions Document, the <partitions> element may appear within a <publish> or <subscribe> element. <partitions> may contain one or more <partition> elements, each containing a string. For example:

```
<subscribe>
    <topics>
        <topic>Square</topic>
    </topics>
    <partitions>
        <partition>aPartition1</partition>
        <partition>aPartition2</partition>
        <partition>bPartition*</partition>
    </partitions>
</subscribe>
```

Note the asterisk in the third partition. POSIX fnmatch() matching is allowed for the <partition> element.

9.2.2.1 Allowed

If the <partitions> are under an <allow_rule>, then the <partitions> delimit an allowed partitions condition section. In order for an action (e.g., a publish action) to meet the allowed partitions condition, the set of the partitions associated with the DDS Entity performing the action (e.g., a *DataWriter* for a publish action) must be contained in the set of partitions defined by the allowed partitions condition section. If there is no <partitions> section, then the default "empty string" partition is assumed. This means that the allow action (e.g., publish action) would only allow publishing on the "empty string" partition.

Example (appearing within a <allow_rule> and within a <publish> action):

```
<partitions>
    <partition>A</partition>
    <partition>B</partition>
</partitions>
```

The above allowed partitions condition would be matched if the partitions associated with the DDS Entity performing the action (e.g., *DataWriter* for publish action) are a subset of the set [A, B] . So it would be OK to publish in partition A, in B, or in [A, B] but not in [A, B, C] (assuming the value of the property access_control.use_530_partitions is FALSE) or in the "empty string" partition.

9.2.2.2 Denied

If the <partitions> are under a <deny_rule>, then the <partitions> delimit a denied partitions condition section. For this condition to be met, the DDS Entity associated with the action (e.g., *DataWriter* for a publish action) must have a partition that matches one of the partitions explicitly listed in the denied partitions condition section. If there is no <partitions> section, then the "*" partition expression is assumed. This means that the deny action (e.g., deny publish action) would apply regardless of the partitions associated with the DDS Endpoint (e.g., *DataWriter* for a publish action).

Example (appearing within a <deny_rule> and within a <publish> action):

```
<partitions>
    <partition>A</partition>
    <partition>B</partition>
</partitions>
```

The above denied partitions condition would be matched if the partitions associated with the DDS Entity performing the action (e.g., *DataWriter* for a publish action) intersect the set [A, B]. So, it would be OK to publish in partition C or in the "empty string" partition, but not in partition A, in [A,B], or in [A, B, C].

9.2.2.3 Partitions Mutability

Security Plugins does not allow a Publisher to change the PartitionQosPolicy after the Publisher has been enabled if the Publisher contains any *DataWriter* that meets the following two criteria:

- The TopicSecurityAttributes for that *DataWriter* have **is_read_protected** (which corresponds to **enable_read_access_control** in the Governance Document) set to TRUE.
- The *DataWriter* has the DurabilityQos policy **kind** set to something other than VOLATILE.

When these two criteria are met, a *DataWriter* should send historical data only to *DataReaders* that were passing the topic access control rules at the time the historical data was generated. The rule about PartitionQos immutability enforces this behavior by conservatively preventing a *DataWriter* of a protected topic from sending historical data to *DataReaders* that were not matched before a PartitionQos change and that potentially could have failed to pass the topic access control rules.

9.2.3 Data Tags

The *RTI Connext DDS Core Libraries User's Manual* describes the DataTagQosPolicy as a sequence of (name, value) string pairs that belong to a *DataWriter* or *DataReader*. The *Security Plugins* Access Control plugin uses these tags to determine whether or not a *DataWriter* or *DataReader* is allowed to exist according to the Permissions Document. Inside the Permissions Document, the <data_tags> element may appear within a <publish> or <subscribe> element. <data_tags> may contain one or more <tag> elements, each containing a <name> and a <value> element. For example:

```
<subscribe>
    <topics>
```

```
        <topic>Sq*</topic>
    </topics>
    <data_tags>
        <tag>
            <name>Department</name>
            <value>Engineering</value>
        </tag>
        <tag>
            <name>Seniority</name>
            <value>Senior</value>
        </tag>
        <tag>
            <name>Title</name>
            <value>*Software*</value>
        </tag>
    </data_tags>
</subscribe>
```

Note the asterisk in the third tag's value. POSIX fnmatch() matching is allowed for the <value> element, but not for the <name> element.

9.2.3.1 Allowed

If the <data_tags> are under an <allow_rule>, then the <data_tags> delimit an allowed data tags condition section. In order for an action (e.g., a publish action) to meet the allowed data tags condition, the set of the data tags associated with the DDS Entity performing the action (e.g., a *DataWriter* for a publish action) must be contained in the set of data tags defined by the allowed data tags condition section. If there is no <data_tags> section, then the default empty set is assumed. This means that the allow action (e.g., publish action) would only allow publishing if there are no data tags associated with the DDS Endpoint (*DataWriter* for a publish action).

Example (appearing within a <allow_rule> and within a <publish> action):

```
<data_tags>
    <tag>
        <name>aTagName1</name>
        <value>aTagValue1</value>
    </tag>
</data_tags>
```

The above allowed data tags condition would be matched if the data tags associated with the DDS Entity performing the action (e.g., *DataWriter* for publish action) are a subset of the set [(aTagName1, aTagValue)]. So it would be OK to publish using a *DataWriter* with no associated data tags, or a *DataWriter* with a single tag with name "aTagName1" and value "aTagValue1".

9.2.3.2 Denied

If the <data_tags> are under a <deny_rule>, then the <data_tags> delimit a denied data tags condition section. For this condition to be met, the DDS Entity associated with the action (e.g., *DataWriter* for a publish action) must have a data tag name and value pair that matches one of the data tags explicitly listed in the denied data tags condition section. If there is no <data_tags> section, then the "set of all possible tags" set is assumed as default. This means that the deny action (e.g., deny publish action) would apply regardless of the data tags associated with the DDS Endpoint (e.g., *DataWriter* for a publish action).

Example (appearing within a <deny_rule> and within a <publish> action):

```
<data_tags>
    <tag>
        <name>aTagName1</name>
        <value>aTagValue1</value>
    </tag>
</data_tags>
```

The above denied data tags condition would be matched if the data tags associated with the DDS Entity performing the action (e.g., *DataWriter* for a publish action) intersect the set [(aTagName1, aTagValue1)]. So it would not deny publishing using a *DataWriter* with no associated data-tags, or a *DataWriter* with a single tag with name "aTagName2", or a *DataWriter* with a single tag with name "aTagName1" and value "aTagValue2". But it would deny publishing using a *DataWriter* with two associated data tags [(aTagName1, aTagValue1), (aTagName2, aTagValue2)].

Chapter 10 Cryptography

Cryptography is the process of making sure no adversaries can manipulate or eavesdrop on communication. To prevent manipulation of data, set the governance attribute **rtps_protection_kind** to SIGN. To prevent eavesdropping of data, set the governance attribute **rtps_protection_kind** to ENCRYPT.

The following properties in the DDS_DomainParticipantQos **property** configure Cryptography:

Table 10.1 RTI Security Plugins Properties for Configuring Cryptography

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
cryptography. max_blocks_per_session	***Optional*** The number of message blocks that can be encrypted with the same key material. Whenever the number of blocks exceeds this value, new key material is computed. The block size depends on the encryption algorithm. You can specify this value in decimal, octal, or hex. This value is an unsigned 64-bit integer. Default: 0xffffffffffffffff
cryptography. encryption_algorithm	***Optional*** The algorithm used for encrypting and decrypting data and metadata. The options are **aes-128-gcm**, **aes-192-gcm**, and **aes-256-gcm** ("gcm" is Galois/Counter Mode (GCM) authenticated encryption). The number indicates the number of bits in the key. Participants are not required to set this property to the same value in order to communicate with each other. In the Domain Governance document, a "protection kind" set to ENCRYPT will use GCM, and a "protection kind" set to SIGN will use the GMAC variant of this algorithm. Default: **aes-128-gcm**

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 10.1 RTI Security Plugins Properties for Configuring Cryptography

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
cryptography. max_receiver_specific_ macs	***Optional*** The maximum number of receiver-specific Message Authentication Codes (MACs) that are appended to an encoded result. For example, if this value is 32, and the Participant is configured to protect both RTPS messages and submessages with origin authentication, there could be 32 receiver-specific MACs in the result of **encode_datawriter_submessage**, and there could be another 32 receiver-specific MACs in the result of **encode_rtps_message.** If there are more than 32 receivers, the receivers will be assigned one of the 32 possible MACs in a round-robin fashion. Note that in the case of **encode_datawriter_submessage,** all the readers belonging to the same participant will always be assigned the same receiver-specific MAC. Setting this value to 0 will completely disable receiver-specific MACs. Default: 0. Range: [0, 3275], excluding 1
cryptography.share_key_ for_metadata_and_data_ protection	***Optional*** Indicator of whether the metadata and data encoding operations share the same key material or use different keys. By default, *DataWriters* with both **metadata_protection_kind** and **data_protection_kind** set to a value other than NONE use the same key material for encoding both submessages and serialized data. To change this behavior, set this property to FALSE. Default: TRUE (they share key material)

10.1 Related Governance Attributes

This section describes the Cryptography attributes that appear in the Governance Document.

10.1.1 ProtectionKind

Attributes whose names end with **_protection_kind** share a type called ProtectionKind. The DDS Security specification lists five possible values of ProtectionKind, all of which are supported by *Security Plugins*.

- **NONE** indicates that no cryptographic transformation is applied.
- **SIGN** indicates that the cryptographic transformation is purely a Galois message authentication code (GMAC). No encryption is performed. The GMAC is placed after the content. If the receiver finds a missing or incorrect GMAC, the receiver will reject the content.

[1]Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

- **ENCRYPT** indicates that the cryptographic transformation is an AES encryption followed by a GMAC computed on the ciphertext, also known as Galois/Counter Mode (GCM). The GMAC is placed after the content. If the receiver finds a missing or incorrect GMAC, the receiver will reject the content.
- **WITH_ORIGIN_AUTHENTICATION protection kinds**. There are two protection kinds that have WITH_ORIGIN_AUTHENTICATION in their names. WITH_ORIGIN_AUTHENTICATION indicates that in addition to using the sender's key to generate a common GMAC, the sender generates receiver-specific GMACs using keys that are specific to individual sender-receiver pairs. The additional GMACs are placed after the common GMAC. They prove to the receiver that the sender originated the message, preventing other receivers from impersonating the sender. If the receiver finds a missing or incorrect common GMAC, the receiver will reject the content. If the receiver finds a missing or incorrect receiver-specific GMAC that was computed using its own receiver-specific key, the receiver will reject the content. WITH_ORIGIN_AUTHENTICATION protection kinds are allowed only if the value of the property **cryptography.max_receiver_specific_macs** is greater than 1.

  The WITH_ORIGIN_AUTHENTICATION protection kinds are as follows:
  - **SIGN_WITH_ORIGIN_AUTHENTICATION** indicates that a common GMAC is performed on the content, and receiver-specific GMACs are performed on the common GMAC.
  - **ENCRYPT_WITH_ORIGIN_AUTHENTICATION** indicates that a GCM is performed on the content, and receiver-specific GMACs are performed on the GMAC of the GCM.

10.1.2 domain_rule

The following attributes belong inside a <domain_rule>.

- **rtps_protection_kind**. This ProtectionKind specifies how to protect a DomainParticipant's outgoing messages and what kind of protection is required of incoming messages. A message consists of an RTPS header and submessages, so a message is an envelope around submessages. If **allow_unauthenticated_participants** is set to TRUE, **rtps_protection_kind** must be set to NONE. Setting **rtps_protection_kind** to NONE will cause the *DomainParticipant* to accept both protected and unprotected incoming RTPS messages. Setting **rtps_protection_kind** to something other than NONE will cause the *DomainParticipant* to reject incoming RTPS messages that have a missing or incorrect GMAC or GCM.
- **discovery_protection_kind**. This ProtectionKind specifies the **metadata_protection_kind** used for the secure builtin *DataWriter* and *DataReader* entities used for discovery, Topic Queries, and Locator Reachability Responses.
- **liveliness_protection_kind**. This ProtectionKind specifies the **metadata_protection_kind** used for the secure builtin *DataWriter* and *DataReader* entities used for liveliness.

10.1.3 topic_rule

The following attributes belong inside a <topic_rule>.

- **metadata_protection_kind**. This ProtectionKind specifies how to protect a *DataWriter*'s or *DataReader*'s outgoing submessages. These submessages include, but are not limited to, DATA, HEARTBEAT, ACKNACK, and GAP. A DATA submessage is an envelope around a serialized payload, so **metadata_protection_kind** affects data as well as metadata. One difference between **metadata_protection_kind** and **data_protection_kind** is that for **metadata_protection_kind**, the submessage protection takes effect immediately before sending out the content, so a protected submessage is re-protected when it is resent.
- **data_protection_kind**. This attribute may be NONE, SIGN, or ENCRYPT. It specifies how to protect a *DataWriter*'s serialized payload. The writer history stores the protected payload, so the protected payload is not re-protected when it is resent. Receiver-specific GMACs are never included in this protection, so the WITH_ORIGIN_AUTHENTICATION values are not allowed here.
- **enable_discovery_protection**. This attribute may be TRUE or FALSE. It specifies whether to use the secure or non-secure builtin endpoints for certain outgoing traffic related to this topic. Such traffic includes endpoint discovery messages and TopicQuery messages. **enable_discovery_protection** also specifies whether or not to reject non-secure incoming endpoint discovery messages related to this topic.
- **enable_liveliness_protection**. This attribute may be TRUE or FALSE. The value of this attribute matters only if the DataWriter LivelinessQosPolicy is AUTOMATIC_LIVELINESS_QOS or MANUAL_BY_PARTICIPANT_LIVELINESS_QOS. In either of these cases, **enable_liveliness_protection** specifies whether or not to use the secure builtin endpoints for exchanging liveliness messages for *DataWriters* of this topic.

10.2 Configuration Properties Common to All Cryptography Plugins

Table 10.2 Properties for Configuring Cryptography Common to Any Cryptography Plugin below lists a set of properties that are not exclusive to the shipped Security Plugins, but that will affect any Cryptography Plugin.

Table 10.2 Properties for Configuring Cryptography Common to Any Cryptography Plugin

Property Name	Property Value Description
dds.data_writer.history.use_530_encoding_alignment	***Optional*** Determines whether or not to align a serialized payload to a 4-byte boundary before encoding it. If TRUE, then this alignment does not occur; this is consistent with Connext 5.3.0 behavior. If FALSE, then this alignment does occur; this is the only way to make the builtin Cryptography plugin work with **data_protection_kind** = SIGN. This property applies to the DataWriterQos. Default: FALSE

10.3 Reliability Behavior When MAC Verification Fails

When setting **data_protection_kind**, **metadata_protection_kind**, or **rtps_protection_kind** to a value other than NONE, the *DataReader* may reject a sample due to MAC verification (for example, if the sample is tampered or replayed). When this happens, the *DataReader* does not deliver the sample to the application, and the sample is lost. If the ReliabilityQosPolicy is configured with DDS_RELIABLE_RELIABILITY_QOS, however, the *DataWriter* can still repair the lost sample.

Note that depending on the level of protection, a tampered/replayed sample may be rejected at different levels:

- If **metadata_protection_kind** or **rtps_protection_kind** is a value other than NONE, the sample will be rejected before reaching the *DataReader* queue.
- If metadata and rtps protection checks passed, and **data_protection_kind** is set to a value other than NONE, the sample will be rejected by the *DataReader* queue.

10.4 Enabling Asynchronous Publishing for the Key Exchange Topic

Security Plugins supports fragmenting Key Exchange (ParticipantSecureVolatileMessageSecure) built-in topic samples. This is useful in scenarios with a hard limit on the transport maximum message size. Key Exchange is a reliable topic; therefore, enabling fragmentation requires changing the publish mode to asynchronous publishing. For more information about how to configure the Key Exchange topic publish mode, see Table 10.3 DDS_DiscoveryConfigQosPolicy fields Affecting Key Exchange Topic below.

Table 10.3 DDS_DiscoveryConfigQosPolicy fields Affecting Key Exchange Topic

Type	Field Name	Description
PUBLISH_MODE QosPolicy (DDSExtension) (Section 6.5.18 of *RTI Connext DDS Core Libraries User's Manual*)	secure_volatile_writer_publish_mode	Determines whether the Key Exchange built-in subscription *DataWriter* publishes data synchronously or asynchronously, and how.

Chapter 11 Logging

Logging is the process of notifying the user of security events. This release supports using NDDS_Config_Logger, printing log messages to a file, distributing log messages over DDS, and adjusting the verbosity level of the log messages. By default, log messages are processed by NDDS_Config_Logger, and the verbosity level of the log messages is ERROR_LEVEL (3).

The following properties in the DDS_DomainParticipantQos **property** configure Logging:

Table 11.1 RTI Security Plugins Properties for Configuring Logging

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
logging.log_file	***Optional*** The file that log messages are printed to. Default: NULL

[1]Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 11.1 RTI Security Plugins Properties for Configuring Logging

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
logging.log_level	***Optional*** The logging verbosity level. All log messages at and below the **log_level** setting will be logged. Possible values: 0: emergency 1: alert 2: critical 3 (default): error 4: warning 5: notice 6: informational 7: debug Default: 3 (error)
logging.distribute.enable	***Optional*** Controls whether security-related log messages should be distributed over a DDS *DataWriter*. If enable is true, then the Logging Plugin will create a *Publisher* and *DataWriter* within the same *DomainParticipant* that is setting this property. There is no option to use a separate *DomainParticipant* or to share a *DataWriter* among multiple *DomainParticipants*. To subscribe to the log messages, run rtiddsgen on **resource/idl/builtin_logging_type.idl.** Create a *DataReader* of type DDSSecurity::BuiltinLoggingType and topic DDS:Security:LogTopic. The *DataReader* must be allowed to subscribe to this topic according to its *DomainParticipant's* permissions file. Boolean. Default: FALSE
logging.distribute.profile	***Optional*** QoS Library and QoS profile used to create logging-related entities (*Publisher*, *Topic* and *DataWriter*). Must be a string of the format **QosLibraryName::QosProfileName**. String. Default: empty string (uses default QoS profile)
logging.distribute.writer_history_depth	***Optional*** History depth (in samples) of the logging *DataWriter*. Integer. Default: 64

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 11.1 RTI Security Plugins Properties for Configuring Logging

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
logging.distribute.writer_timeout	***Optional*** Number of milliseconds to wait before giving up trying to write a log message. This property overwrites the **max_blocking_time** QoS of the logging *DataWriter*. Integer. Default: 5000
logging.distribute.queue.size	***Optional*** Size of the logging thread queue, in bytes. Integer. Default: 50688
logging.distribute.queue.message_count_max	***Optional*** Maximum number of log messages in the logging queue. Integer. Default: 64
logging.distribute.queue.message_size_max	***Optional*** Maximum serialized size of a log message in the logging queue. Integer. Default: 792
logging.distribute.thread.message_threshold	***Optional*** Number of bytes to preallocate for the logging message string in the logging thread, beyond which dynamic allocation will occur. Integer. Default: 256
logging.distribute.thread.plugin_method_threshold	***Optional*** Number of bytes to preallocate for the plugin method string in the logging thread, beyond which dynamic allocation will occur. Integer. Default: 256
logging.distribute.thread.message_threshold	***Optional*** Number of bytes to preallocate for the plugin class string in the logging thread, beyond which dynamic allocation will occur. Integer. Default: 256

[1]Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 11.2 Log Messages lists security-related events and the log messages they generate.

Table 11.2 Log Messages

Event	Log Level	Message
Failed to allocate memory	EMERGENCY	insufficient memory
allow_unauthenticated_participants = FALSE, and discovered remote participant that is unauthenticable, i.e. has not enabled security	ERROR	unauthenticated remote participant [participant ID] denied
allow_unauthenticated_participants = TRUE, and discovered remote participant that is either unauthenticable or fails authentication	WARNING	allowing unauthenticated participant [participant ID]
Received invalid X509 certificate, from either remote or local participant	ERROR	failed to decode certificate
Couldn't verify certificate's signature against neither the certificate of the Identity Certificate Authority nor any alternative CAs	ERROR	failed to verify certificate
Certificate appears in Certificate Revocation List	ERROR	certificate revoked
Upon receiving HandshakeReplyMessageToken or HandshakeFinalMessageToken, couldn't verify challenge's signature against peer's certificate. Peer likely has mismatched private and public keys, so it’s an imposter.	ERROR	failed to verify challenge signature
Couldn't verify permissions or governance file signature against neither the certificate of the Permissions Authority nor any alternative permissions authorities	ERROR	!PKCS7_verify: document signature verification failed. Make sure document was signed by the right permissions authority.
Received signed permissions document that is not an XML document	ALERT	received invalid signed permissions document
Received signed governance document that is not an XML document	ERROR	received invalid signed governance document
Couldn't parse the permissions file for some reason, such as duplicate grants for the same subject name or no grant for the intended subject name	ALERT	failed to parse permissions file
Couldn't parse the governance file for some reason	ALERT	failed to parse governance file
Denied participant because there is a deny rule explicitly prohibiting the participant	ERROR	participant not allowed: deny rule found
Denied participant because there is no rule for the participant, and the default is to deny	ERROR	participant not allowed: no rule found; default DENY
Denied writer or reader because there is a deny rule explicitly prohibiting the writer or reader	ERROR	endpoint not allowed: deny rule found
Denied writer or reader because there is no rule for the writer or reader, and the default is to deny	ERROR	endpoint not allowed: no rule found; default DENY

Table 11.2 Log Messages

Event	Log Level	Message
Parsed publish/subscribe rule in permissions file that does not apply to the writer/reader because no topic expressions match the writer-/reader's topic	DEBUG	This publish/subscribe rule doesn't apply because none of the rule's topic expressions match the endpoint's topic name of [topic name]
Parsed publish/subscribe rule in permissions file that does not apply to the writer/reader because even though there's a matching topic expression, there are no matching partition expressions	DEBUG	This publish/subscribe rule doesn't apply because none of the rule's partition expressions match with any of the en-dpoint's partitions
Received authenticated content that has been tampered with, i.e. EVP_DecryptFinal_ex failed because the GCM or GMAC tag veri-fication failed	ALERT	DecryptFinal failed. Possible GCM authentication failure.
Received submessage encrypted with a key whose MasterKeyId hasn't yet been exchanged via CryptoToken	DEBUG	received submessage from an endpoint that discovered me but that I haven't discovered yet; dropping submessage hop-ing it will be repaired. It will not be repaired if the endpoint did not properly share its MasterKeyId in its CryptoToken
Writing a log message over the LogTopic fails due to insufficient log-ging queue size	LOCAL[1]	Failed to write log message of size = [message size] because the logging queue is full. Try to increase log-ging.distribute.queue. message_count_max, which is currently [message_count_ max].
Parsed publish/subscribe <allow_rule> in permissions file that does not apply to the writer/reader because even though there's a match-ing topicexpression, the partition expressions in the QoS are not a subset of the ones in the <allow_rule>	DEBUG	This publish/subscribe rule doesn't apply because en-dpoint's partitions are not a subset of the rule's partition ex-pressions

[1]This log message can be viewed by configuring the verbosity of the NDDS_Config_Logger.

Chapter 12 Support for OpenSSL Engines

RTI Security Plugins support the option of using an OpenSSL engine. The following property in the DDS_DomainParticipantQos **property** configures the usage of OpenSSL engines:

Table 12.1 Properties for Configuring OpenSSL Engines

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
openssl_engine	***Optional*** The dynamic library that implements an OpenSSL engine. If this property value is not set, then the RTI Security Plugins will use native OpenSSL code with its default engine. Otherwise, you must set this value to the filename, excluding the "lib" prefix and the file extension, of the dynamic library that implements the engine, and you must set your $LD_LIBRARY_PATH or %path% environment variable to include the dynamic library and any of its dependent libraries. Failure to load the engine, due to an incorrect $LD_LIBRARY_PATH or otherwise, will result in failure to create the *DomainParticipant*. The engine will perform all security operations, including encryption, HMAC, and Diffie-Hellman. The value of this property for the first *DomainParticipant* of the application will be the value for all other *DomainParticipants* in the application. Setting this property to a different value for subsequent *DomainParticipants* will not be effective. Default: not set

One example of an OpenSSL engine is Certicom Corp.'s *Security Builder Engine for OpenSSL*, which supports the architecture armv7aQNX6.6.0qcc_cpp4.7.3. Usage of Certicom requires their dynamically-loaded libraries (which RTI does not provide) and your LD_LIBRARY_PATH environment variable must include:

[1] Assuming you used 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

```
$RTI_OPENSSLHOME/release/lib/:$CERTICOM_SBENGINEHOME/tools/sb/sb-$(CERTICOMOS)/lib/:$CERTICOM_
SBENGINEHOME/lib/$(CERTICOMOS)
```

where RTI_OPENSSLHOME is the ***installation directory*****/armv7aQNX6.6.0qcc_cpp4.7.3** of the OpenSSL distributed by RTI, CERTICOM_SBENGINEHOME is the installation directory of Certicom *Security Builder Engine*, and CERTICOMOS is Certicom's architecture corresponding to RTI's arm-v7aQNX6.6.0qcc_cpp4.7.3, e.g. qnx6.5_armv7. The authentication.shared_secret_algorithm ecdsa-ecdh does not work with static OpenSSL libraries when enabling Certicom *Security Builder Engine.*

Chapter 13 Support for RTI Persistence Service

RTI's security solution may be used in conjunction with *RTI Persistence Service*. To store persisted data encrypted, *Persistence Service* must use a configuration whose **participant_qos** includes security properties for 1) dynamically loading the security libraries and 2) using a Governance document that sets **data_protection_kind** to ENCRYPT for the desired topics (or * for all topics). The %PATH% or $LD_LIBRARY_PATH environment variable must include RTI and OpenSSL DLLs or libraries.

If *Persistence Service* stores encrypted data, it also stores the PRSTDataWriter's encryption key along with the rest of the writer's metadata. If *Persistence Service* shuts down and restarts with the same configuration, the new PRSTDataWriter will discard its normally random key and use the old PRSTDataWriter's key, which it securely exchanges with user *DataReaders* to allow them to correctly decrypt the data. Key rotation works seamlessly in this scenario because the stored encrypted data includes not only the payload but also the metadata necessary to decrypt it, including the **session_id** used to derive the session key from the master key. When the encryption key is stored, it is stored encrypted. The key of this encryption is the output of a derivation function whose input is an optional user-specified property, and the Cryptography Plugin implementation determines both the key derivation function and the encryption algorithm.

In RTI's default plugin implementation, the key derivation function involves PBKDF2 (Password-Based Key Derivation Function) with SHA-512 (Secure Hash Algorithm with a 512-bit hash value) and a random salt, and the encryption algorithm involves AES-256-GCM. The key derivation function derives both the key and the IV (Initialization Vector) used in the encryption. *Persistence Service* stores the random salt along with the PRSTDataWriter's encrypted key.

Attempting to use an insecure *Persistence Service* to restore encrypted data or a secure *Persistence Service* to restore plain-text data will result in a graceful failure to create Persistence Service.

The following properties in the *Persistence Service* **participant_qos** or **persistence_ group.datawriter_qos** property configure the *Persistence Service's* use of security:

Table 13.1 Properties for Configuring Secure Persistence Service

Property Name	Property Value Description
dds.data_writer-.history.key_material_key	***Optional*** The basis of the key material used to encrypt the PRSTDataWriter's key material. This property may be specified in either the DomainParticipantQos or the DataWriterQos. Attempting to restore encrypted data using the wrong **key_material_key** will result in an informative log message and failure to create Persistence Service. **Note:** using the default key is discouraged, and you should set **key_material_key** to a value other than the default. Default: undisclosed non-NULL

Chapter 14 RTPS-HMAC-Only Mode

The *Security Plugins* library includes an alternative set of "RTPS-HMAC-Only" plugins. These plugins allow RTPS messages to be signed with a user-provided HMAC key while disabling all other security features (authentication, access control and encryption). To set up the behavior of the RTPS-HMAC-Only mode, refer to Table 14.1 Properties for Configuring HMAC-Only Mode below.

Table 14.1 Properties for Configuring HMAC-Only Mode

Property Name (prefix with 'com.rti.serv.secure.') [1]	Property Value Description
hmac_only.enabled	***Optional*** Enables or disables the HMAC-only mode. Default: FALSE
hmac_only.cryp-tography.key	***Required*** Sets the static HMAC key used to compute message signatures. The HMAC key can be either a plain text string or an arbitrary binary string. Empty keys (either string or binary) are not allowed. The maximum HMAC key size is bounded by the maximum property size, controlled by the *Do-mainParticipant* resource limit **participant_property_string_max_length**. Plain text HMAC keys are case sensitive, and must start with the prefix **str:** (e.g.: str:Some secret key string) Binary HMAC keys must be provided as a sequence of upper- or lower-case hexadecimal digits prefixed by **hex:** (e.g.: hex:1489a95de3873df5). Default: not set

[1] Assuming you use 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Table 14.1 Properties for Configuring HMAC-Only Mode

Property Name (prefix with 'com.rti.serv.secure.')[1]	Property Value Description
hmac_only.cryptography.max_blocks_per_session	***Optional*** For signing RTPS messages, HMAC-only mode uses a key derived from the HMAC key and a sessionId that is serialized as part of the signed RTPS message representation. This property sets the number of message blocks that can be signed with the same sessionId. The current message block size is fixed at 32 bytes. Default: 0xffffffffffffffff)

[1]Assuming you use 'com.rti.serv.secure' as the alias to load the plugin. If not, change the prefix to match the string used with com.rti.serv.load_plugins. This prefix must begin with 'com.rti.serv.'

Chapter 15 What's Different from the OMG Security Specification

This section describes differences between *Security Plugins* 6.0.0 and the OMG DDS Security specification (Version 1.1).

15.1 Differences Affecting Builtin Plugins to be Addressed by Next DDS Security Specification

15.1.1 Acess Control

15.1.1.1 Mutability of Publisher PartitionQosPolicy

Section 7.3.5 in the specification defines the kind of *DataWriters* that a Publisher must contain in order for its PartitionQosPolicy to be immutable. These *DataWriters* meet the following two criteria:

1. The *DataWriter* either encrypts the SerializedPayload submessage element or encrypts the Data or DataFrag submessage elements.
2. The *DataWriter* has the DurabilityQosPolicy kind set to something other than VOLATILE.

The next version of the specification will change the first criterion to be the following:

1. The TopicSecurityAttributes for that *DataWriter* have **is_read_protected** set to TRUE.

The second criterion still applies. *Security Plugins* uses this new criteria to determine PartitionQosPolicy immutability. (**is_read_protected** corresponds to <enable_read_access_control> in the Governance Document.)

15.2 Differences Affecting Builtin Plugins

15.2.1 General

15.2.1.1 Support for Infrastructure Services

Section 7.1.1.4 in the specification describes the mechanism for preventing unauthorized access to data by infrastructure services. To support this capability, certain functions have an output parameter called **relay_only**. While *Security Plugins* functions include this additional parameter, *Security Plugins* does not implement this mechanism, and the parameter is currently not used or populated.

15.3 Differences Affecting Custom Plugins

15.3.1 Authentication

15.3.1.1 Revocation

Section 8.3.2.12 in the specification describes the mechanism for revoking identities. *Security Plugins* do not implement this mechanism. This release supports looking up a certificate revocation list upon *DomainParticipant* creation and discovery.

15.3.2 Access Control

15.3.2.1 check_local_datawriter_register_instance

Section 8.4.2.6.7 in the specification describes the **check_local_datawriter_register_instance()** operation. *Security Plugins* do not implement this operation.

15.3.2.2 check_local_datawriter_dispose_instance

Section 8.4.2.6.8 in the specification describes the **check_local_datawriter_dispose_instance()** operation. *Security Plugins* do not implement this operation.

15.3.2.3 check_remote_datawriter_register_instance

Section 8.4.2.6.15 in the specification describes the **check_remote_datawriter_register_instance()** operation. *Security Plugins* do not implement this operation.

15.3.2.4 check_remote_datawriter_dispose_instance

Section 8.4.2.6.16 in the specification describes the **check_remote_datawriter_dispose_instance()** operation. *Security Plugins* do not implement this mechanism.

15.3.2.5 check_local_datawriter_match / check_local_datareader_match

When calling **check_local_datawriter_match** / **check_local_datareader_match**, the subscription_data and publication_data parameters are not set.

15.3.2.6 Revocation

Section 8.4.2.10 in the specification describes the mechanism for revoking permissions. *Security Plugins* do not implement this mechanism.

15.3.2.7 PermissionsToken

Table 10 in the specification mentions PermissionsToken as a new parameter in ParticipantBuiltinTopicData. *Security Plugins* sends this parameter, but when receiving this parameter, it is not used in any Access Control functionality. The built-in Access Control plugin does not use PermissionsToken, so this issue only affects certain custom Access Control plugins.

15.3.2.8 check_remote_topic

Section 8.4.2.9.12 in the specification describes the **check_remote_topic()** operation, which receives a TopicBuiltinTopicData as an input. Instead of invoking this operation when the remote DomainParticipant creates a certain Topic, *Connext DDS* invokes this operation when discovering the first *DataWriter* or *DataReader* belonging to that Topic-DomainParticipant combination.

This distinction matters if the implementation of **check_remote_topic()** considers any of the QosPolicies within the TopicBuiltinTopicData structure. (The builtin plugins do not consider these QosPolicies.) For example, if Participant B creates two *DataReaders* of the same topic, Participant A will call **check_remote_topic()** only when it discovers the first *DataReader*. If the second *DataReader*'s DeadLineQosPolicy matches that of Participant B's TopicQos and the first *DataReader*'s DeadlineQosPolicy does not match, then **check_remote_topic()** will receive the wrong DeadlineQosPolicy as part of the input TopicBuiltinTopicData. This problem would occur only if **check_remote_topic()** considers the DeadlineQosPolicy when deciding whether to return TRUE or FALSE.

Appendix A Quick Reference: Governance File Settings

The following tables show common security objectives and the Governance file settings necessary to achieve them. The highlighted cells indicate settings that increase security.

Table A.1 Domains

Security Objective	Governance Parameter				
	allow_ unauthenticated_ join	enable_ join_ access_ control	discovery_ protection_ kind	liveliness_ protection_ kind	rtps_ protection_ kind
Baseline	T	F	N	N	N
Enable authentication & access control	F	T	N	N	N
Encrypt-then-MAC discovery data	T	F	E	N	N
MAC liveliness messages (protect builtin topic)	T	F	N	S	N
MAC entire RTPS packet (including header)	T	F	N	N	S
MAC entire RTPS packet (including header), protecting against tampering and replay by an authorized subscriber	T	F	N	N	SOA
MAC entire RTPS packet (including header) and encrypt-then-MAC data	T	F	N	N	S
MAC entire RTPS packet (including header) and encrypt-then-MAC data and metadata	T	F	N	N	S
All possible participant-level protections	F	T	N	N	EOA

Table A.2 Topics

Security Objective	Governance Parameter					
	enable_ discovery_ protection	enable_ liveliness_ protection	enable_read_ access_ control	enable_write_ access_control	metadata_ protection_ kind	data_ protection_ kind
Baseline	F	F	F	F	N	N
Enable authentication & access control	F	F	T	T	N	N
Encrypt-then-MAC discovery data	T	F	F	F	N	N
MAC liveliness messages (protect builtin topic)	F	T	F	F	N	N
MAC entire RTPS packet (including header)	F	F	F	F	N	N
MAC entire RTPS packet (including header), protecting against tampering and replay by an authorized subscriber	F	F	F	F	N	N
MAC entire RTPS packet (including header) and encrypt-then-MAC data	F	F	F	F	N	E
MAC entire RTPS packet (including header) and encrypt-then-MAC data and metadata	F	F	F	F	E	N
All possible participant-level protections	F	F	T	T	N	N

Legend:

T = TRUE	E = ENCRYPT	SOA = SIGN_WITH_ORIGIN_AUTHENTICATION
F = FALSE	EOA = ENCRYPT_WITH_ ORIGIN_ AUTHENTICATION	
N = NONE	S = SIGN	